Egypt. J. Plant Breed. 24(2):389– 412(2020)

TOLERANCE RESPONSE OF MUSKMELON RECOMBINANT INBRED LINES AGAINST SALINITY

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ABSTRACT

Muskmelon is the most important vegetable crop of arid and semi-arid regions and salinity is the most prevailing abiotic stress in such areas. Therefore, the present study was conducted to determine salt tolerance of twenty muskmelon recombinant inbred lines (RILs) based on determining of seeds germination rate and percentage in laboratory experiment and measuring of some morphological and horticultural attributes for them in pots experiment under netted house at Horticultural Research Institute-Agricultural Research Centre, Egypt during 2016 and 2017 early summer seasons. These RILs were exposed to four different levels of sodium chloride (NaCl) viz., 0 mM, 50 mM, 75 mM and 100 mM after 15 days from seed sowing. The findings confirmed that the salinity tolerance of any genotype was increased as the reduction or increment rate for this genotype compared to control reduced and vice versa. So, the muskmelon RILs 305 and 307 showed salinity tolerance till 50 mM NaCl and RIL 309 had salinity tolerance till 75 mM NaCl, but none of RILs had salinity tolerance at 100 mM NaCl in all measured traits. Based on these two salinity experiments, these three muskmelon RILs were selected as salt tolerant and were made all the combinations of crosses among them in one direction to produce three F_1 hybrids that were grown under greenhouse at Kaha Vegetable Research Farm (KVRF), Kalubia during 2017 late summer season. These three F_1s beside their parents and hybrid Gal 23 (used as control) were sown in the two open fields using drip irrigation system at Sadat city, Menofia Governorate, one of them was irrigated with groundwater 955 ppm salinity (used as control) and the other field was irrigated with groundwater 2760 ppm salinity (used as a field dose for salinity tolerance evaluation) during 2018 early summer season. The results of these hybrids evaluation under salinity stress compared to control field showed that the hybrid RIL 309 × RIL 307 had high level of salinity tolerance, hybrid RIL 309 × RIL 305 had moderate level of salinity tolerance and hybrid RIL 307 × RIL 305 had low level of salinity tolerance. Finally, all measured traits didn't differ under salinity stress compared to control field in the hybrid RIL 309 × RIL 307. This indicated that the hybrid RIL 309 × RIL 307 could be used under salinity stress condition.

Key words: ***Muskmelon, Cucumis melo L., Salt tolerance, Salinity, Hybrids, Sodium chloride, Recombinant inbred lines.***

INTRODUCTION

Muskmelon (*Cucumis melo* L.) is an important potential crop of arid and semiarid areas, which is threatened with medium to high salinity (Botia *et al* 2005).Although muskmelon is recognized to be semi tolerant to salinity (Franco *et al* 1997), but how much it can withstand against salinity depends on the genetic diversity, environment and genotype (Gurmani *et al* 2014). So, salinity is a major abiotic stress reducing the yield of a wide variety of crops all over the world (Tester and Davenport2003, Ashraf and Foolad 2007 and Edelstein *et al* 2011).

Melon salinity tolerance has been studied by several researchers (Shannon and Francois 1978, Meiri *et al* 1981, Mangal *et al* 1988, Mendlinger and Pasternak 1992a and b and Shani and Dudley 2001).The results showed that melons can moderately tolerate water salinity, and that soluble solid content rose as water salinity increased. However, fruit size and yield were reduced by saline water (Shannon and Francois 1978). Also, a common adverse effect of salt stress on crop plants is the reduction in fresh and dry biomass production (Dasgan *et al* 2002, Grzesıak *et al* 2006, Dasgan and Koc 2009 and Kusvuran 2010). Moreover, the salinity stress caused reduction of fruit weight, netting quality and time to harvest, but increasing of total soluble solids content and didn't affect the number of fruits in melon (Mendlinger and Pasternak 1992 a and b). Similarly, a number of plant species showed decline in growth and production under saline conditions due to decrease in photosynthesis by the action of stomatal and non-stomatal restrictions (Stepien and Klobus 2006 and Dadkhah 2011). Likewise, increasing levels of salt stress substantially declined the shoot and root biomass, plant height, root length and leaf area in all the tested muskmelon genotypes, however, genotypes differed in their response (Ibrarullah *et al* 2019).

In general, melon is known to be moderately resistant to salinity. 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). So, Physiological changes in plants growing under salt stress have been developed as effective indices for resistant screening in plant breeding programs (Ashraf and Harris 2004, Parida and Das 2005, Ashraf and Foolad 2007 and Cha-um and Kirdmanee 2009).

Salinity induced decline in net photosynthetic rate is mainly dependent on plant genotype. Generally salt tolerant genotypes showed least reduction in net photosynthetic rate and stomatal conductance than salt sensitive genotypes (Kanwal *et al* 2011 and Gurmani *et al* 2014).

No attempt was made to assess potential variability for salinity tolerance across a wide spectrum of the gene pool in a field study. So, the main objective of the present study was identification the performance of 20 recombinant inbred lines (RILs) of muskmelon under water salt stress on the basis of various morphological and physiological attributes, in a pots experiment under netted house, then the tolerant RILs were chosen and crossed between them in one direction to evaluate the performance of their F_1s for water salt stress beside their parents compared to control in field trail. Also, the heterosis for these F_1s was determined.

MATERIALS AND METHODS

Seeds of twenty muskmelon RILs (15 RILs galia type and 5 RILs charentais type) were obtained from former breeding program. These RILs were exposed to four salinity levels *viz*., 0 (control), 50, 75 and 100 mM of sodium chloride (NaCl) solutions to evaluate them for salinity tolerance. The salinity evaluation involved seeds germination tolerance and vegetative growth tolerance of these 20 RILs for the four levels of salinity, then the highest salinity tolerance RILs were chosen and crossed between them in one direction to produce the F_1s seeds. These F_1s beside their parents were evaluated in two open fields at one location.

The seeds germination tolerance experiment of twenty RILs was carried out during 2016 and 2017 early summer in a complete randomized design (CRD) with three replicates for each RIL and each salinity level. Each replicate involved 80 petri dishes and each petri dish contained 25 seeds. Each three petri dishes with the same RIL were irrigated with the same salinity level to represent the three replicates. These petri dishes were put inside an incubator at 28° cunder laboratory conditions at Horticultural Research Institute. The measured traits for this experiment were seeds germination rate and percentage and were recorded daily after 48 hours from the start of the experiment.

The vegetative growth tolerance experiment of these 20 RILs for the four levels of salinity was carried out in pots experiment under netted house at Horticultural Research Institute during 2016 and 2017 early summer seasons in a factorial design with three replicates for each RIL and each salinity level. Each experimental plot (EP) contained two pots with diameter 25 cm and filled with washed sand for each RIL and each salinity level. So, one replicate involved 80 EP which equal 160 pots. These pots were sown with one direct seed per each pot and were irrigated with natural water till 15 days, then were subjected to0, 50, 75 and 100mMNaCl levels and were allowed to grow for 50 days. Plants (65 days old) were harvested and data (leaf area index (LAI), stem diameter, internodes length, root length, flowering date of perfect flowers, shoot and root dry weights) were collected immediately. Leaf area was determined by area meter (Li-Cor, model LI-3050A, USA) measured as an average of 2 plants per replicate for each RIL and salinity level and the LAI was calculated by average leaf area divided by the pot area occupied by the plant. Also, the stem diameter, internodes length and root length measured as an average of 2 plants per replicate for each RIL and salinity level. As for flowering date of perfect flowers, two plants were used per replicate for each RIL and salinity level to determine the number of days from seeds sowing to appearance of the first andromonocious flower on the plant. Shoot and root biomass were dried in oven at 70°C for 72 hours and weighed to determine the shoot and root dry weights which measured as an average of 2 plants per replicate for each RIL and salinity level. The plants were given the recommended fertilizers quantities for melon dissolved in the salinity solution (0 as control, 50, 75 and 100 mM NaCl levels) three times per week.

Three RILs were selected from previous seed germination and vegetative growth tolerance evaluations. These RILs were crossed among them in one direction to produce three F_1s which were produced under greenhouse at Kaha Vegetable Research Farm (KVRF), Kalubia during 2017 late summer season. The seeds of these three RILs were sown direct in the greenhouse soil at 15/6/2017 and all the cross-pollinations were made between the three RILs in one direction to obtain three of F_1seeds. These three F_1s hybrids beside their parents and hybrid Gal 23 (used as control, which was the most prevalence hybrid in cantaloupe plantings under Egypt conditions, D.T. Seeds company, Turkey) were sown in the two open fields using drip irrigation system at Sadat city, Menofia Governorate, one of them was irrigated with groundwater 955 ppm salinity (used as control) and the other field was irrigated with groundwater 2760 ppm salinity (used as a field for salinity tolerance evaluation). Direct seeds were sown in the two fields soils during 2018 early summer season in a factorial design with three replicates. Each replicate of each field contained 7 experimental plots (EP) for 3 parents, 3 F_1s and one control. Each plot 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. The plants were irrigated directly after seeds sowing in the soil according to the type of water for each field. Also, the fertigation system was used to apply plants with fertilizers and all the fertilizer quantities were dissolved in the water according to the type of water for each field and were injected inside the fertigation system. The measured traits of the hybrids evaluation experiment were as follows:

1- 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.
2- Fruit number/plant: It measured as an average of the number of fruits/plant for five plants were chosen randomly from each EP.
3- Fruit quality: average fruit weight (AFW) and fruit 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 RILs in both early summer seasons 2016and 2017were homogeneous for all traits. So, the combined analysis of variance for the two early summer seasons was computed for all traits according to Koch and Sen (1968). While the analysis of variance for the hybrids evaluation under salinity stress was conducted for only one year (2018 early summer season).

The reduction and increment rates were estimated for all studied traits in seeds germination tolerance, vegetative growth tolerance and selected hybrids tolerance for salinity as the deviation of each RIL mean under salinity stress level (50, 75 and 100 mM NaCl) over the control (0 mM NaCl) of the same RIL. Also, relative heterosis and heterobeltiosis were estimated as the deviation of F_1 mean over the mid-parent (MP) and better parent (BP) in each cross, respectively for all studied traits.

RESULTS AND DISCUSSION

Seeds germination and vegetative growth tolerance for salinity

Obtained data of combined analysis on seeds germination rate, seeds germination percentage and LAI of muskmelon RILs during 2016 and 2017 early summer seasons were presented in Table 1. Also, the reduction and increment rates of each RIL when evaluated at different salinity level (50, 75 and 100 mM) compared to control for the same previous traits were presented in Table 2.

Table 1. Effect of different levels of NaCl on seeds germination rate, seeds germination percentage and leaf area index of muskmelon RILs evaluated in pots experiment during 2016 and 2017 early summer seasons in a combined analysis for two years.

RILs	Seeds germination rate (days)				Seeds germination percentage (%)				Leaf area index			
	0 mM	50 mM	75 mM	100 mM	0 mM	50 mM	75 mM	100 mM	0 mM	50 mM	75 mM	100 mM
301	3.67	6.90	6.83	9.13	100.00	100.00	100.00	100.00	1.13	0.85	0.73	0.49
302	4.30	4.37	6.13	6.80	100.00	100.00	100.00	100.00	1.43	0.98	0.80	0.74
303	4.70	6.10	5.60	10.00	100.00	100.00	100.00	50.00	1.32	1.01	0.86	0.65
304	4.50	4.20	3.70	5.10	90.00	90.00	100.00	80.00	1.60	0.99	0.85	0.62
305	4.00	5.70	5.50	6.60	90.00	90.00	90.00	70.00	1.87	1.76	0.98	0.62
306	3.90	3.50	3.30	3.60	100.00	100.00	100.00	100.00	1.55	0.87	0.65	0.50
307	4.70	3.40	4.50	3.00	100.00	100.00	100.00	100.00	2.05	1.90	0.93	0.72
308	3.70	3.60	3.30	3.50	100.00	100.00	100.00	100.00	1.84	0.99	0.71	0.45
309	3.10	3.00	3.00	3.60	100.00	100.00	100.00	100.00	2.14	1.87	1.86	0.84
310	3.20	3.30	4.70	3.00	100.00	100.00	100.00	100.00	1.06	0.60	0.39	0.35
311	3.20	3.00	3.00	3.30	100.00	100.00	100.00	100.00	1.18	0.62	0.43	0.37
312	3.80	3.00	3.30	3.90	100.00	100.00	100.00	100.00	1.43	0.97	0.52	0.39
313	3.80	3.40	3.60	4.00	100.00	100.00	100.00	100.00	2.16	0.78	0.69	0.41
314	3.00	3.00	3.00	5.00	100.00	100.00	100.00	80.00	1.54	0.76	0.51	0.35
315	3.10	3.90	4.20	4.20	100.00	100.00	100.00	100.00	1.62	1.00	0.72	0.52
516	3.00	3.00	3.10	3.40	90.00	100.00	100.00	100.00	1.95	0.82	0.58	0.41
517	3.10	3.40	5.70	5.00	90.00	100.00	70.00	60.00	1.33	0.80	0.62	0.49
518	3.00	3.00	3.00	3.30	100.00	100.00	100.00	100.00	1.01	0.70	0.49	0.39
519	3.00	3.00	3.60	3.00	100.00	100.00	80.00	100.00	1.13	0.78	0.57	0.41
520	3.00	3.00	3.20	3.00	100.00	100.00	100.00	100.00	0.93	0.70	0.54	0.40
LSD $_{(0.05)}$	0.43				4.34				0.15			

Table 2. The reduction and increment rates in seeds germination rate, seeds germination percentage and leaf area index traits for each salinity level compared to control of each muskmelon RIL evaluated in pots experiment during 2016 and 2017 early summer seasons in a combined analysis for two years.

RILs	Seeds germination rate (days)			Seeds germination percentage (%)			Leaf area index		
	50 mM	75 mM	100 mM	50 mM	75 mM	100 mM	50 mM	75 mM	100 mM
301	88.18	86.36	149.09	0.00	0.00	0.00	-25.00	-35.29	-56.47
302	-1.53	40.46	55.73	0.00	0.00	0.00	-31.86	-44.19	-48.60
303	29.79	19.15	112.77	0.00	0.00	-50.00	-23.68	-35.01	-50.88
304	-6.67	-17.78	13.33	0.00	11.11	-11.11	-37.92	-46.88	-61.04
305	42.50	37.50	65.00	0.00	0.00	-22.22	-6.05	-47.69	-67.08
306	-10.26	-15.38	-7.69	0.00	0.00	0.00	-43.87	-58.06	-67.53
307	-27.66	-4.26	-36.17	0.00	0.00	0.00	-7.15	-54.47	-65.04
308	-2.70	-10.81	-5.41	0.00	0.00	0.00	-46.20	-61.59	-75.54
309	-3.23	-3.23	16.13	0.00	0.00	0.00	-12.64	-12.95	-60.69
310	3.12	46.88	-6.25	0.00	0.00	0.00	-43.22	-63.09	-66.88
311	-6.25	-6.25	3.13	0.00	0.00	0.00	-47.89	-63.38	-69.01
312	-21.05	-13.16	2.63	0.00	0.00	0.00	-32.24	-63.32	-72.43
313	-10.53	-5.26	5.26	0.00	0.00	0.00	-64.10	-68.26	-81.05
314	0.00	0.00	66.67	0.00	0.00	-20.00	-50.87	-66.67	-77.06
315	25.81	35.48	35.48	0.00	0.00	0.00	-38.14	-55.46	-68.04
516	0.00	3.33	13.33	11.11	11.11	11.11	-58.19	-70.48	-79.01
517	9.68	83.87	61.29	11.11	-22.22	-33.33	-40.25	-53.50	-63.00
518	0.00	0.00	10.00	0.00	0.00	0.00	-30.36	-51.49	-61.06
519	0.00	20.00	0.00	0.00	-20.00	0.00	-31.18	-50.00	-63.82
520	0.00	6.67	0.00	0.00	0.00	0.00	-24.10	-41.73	-57.19

Data illustrated that most of melon RILs had high level of salinity tolerance in seeds germination rate and seeds germination percentage. Regarding the seeds germination rate, the lowest value was recorded in RIL 309 when evaluated at 50, 75 and 0 mM, but it wasn't significantly different from most of other melon RILs under different salinity levels. Also, the reduction rate of this RIL compared to control (0 mM of NaCl) was -3.23% when evaluated at 50 and 75 mM. On the contrary, the RIL 303 under salinity level 100 mM had the highest value in seeds germination rate and was significantly different over all other treatments. Likewise, the increment rate of this RIL under salinity level 100 mM compared to control was 112.77%. So, the RIL 309 had high level of salinity tolerance, but RIL 303 was sensitive to salinity stress in seeds Germination rate. Concerning seeds germination percentage, there weren't significant differences among most of RILs when evaluated at different salinity levels. So, the reduction rate of these RILs at different salinity levels compared to control was zero except RILs 303, 305 and 314 at salinity level 100 mM, 304 at salinity levels 75 and100 mM, 516 and 517 at salinity levels 50, 75, 100 mM and 519 at salinity level 75 mM. The least seeds germination percentage was estimated in RIL 303 when evaluated at salinity level 100 mM, with reduction rate compared to control reached to -50%. As for leaf area index, in general, LAI was reduced as salinity level increased. Although this result was obtained, the RIL 307 ranked second at salinity level 50 mM with little reduction rate compared to control reached to -7.15%, RIL 309 ranked third at salinity levels 50 and 75 mM with little reduction rates compared to control reached to -12.64 and -12.95%, respectively. Besides, RIL 305 ranked fourth at salinity level 50 mM with very little reduction rate compared to control reached to -6.05%. In contrast, the RIL 310 had the least LAI when evaluated at salinity level 100 mM with high reduction rate compared to control reached to -66.88%, but without significant differences from most of other RILs which evaluated at salinity levels 75 and 100 mM. So, the RILs 305 and 307 had high level of salinity tolerance till 50 mM and RIL 309 had high level of salinity tolerance till 75 mM in LAI trait.

These results coincided with those of Ibrarullah *et al* (2019) who reported that increasing levels of salt stress substantially declined leaf area in all the tested muskmelon genotypes. However, genotypes differed in their response. Also, Gurmani *et al* (2014) stated that leaf is the important food preparatory component of plant. Higher buildup of Na+ ions in cytoplasm is the possible reason for leaf area reduction in plants as high salinity creates osmotic stress and reduces the uptake of essential mineral elements. Similar results have been observed on muskmelon (Franco *et al* 1997), squash (Yildirim *et al* 2006).

Likewise, obtained data of combined analysis on stem diameter, internodes length and root length of muskmelon RILs in pots experiment during early summer seasons 2016 and 2017 were shown in Table 3. Also, the reduction and increment rates of each RIL when evaluated at different salinity level (50, 75 and 100 mM) compared to control for the same previous traits were presented in Table 4.

Table 3. Effect of different levels of NaCl on stem diameter, internodes length and root length of muskmelon RILs in pots experiment during 2016 and 2017 early summer seasons in a combined analysis for two years.

RILs	Stem diameter (mm)				Internodes length (mm)				Root length (mm)			
	0 mM	50 mM	75 mM	100 mM	0 mM	50 mM	75 mM	100 mM	0 mM	50 mM	75 mM	100 mM
301	7.33	4.57	3.53	2.57	65.00	53.33	46.33	40.67	120.33	97.17	84.33	71.00
302	7.67	5.07	3.80	3.07	67.33	44.33	40.00	37.33	105.00	84.33	72.00	68.00
303	6.57	4.83	4.03	2.43	62.67	47.67	38.00	31.00	106.67	84.67	74.00	63.33
304	6.97	4.97	3.67	3.03	52.67	40.33	30.33	26.33	100.67	83.67	72.33	62.33
305	7.37	6.37	4.57	3.07	71.00	66.00	46.00	31.33	134.67	124.67	85.00	70.00
306	6.80	4.20	3.37	2.63	72.67	47.33	40.00	29.00	137.67	110.67	88.33	73.00
307	8.03	7.37	5.20	3.00	67.67	61.33	43.00	27.67	131.33	118.33	87.00	74.33
308	7.27	4.90	4.17	3.13	52.00	38.67	27.67	20.00	142.00	86.67	70.00	63.00
309	8.20	7.60	7.47	4.07	74.33	70.33	60.00	40.67	142.67	131.33	122.00	88.00
310	6.73	4.87	3.73	2.67	69.00	46.67	39.00	29.00	116.33	83.00	73.00	64.33
311	7.07	4.77	3.83	2.70	71.33	43.00	33.33	25.67	107.67	86.00	74.67	66.00
312	7.50	5.03	3.93	3.07	68.00	41.33	32.00	25.67	132.00	94.00	74.33	66.67
313	7.10	4.97	4.00	3.00	67.33	40.33	35.00	23.00	119.67	82.67	74.67	64.33
314	6.87	4.80	3.50	2.53	66.00	44.33	35.00	28.67	119.00	88.33	72.67	62.33
315	5.80	4.00	3.27	2.07	70.00	47.33	37.33	29.00	121.33	91.33	73.33	65.67
516	7.27	5.17	3.73	2.70	73.33	49.33	40.67	31.67	139.00	99.33	83.00	71.67
517	7.40	5.23	4.20	1.67	67.00	48.67	26.67	19.67	127.67	90.33	70.00	65.00
518	7.07	5.03	4.27	1.50	60.67	43.33	34.67	27.00	101.00	90.00	79.33	68.33
519	6.03	5.00	3.70	1.90	68.00	45.67	35.33	27.00	121.00	103.67	93.33	84.67
520	6.33	4.37	3.73	2.00	69.33	45.67	35.33	27.67	130.00	106.67	91.00	84.33
$LSD_{(0.05)}$	0.61				4.98				6.02			

Table 4. The reduction and increment rates in stem diameter, internodes length and root length traits for each salinity level compared to control of each muskmelon RIL evaluated in pots experiment during 2016 and 2017 early summer seasons in a combined analysis for two years.

RILs	Stem diameter (mm)			Internodes length (mm)			Root length (mm)		
	50 mM	75 mM	100 mM	50 mM	75 mM	100 mM	50 mM	75 mM	100 mM
301	-37.73	-51.82	-65.00	-17.95	-28.72	-37.44	-19.25	-29.92	-41.00
302	-33.91	-50.43	-60.00	-34.16	-40.59	-44.55	-19.68	-31.43	-35.24
303	-26.40	-38.58	-62.94	-23.94	-39.36	-50.53	-20.63	-30.63	-40.63
304	-28.71	-47.37	-56.46	-23.42	-42.41	-50.00	-16.89	-28.15	-38.08
305	-13.57	-38.01	-58.37	-7.04	-35.21	-55.87	-7.43	-36.88	-48.02
306	-38.24	-50.49	-61.27	-34.86	-44.95	-60.09	-19.61	-35.84	-46.97
307	-8.30	-35.27	-62.66	-9.36	-36.45	-59.11	-9.90	-33.76	-43.40
308	-32.57	-42.66	-56.88	-25.64	-46.79	-61.54	-38.97	-50.70	-55.63
309	-7.32	-8.94	-50.41	-5.38	-19.28	-45.29	-7.94	-14.49	-38.32
310	-27.72	-44.55	-60.40	-32.37	-43.48	-57.97	-28.65	-37.25	-44.70
311	-32.55	-45.75	-61.79	-39.72	-53.27	-64.02	-20.12	-30.65	-38.70
312	-32.89	-47.56	-59.11	-39.22	-52.94	-62.25	-28.79	-43.69	-49.49
313	-30.05	-43.66	-57.75	-40.10	-48.02	-65.84	-30.92	-37.60	-46.24
314	-30.10	-49.03	-63.11	-32.83	-46.97	-56.57	-25.77	-38.94	-47.62
315	-31.03	-43.68	-64.37	-32.38	-46.67	-58.57	-24.73	-39.56	-45.88
516	-28.90	-48.62	-62.84	-32.73	-44.55	-56.82	-28.54	-40.29	-48.44
517	-29.28	-43.24	-77.48	-27.36	-60.20	-70.65	-29.24	-45.17	-49.09
518	-28.77	-39.62	-78.77	-28.57	-42.86	-55.49	-10.89	-21.45	-32.34
519	-17.13	-38.67	-68.51	-32.84	-48.04	-60.29	-14.33	-22.87	-30.03
520	-31.05	-41.05	-68.42	-34.13	-49.04	-60.10	-17.95	-30.00	-35.13

In general, data showed that stem diameter, internodes length and root length of muskmelon RILs were reduced as salinity level increased. Although this result was obtained, the RIL 309 ranked first at salinity level 50 mM in stem diameter and internodes length traits and it ranked fourth at the same salinity level in root length trait. The little reduction rate of this RIL at the salinity level 50 mM compared to control reached to -7.32, -5.38 and -7.94% in the stem diameter, internodes length and root length traits, respectively. Also, RIL 309 ranked second, tenth and seventh at salinity level 75 mM with little reduction rates compared to control reached to -8.94, -19.28 and -14.49% in the stem diameter, internodes length and root length traits, respectively. Likewise, RIL 307 ranked third, eighth and ninth at salinity level 50 mM with very little reduction rate compared to control reached to -8.30, -9.36 and -9.90%in the stem diameter, internodes length and root length traits, respectively. At the same time, RIL 305 ranked ninth, fifth and sixth at salinity level 50 mM with very little reduction rate compared to control reached to -13.57, -7.04 and -7.43%in the stem diameter, internodes length and root length traits, respectively. In contrast, other RILs had high reduction rates compared to control when evaluated at different salinity levels in the three previous traits. Also, the 100 mM NaCl level had large harmful effect on all evaluated RILs. So, the RILs 305and 307 had high level of salinity tolerance till 50 mM and RIL 309 had high level of salinity tolerance till 75 mM in the three previous traits.

Similar results have been reported on muskmelon by those of Stepien and Klobus (2006), Dadkhah (2011), Ibrarullah *et al* (2019), Franco *et al* (1997), Mendlinger (1994), Dasgan and Koc (2009) and Kusvuran (2010).

In the same time obtained data of combined analysis on flowering date of perfect flowers, shoot and root dry weights of muskmelon RILs in pots experiment during early summer seasons 2016 and 2017 were combined in Table 5. Also, the reduction and increment rates of each RIL when evaluated at different salinity level (50, 75 and 100 mM) compared to control for the same previous traits were presented in Table 6.

In the same direction, data showed that flowering date of perfect flowers, shoot and root dry weights of muskmelon RILs were reduced as salinity level increased. Although this result was obtained, the RIL 305 ranked fourth at salinity level 50 mM in flowering date of perfect flowers trait, eleventh in shoot dry weight trait and fourth in root dry weight trait. The little reduction rate of this RIL at the salinity level 50 mM compared to control reached to -4.93, -4.65 and -6.82% in the flowering date of perfect flowers, shoot and root dry weight traits, respectively. Also, RIL 307 ranked sixteenth, first and fifth at salinity level 50 mM with little reduction rates compared to control reached to -5.04, -4.53 and -11.96% in the flowering date of perfect flowers, shoot and root dry weight traits, respectively.

Table 5. Effect of different levels of NaCl on flowering date of perfect flowers, shoot and root dry weights of muskmelon RILs in pots experiment during 2016 and 2017 early summer seasons in a combined analysis for two years.

RILs	Flowering date of perfect flowers (days)				Shoot dry weight (g)				Root dry weight (g)			
	0 mM	50 mM	75 mM	100 mM	0 mM	50 mM	75 mM	100 mM	0 mM	50 mM	75 mM	100 mM
301	41.00	33.33	29.33	29.00	2.25	1.87	1.21	0.80	0.27	0.16	0.12	0.08
302	38.33	31.33	29.33	27.00	2.52	1.68	1.01	0.67	0.30	0.19	0.13	0.08
303	43.00	37.00	33.00	30.00	2.94	1.96	1.39	0.81	0.27	0.17	0.13	0.10
304	46.33	38.33	33.67	29.67	2.30	1.48	0.94	0.65	0.29	0.17	0.13	0.10
305	47.33	45.00	35.67	30.67	2.15	2.05	1.45	1.06	0.29	0.27	0.16	0.12
306	47.00	39.33	37.67	30.33	2.86	1.83	1.26	0.97	0.27	0.15	0.12	0.10
307	39.67	37.67	30.33	27.67	3.09	2.95	1.84	1.32	0.31	0.27	0.18	0.14
308	46.00	41.00	36.67	32.33	2.77	1.60	1.28	0.96	0.27	0.17	0.13	0.10
309	47.33	44.33	43.67	33.67	2.82	2.63	2.52	1.15	0.28	0.25	0.24	0.17
310	48.67	39.00	33.33	29.67	2.99	1.35	1.16	0.75	0.28	0.18	0.14	0.11
311	49.33	40.67	34.67	31.33	3.13	1.95	1.30	0.98	0.29	0.19	0.13	0.10
312	44.00	39.33	33.67	29.00	2.89	1.55	1.32	0.94	0.30	0.17	0.12	0.09
313	49.67	41.67	36.33	31.00	2.75	1.74	1.28	0.97	0.31	0.19	0.12	0.09
314	43.67	38.67	33.33	28.67	2.92	1.51	1.07	0.81	0.29	0.18	0.12	0.09
315	43.33	37.33	32.33	28.67	2.93	1.65	1.26	0.93	0.27	0.16	0.13	0.09
516	46.33	40.67	36.00	32.67	2.61	1.86	1.32	0.93	0.29	0.17	0.14	0.09
517	41.33	35.67	32.00	28.67	2.83	1.74	1.34	1.03	0.31	0.18	0.15	0.11
518	45.67	39.67	35.00	30.00	2.91	1.51	1.28	0.97	0.30	0.18	0.13	0.10
519	44.00	40.00	36.33	31.67	2.71	1.75	1.38	1.03	0.30	0.19	0.16	0.11
520	48.00	40.67	35.33	31.67	2.88	1.88	1.39	1.05	0.32	0.18	0.14	0.10
$LSD_{(0.05)}$	2.71				0.24				0.03			

Likewise, RIL 309 ranked fifth, sixth and seventh at salinity level 50 mM with very little reduction rate compared to control reached to-6.34, -6.51 and -8.43%in the flowering date of perfect flowers, shoot and root dry weight traits, respectively. At the same time, RIL 309 ranked sixth in the flowering date of perfect flowers and eighth in the shoot and root dry weight traits at salinity level 75 mM. The very little reduction rate compared to control reached to -7.75, -10.65 and -14.46% in the flowering date of perfect flowers, shoot and root dry weight traits, respectively. In contrast, other RILs had high reduction rates compared to control when evaluated at different salinity levels in the three previous traits. Also, the 100 mM NaCl level had large harmful effect on all evaluated RILs in the shoot and root dry weight traits, but it had desirable effect in the flowering date of perfect flowers. So, the RILs 305 and 307 had high level of salinity tolerance till 50 mM and RIL 309 had high level of salinity tolerance till 75 mM in the three previous traits.

Table 6. The reduction and increment rates in flowering date of perfect flowers, shoot and root dry weights traits for each salinity level compared to control of each muskmelon RIL evaluated in pots experiment during 2016 and 2017 early summer seasons in a combined analysis for two years.

RILs	Flowering date of perfect flowers (days)			Shoot dry weight (g)			Root dry weight (g)		
	50 mM	75 mM	100 mM	50 mM	75 mM	100 mM	50 mM	75 mM	100 mM
301	-18.70	-28.46	-29.27	-16.74	-46.37	-64.44	-42.68	-57.32	-70.73
302	-18.26	-23.48	-29.57	-33.20	-59.92	-73.41	-34.83	-55.06	-71.91
303	-13.95	-23.26	-30.23	-33.33	-52.61	-72.45	-37.80	-52.44	-63.41
304	-17.27	-27.34	-35.97	-35.89	-59.04	-71.92	-40.70	-54.65	-66.28
305	-4.93	-24.65	-35.21	-4.65	-32.56	-50.70	-6.82	-44.32	-59.09
306	-16.31	-19.86	-35.46	-36.20	-55.88	-66.12	-45.12	-54.88	-64.63
307	-5.04	-23.53	-30.25	-4.53	-40.41	-57.33	-11.96	-41.30	-55.43
308	-10.87	-20.29	-29.71	-42.05	-53.61	-65.30	-37.80	-52.44	-63.41
309	-6.34	-7.75	-28.87	-6.51	-10.65	-59.05	-8.43	-14.46	-39.76
310	-19.86	-31.51	-39.04	-54.79	-61.25	-75.06	-36.90	-50.00	-60.71
311	-17.57	-29.73	-36.49	-37.63	-58.42	-68.55	-35.63	-54.02	-65.52
312	-10.61	-23.48	-34.09	-46.19	-54.27	-67.55	-43.82	-59.55	-69.66
313	-16.11	-26.85	-37.58	-36.53	-53.40	-64.81	-39.13	-59.78	-69.57
314	-11.45	-23.66	-34.35	-48.40	-63.24	-72.37	-38.64	-60.23	-70.45
315	-13.85	-25.38	-33.85	-43.62	-56.83	-68.11	-40.00	-51.25	-65.00
516	-12.23	-22.30	-29.50	-28.95	-49.62	-64.54	-39.53	-52.33	-67.44
517	-13.71	-22.58	-30.65	-38.71	-52.59	-63.53	-40.22	-51.09	-64.13
518	-13.14	-23.36	-34.31	-48.17	-55.85	-66.63	-38.89	-56.67	-66.67
519	-9.09	-17.42	-28.03	-35.50	-49.14	-62.16	-35.96	-46.07	-61.80
520	-15.28	-26.39	-34.03	-34.72	-51.74	-63.43	-43.75	-56.25	-68.75

Our results are in agreement with those of Kanwal *et al* (2011), Gurmani *et al* (2014) and Ibrarullah *et al* (2019) who reported that shoot and root dry weight of muskmelon were reduced as salinity level increased. Also, Dasgan *et al* (2002), Grzesıak *et al* (2006), Dasgan and Koc (2009) and Kusvuran (2010) stated that a common adverse effect of salt stress on crop plants is the reduction in fresh and dry biomass production. Likewise, earlier studies confirm that the salinity tolerance exist in wide genotypic diversity within the plant species (Islam *et al* 2008, Hussain *et al* 2013 and Gurmani *et al* 2014).

The hybrids and their parents tolerance for salinity

Obtained data on early yield, total yield, fruit numbers and average fruit weight traits of the three selected muskmelon RILs for salinity tolerance and their hybrids in one direction besides the control (Gal 23) evaluated in the two open fields during 2018 early summer season were presented in Table 7. Also, the reduction and increment rates of each genotype when evaluated at different salinity levels (50, 75 and 100 mM) compared to control for the same previous traits were presented in the same Table.

With respect to early yield, data confirmed that the early yield of all genotypes was increased as salinity level increased. Regarding RILs, the RILs 307 under salinity stress and 309 either in the control field or under salinity stress ranked first in this trait, without any significant differences among them. The least increment rate compared to control was estimated in RILs 309 and 307 and reached to 1.96% and 9.85%, respectively. On the contrary, the least early yield was given in the RIL305 in the control field and this RIL under salinity stress had the highest increment rate compared to control that reached to 53.85%. Referring to hybrids, hybrid RIL 309 × RIL 307 gave the highest early yield under salinity stress, but it wasn't significantly different from the same hybrid in the control field, hybrid Gal 23 and hybrid RIL 307 × RIL 305 under salinity stress. The least increment rate compared to control was estimated in hybrid RIL 309 × RIL 307 and reached to 4.34%. The remaining hybrids had high increment rate compared to control and this indicate that hybrid RIL 309 × RIL 307 had high salinity tolerance in this trait.

Regarding total yield, data illustrated that the RIL 309 had the highest total yield in the control field, but it wasn't significantly different from the same RIL under salinity stress and RIL 307 in the control field. The least reduction rate compared to control was estimated in this RIL and reached to -1.00%.

Table 7. Effect of salinity on early yield, total yield, fruit numbers and average fruit weight traits of the three hybrids and their parents evaluated in the two open fields during 2018 early summer season.

Genotypes	Early yield (ton/feddan)			Total yield (ton/feddan)		
	C*	S**	Reduction rate (%)	C*	S**	Increment rate (%)
RIL 309	1.19	1.22	1.96	9.04	8.95	-1.00
RIL 307	1.12	1.23	9.85	8.50	7.87	-7.50
RIL 305	0.65	1.00	53.85	7.85	7.36	-6.20
RIL 309 × RIL 307	1.46	1.52	4.34	14.64	14.11	-3.60
RIL 309 × RIL 305	0.84	1.18	40.64	12.99	12.54	-3.50
RIL 307 × RIL 305	0.90	1.28	41.85	14.08	11.72	-16.80
Gal 23	1.14	1.42	24.85	12.51	9.35	-25.20
$LSD_{(0.05)}$	0.35			0.91		

Genotypes	Fruit numbers/plant			Average friut weight (g)		
	C*	S**	Reduction rate (%)	C*	S**	Reduction rate (%)
RIL 309	4.03	3.83	-4.96	596.67	578.33	-3.07
RIL 307	3.37	3.22	-4.46	498.33	470.00	-5.69
RIL 305	3.13	2.92	-6.91	423.67	356.67	-15.81
RIL 309 × RIL 307	5.77	5.60	-2.89	648.33	640.00	-1.29
RIL 309 × RIL 305	5.17	4.78	-7.42	565.00	504.00	-10.80
RIL 307 × RIL 305	5.63	4.47	-20.71	512.33	463.33	-9.56
Gal 23	5.07	3.63	-28.29	668.33	383.33	-42.64
$LSD_{(0.05)}$	0.65			65.02		

C* The control field which was irrigated by water with salinity reached to 955 ppm = 16.24 mM.

S The stressed field which was irrigated by water with salinity reached to 2760 ppm = 46.92mM.**

Concerning hybrids, hybrid RIL 309 × RIL 307 gave the highest total yield in the control field, but it wasn't significantly different from the same hybrid under salinity stress and hybrid RIL 307 × RIL 305 in the control field only. The little reduction rate compared to control for this hybrid reached to -3.60% and the least reduction rate compared to control was shown in hybrid RIL 309 × RIL 305. Although hybrid RIL 309 × RIL 305 had the least reduction rate compared to control, it ranked second in total yield trait. So, the hybrid RIL 309 × RIL 307 was better than it because it ranked first in total yield and its reduction rate compared to control differed from the reduction rate compared to control of the hybrid RIL 309 × RIL 305 by 0.1%. In contrast, the least total yield was produced in hybrid Gal 23 under salinity stress and it had the highest reduction rate compared to control which reached to -25.20%.

Concerning fruit numbers/plant, data showed that the RIL 309 had the highest fruit numbers/plant in the control field, but it wasn't significantly different from the same RIL under salinity stress. The least reduction rate compared to control was estimated in RILs 307 and 309 and reached to -4.46 and 4.96%, respectively. Although RIL 307 had the least reduction rate compared to control, it ranked second in this trait among RILs either in the control field or under salinity stress. Concerning hybrids, hybrid RIL 309 × RIL 307 gave the highest fruit numbers/plant in the control field, but it wasn't significantly different from the same hybrid under salinity stress, hybrid RIL 307 × RIL 305 and hybrid RIL 309 × RIL 305 in the control field only. The least reduction rate compared to control was shown in this hybrid and reached to -2.89%. Also, hybrid RIL 309 × RIL 305 had little reduction rate compared to control and reached to 7.42%, but it ranked third under salinity stress. The remaining hybrids had high reduction rate compared to control and this indicate that hybrid RIL 309 × RIL 307 had high salinity tolerance in this trait. In contrast, the least fruit numbers/plant was produced in hybrid Gal 23 under salinity stress, in spite of it ranked second in this trait in the control field. So, it had the highest reduction rate compared to control which reached to -28.29%.

As for average fruit weight, data illustrated that the average fruit weight of all genotypes was reduced as salinity level increased. The RIL 309 had the highest average fruit weight in the control field, but it ranked second under salinity stress in this trait and was significantly different from all other RILs either in the control field or under salinity stress. The least reduction rate compared to control was estimated in this RIL and reached to -3.07%. Likewise, RIL 307 had little reduction rate reached to -5.69% and ranked third either in the control field or under salinity stress, but RIL 305 had high reduction rate reached to -15.81%. Concerning hybrids, hybrid Gal 23 produced the heaviest fruits in the control field, but it wasn't significantly different from hybrid RIL 309 × RIL 307 either in the control field or under salinity stress. The least reduction rate compared to control was obtained in hybrid RIL 309 × RIL 307 and reached to -1.29%. Although hybrid Gal 23 (the control entry) produced the heaviest fruits in the control field, it had the least average fruit weight under salinity stress and gave the highest reduction rate compared to control reached to -42.64%. So, the average fruit weight trait didn't change under salinity stress in hybrid RIL 309 × RIL 307.

The remaining obtaining data on netting percentage, fruit flesh thickness and total soluble solids (TSS) traits of hybrids, their parents and the control (Gal 23) evaluated in the two open fields during 2018 early summer season were presented in Table 8. Also, the reduction and increment rates of each genotype when evaluated at different salinity levels (50, 75 and 100 mM) compared to control for the same previous traits were presented in the same Table.

Concerning netting percentage, data illustrated that in some RILs and hybrids the netting percentage was increased as the salinity level increased. So, the RILs 309 and 307 either in the control field or under salinity stress ranked first, but RIL 305 either in the control field or under salinity stress ranked last in this trait. The least increment rate compared to control was obtained in RIL 309 and reached to zero. Also, the RIL 307 had very little increment rate reached to 5.26%, but RIL 305 had very high increment rate compared to control. As for hybrids, both hybrids RIL 309 × RIL 307 and Gal 23 either in the control field or under salinity stress ranked first in this trait with very little increment rate compared to control reached to zero. The remaining hybrids had high increment rate compared to control. So, the netting percentage trait didn't change under salinity stress in hybrid RIL 309 × RIL 307.

Table 8. Effect of salinity on netting percentage, fruit flesh thickness and total soluble solids (TSS) traits of the three hybrids and their parents evaluated in the two open fields during 2018 early summer season.

Genotypes	Netting percentage (%)			Fruit flesh thickness (cm)			Total soluble solids (%)		
	C*	S**	Increment rate (%)	C*	S**	Reduction rate (%)	C*	S**	Increment rate (%)
RIL 309	100.00	100.00	0.00	3.30	3.17	-4.04	12.47	14.47	16.04
RIL 307	95.00	100.00	5.26	2.73	2.33	-14.63	11.07	13.13	18.67
RIL 305	1.00	8.33	733.33	3.20	2.73	-14.58	11.20	12.33	10.12
RIL 309 × RIL 307	100.00	100.00	0.00	3.77	3.53	-6.19	14.53	16.33	12.39
RIL 309 × RIL 305	53.33	81.67	53.13	3.63	2.97	-18.35	13.87	15.53	12.02
RIL 307 × RIL 305	60.00	85.00	41.67	3.53	2.77	-21.70	13.13	15.27	16.24
Gal 23	100.00	100.00	0.00	3.67	2.53	-30.91	12.33	14.07	14.05
LSD $_{(0.05)}$	12.17			0.46			1.12		

C*The control field which was irrigated by water with salinity reached to 955 ppm = 16.24 mM.
SThe stressed field which was irrigated by water with salinity reached to 2760 ppm = 46.92 mM.**

With regard to fruit flesh thickness, data showed that the fruit flesh thickness of all genotypes was reduced as salinity level increased. The RIL 309 in the control field ranked first, but it ranked third under salinity stress in this trait. The least reduction rate compared to control was estimated in this RIL and reached to -4.04%. The remaining RILs had moderate reduction rate compared to control. Concerning hybrids, the hybrids RIL 309 × RIL 307 either in the control field or under salinity stress, Gal 23, RIL 309 × RIL 305 and RIL 307 × RIL 305 in the control field ranked first in the fruit flesh thickness. In contrast, hybrid Gal 23 under salinity stress ranked last in this trait. So, the least reduction rate compared to control was obtained in hybrid RIL 309 × RIL 307 and reached to -6.19%, but the highest reduction rate compared to control was estimated in hybrid Gal 23 and reached to -30.91%. So, the fruit flesh thickness didn't significantly affect under salinity stress in the hybrid RIL 309 × RIL 307, but it had a large reduction under salinity stress in the other hybrids.

Regarding total soluble solids (TSS), data confirmed that in all genotypes the TSS was increased as the salinity level increased. So, the RILs 309 under salinity stress had the highest TSS and was significantly different from all other RILs either in the control field or under salinity stress. In contrast, RIL 307 had the lowest TSS, but it wasn't significantly different from RIL 305 in the control field. The least increment rate compared to control was obtained in RIL 305 and reached to10.12%, but RIL 309 had moderate increment rate compared to control and reached to 16.04%.As for hybrids, the hybrid RIL 309 × RIL 307 had the highest TSS, but it wasn't significantly different from hybrids RIL 309 × RIL 305 and RIL 307 × RIL 305 under salinity stress. The least increment rate compared to control was obtained in hybrids RIL 309 × RIL 305 and RIL 309 × RIL 307 and reached to 12.02 and 12.39%, respectively. On the contrary, the lowest TSS was shown in hybrid Gal 23 in the control field and was significantly different from all other hybrids either in the control field or under salinity stress. The highest increment rate compared to control was estimated in hybrid RIL 307 × RIL 305 and reached to 16.24%. So, the TSS trait didn't much affect under salinity stress in hybrids RIL 309 × RIL 307 and RIL 309 × RIL 305.

So, from all these results illustrated that the salinity tolerance of any genotype was increased as the reduction or increment rate for this genotype compared to control reduced and vice versa. Likewise the total yield, fruit numbers/plant, average fruit weight and fruit flesh thickness were reduced as salinity level increased, but early yield, netting percentage and TSS were increased as salinity level increased. These results coincided with those of Shannon and Francois (1978) stated that fruit size and yield were reduced by saline water. Also, Meiri *et al* (1981), Mangal *et al* (1988) and Mendlinger and Pasternak (1992 a and b) found that the salinity stress caused reduction of fruit weight and time to harvest, but increasing of total soluble solids content in melon. Likewise, Del Amor *et al* (1999) reported that the salinity stress caused yield and fruit quality losses. In contrast, these results are disagree with some obtained results by Mendlinger and Pasternak

(1992 a and b) who found that the salinity stress didn't affect the number of fruits and caused reduction of netting quality in melon.

Hybrid vigor under salinity stress

Heterosis value determines the hybrid vigor in each horticultural trait. So, the obtained data in Table 9 showed the heterosis (%) values relative to mid-parent (MP) and better-parent (Heterobeltiosis-BP) for some muskmelon characters of the previous three F_1 hybrids evaluated in the two open fields during 2018 early summer season.

Table 9. Heterosis (%) values relative to mid-parent (MP) and better-parent (Heterobeltiosis-BP) for some muskmelon characters of 3 F_1 hybrids evaluated in the two open fields during 2018 early summer season.

Traits	RIL 309 × RIL 307				RIL 309 × RIL 305				RIL 307 × RIL 305			
	MPH		BPH		MPH		BPH		MPH		BPH	
	C*	S**	C*	S**	C*	S**	C*	S**	C*	S**	C*	S**
Early yield (ton/feddan)	26.41	24.35	22.35	24.18	-9.06	6.01	-29.89	-3.29	1.69	14.50	-19.40	4.08
Total yield (ton/feddan)	67.35	67.78	62.04	57.65	54.05	53.73	43.71	40.07	72.27	53.86	65.69	48.94
Fruit numbers /plant	55.86	58.87	42.98	46.09	44.32	41.73	28.10	24.78	73.33	45.49	67.33	38.86
Average friut weight (gm)	18.42	22.10	8.66	10.66	10.75	7.81	-5.31	-12.85	11.14	12.10	2.81	-1.42
Netting percentage (%)	2.56	0.00	0.00	0.00	6.67	50.77	-46.67	-18.33	26.32	56.93	-36.84	-15.00
Flesh thickness (cm)	24.93	28.48	14.14	11.58	11.79	0.56	10.10	11.58	19.17	9.35	10.42	1.22
TSS (%)	23.48	18.36	16.58	12.90	17.17	15.92	11.23	7.37	17.95	19.93	17.26	16.24

C*The control field which was irrigated by water with salinity reached to 955 ppm = 16.24 mM.

SThe stressed field which was irrigated by water with salinity reached to 2760 ppm = 46.92mM.**

Positive heterosis and heterobeltiosis were observed in all traits of the hybrid RIL 309 × RIL 307 either in the control field or under salinity stress. In this hybrid, the values of the positive heterosis and heterobeltiosis in the control field were the nearest of their values under salinity stress for all traits. So, this result confirmed the above results and demonstrated that the hybrid RIL 309 × RIL 307 had high level of salinity tolerance and could be using it under salinity stress. Likewise, in the hybrid RIL 309 × RIL 305 had positive heterosis and heterobeltiosis for total yield, fruit numbers/plant, fruit flesh thickness and TSS either in the control field or under salinity stress, but negative heterosis and heterobeltiosis for early yield in the control field and under salinity stress for heterobeltiosis only. Also, negative heterobeltiosis for average fruit weight and netting percentage either in the control field or under salinity stress, but positive heterosis for the same two traits and conditions. The values of heterosis and heterobeltiosis in the control field were the nearest of their values under salinity stress in some traits, but they were the farthest of their values under salinity stress in other traits. So, this result confirmed the above results and demonstrated that the hybrid RIL 309 × RIL 305 had moderate level of salinity tolerance. Finally, the hybrid RIL 307 × RIL 305 had positive heterosis and heterobeltiosis either in the control field or under salinity stress for all traits except early yield which had negative heterobeltiosis only in the control field, average fruit weight which had negative heterobeltiosis only under salinity stress and netting percentage which had negative heterobeltiosis either in the control field or under salinity stress. The values of heterosis and heterobeltiosis in the control field were the farthest of their values under salinity stress in all traits, except average fruit weight and TSS traits. So, this result confirmed the above results and demonstrated that the hybrid RIL 307 × RIL 305 had low level of salinity tolerance.

In conclusion, the findings confirmed that the muskmelon RILs 305 and 307 showed salinity tolerance till 50 mM NaCl and RIL 309 had salinity tolerance till 75 mM NaCl, but none of RILs had salinity tolerance at 100 mM NaCl. So, these selected three RILs produced three hybrids in one direction and their findings demonstrated that the hybrid RIL 309 × RIL 307 had high level of salinity tolerance, hybrid RIL 309 × RIL 305 had moderate level of salinity tolerance and hybrid RIL 307 × RIL 305 had low level of salinity tolerance. Finally, all measured traits didn't affect under salinity stress compared to control in the hybrid RIL 309 × RIL 307. This indicated that the hybrid RIL 309 × RIL 307 could be used under salinity stress condition.

REFERENCES

Ashraf, M. and M.A. Foolad (2007). Improving plant abiotic-stress resistance byexogenous application of osmoprotectants glycine betaine and proline. Env. Exp. Bot. 59: 206-216.

Ashraf, M. and P.J.C. Harris (2004). Potential biochemical indicators of salinity tolerance in plants. Plant Science 166: 3-16.

Botia, P., J.M. Navarro, A. Cerda and V. Martinez (2005). Yield and fruit quality of two melon cultivars irrigated with saline water at different stages of development. Eur. J. Agron. 23: 243-253.

Cha-um, S. and C. Kirdmanee (2009). Proline accumulation, photosynthetic abilities and growth characters of sugarcane (*Saccharum officinarum* L.) plantlets in response to iso-osmotic salt and water-deficit stress. Agric. Sci. China 8 (1): 51-58.

Dadkhah, A. (2011). Effect of salinity on growth and leaf photosynthesis of two sugar beet (*Beta vulgaris* L.) cultivars. J. Agric. Sci. Technol. 13:1001-1012.

Dasgan, H.Y., H. Aktas, K. Abak and I. Cakmak (2002). Determination of screening techniques to salinity tolerance in tomatoes and investigation of genotype responses. Plant Sci. 163: 695-703.

Dasgan, H.Y. and S. Koc (2009). Evaluation of salt tolerance in common bean genotypes by ion regulation and searching for screening parameters. J. Food Agric. Environ. 7(2): 363-372.

Del Amor, F.M, V. Martinez and A. Cerdá (1999). Salinity duration and concentration affect fruit yield and quality, and growth and mineral composition of melon plants grown in perlite. HortScience 34: 1234-1237.

Edelstein, M., Z. Plaut and M. Ben-Hur (2011). Sodium and chloride exclusion and retention by non-grafted and grafted melon and cucurbits plants. J. Exp. Bot. 62: 177-184.

Franco, J.A., J.A. Fernandez and S. Banon (1997). Relationship between the effects of salinity on seedling leaf-area and fruit yield of six muskmelon cultivars. HortScience 32: 642-644.

Gomez, A.K. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. 2nd ed. John Wiley & Sons Pub., New York**.**

Grzesiak, M.T., S. Grzesiak and A. Skoczowski (2006). Changes of leaf water potential and gas exchange during and after drought in triticale and maize genotypes differing in drought tolerance. Photosynthetica 44(4): 561-568.

Gurmani, A.R., S.U. Khan, F. Mabood, Z. Ahmed, S.J. Butt, J. Din, A. Mujeeb-Kazi and D. Smith (2014). Screening and selection of synthetic hexaploid wheat germplasm for salinity tolerance based on physiological and biochemical characters. Int. J. Agric. Biol. 16: 681-690.

Hussain, M., H.W. Park, M. Farooq, K. Jabran and D.J. Lee (2013). Morphological and physiological basis of salt resistance in different rice genotypes. Int. J. Agric. Biol. 15: 113-118.

Ibrarullah, H.U. Rahman, M.S. Jilani1, A.R. Gurmani and K. Ullah (2019). Tolerance response of muskmelon genotypes against salinity. Pak. J. Agri. Sci. 56(1): 63-70.

Islam, M., S. Afzal, I. Ahmad, Ahsan-ul-Haq and A. Hussain (2008). Salt tolerance among different sunflower genotypes. Sarhad J. Agric. 24: 241-250.

Kanwal, H., M. Ashraf and M. Shahbaz (2011). Assessment of salt tolerance of some newly developed and candidate wheat (*Triticum aestivum* L.) cultivars using gas exchange and chlorophyll fluorescence attributes. Pak. J. Bot. 43: 2693-2699.

Koch, Gary G. and P. K. Sen (1968). Some aspects of the statistical analysis of the mixed models. Biometrics 24: 27-48.

Kusvuran, S. (2010). Relationships between physiological mechanisms of tolerances to drought and salinity in melons. Ph.D. Thesis, Department of Horti. Inst. Of Natural and Appl. Sci. Uni. Of Çukurova, 356 pp.

Mangal, J.L., P.S. Hooda and S. Lal (1988). Salt tolerance of five muskmelon cultivars. J. Agr. Sci. 67: 535–540.

Mavrogianopoulos, G.N, J. Spanakis and P. Tsikalas (1999). Effect of carbondioxide enrichment and salinity on photosynthesis and yield inmelon. Sci. Hortic. 79: 51-63.

Meiri, A., Z. Plaut and L. Pincas (1981). Salt tolerance of glasshouse grown muskmelon. Soil Sci. 131: 189-193.

Mendlinger, S. (1994). Effect of increasing plant density and salinity on yield and fruit quality in muskmelon. Scientia Hort. 57: 41–49.

Mendlinger, S. and D. Pasternak (1992a). Effect of time of salinization on flowering, yield and fruit quality factors in melon, *Cucumis melo* L. J. Hort. Sci. 67: 529-534.

Mendlinger, S. and D. Pasternak (1992b). Screening for salt tolerance in melons. HortScience 27: 905-907.

Parida, A.K. and A.B. Das (2005). Salt tolerance and salinity effects on plants: a review. Ecotoxicol. Environ. Saf. 60: 324-349.

Shani, U. andL.M. Dudley (2001). Field studies of crop response to water and salt stress. Soil Sci. Soc. Am. J. 65: 1522-1528.

Shannon, M.C. and L.E. Francois (1978). Salt tolerance of three muskmelon cultivars. J. Amer. Soc. Hort. Sci. 103:127-130.

Stepien, P. and G. Klobus (2006). Water relations and photosynthesis in *Cucumis sativus* L. leaves under salt stress. Biol. Plant. 50: 610-616.

Tester, M. and R. Davenport (2003). Na+ tolerance and Na+ transport in higher plants. Ann. Bot. 91: 503-527.

Yildirim, E., A.G. Taylor and T.D. Spittler (2006). Ameliorative effects of biological treatments on growth of squash plants under salt stress. Sci. Hortic. 111: 1-6.

استجابة تحمل السلالات المرباه داخليا من الكنتالوب ضد للملوحة

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يعتبر الكنتالوب من أهم محاصيل الخضر التى تُزرع فى المناطق الجافة والشبه جافة حيث تنتشر الملوحة فى مثل هذه المساحات. لذلك أُجريت هذه الدراسة لتقدير التحمل للملوحة لعدد عشرون سلالة مرباه داخليا من الكنتالوب من خلال قياس معدل ونسبة انبات البذور فى تجربة معملية و قياس بعض الصفات المورفولوجية والبستانية لهذه السلالات فى تجربة قصارى تحت الصوب الشبكية بمعهد بحوث البساتين – مركز البحوث الزراعية – مصر اثناء العروه الصيفية المبكرة لعامى ٢٠١٦ و٢٠١٧، حيث عُرضت هذه السلالات لأربعة مستويات مختلفة من كلوريد الصوديوم بتركيزات صفر ملليمولر، و ٥٠ ملليمولر، و ٧٥ ملليمولر، و ١٠٠ ملليمولر، بعد ١٥ يوماً من زراعة البذور. النتائج أثبتت إزدياد التحمل للملوحة لأى تركيب وراثى مع إنحفاض قيمة معدل إنخفاض أو زيادة التركيب الوراثى عن الكنترول وذلك على حسب طبيعة الصفة محل الدراسة ، والعكس صحيح. لذلك أظهرت سلالات الكنتالوب RIL 305، وRIL 307 تحمل للملوحة حتى تركيز ٥٠ ملليمولر، بينما أظهرت السلالة RIL 309 تحملاً للملوحة حتى تركيز ٧٥ ملليمولر، ولكن لم تُظهر اى سلالة تحملاً للملوحة فى تركيز ١٠٠ ملليمولر فى كل الصفات المُقاسة. بناءاً على هذا التقييم، تم إختيار الثلاث سلالات السابقة كمُتحملة للملوحة، وأُجريت كل التلقيحات الممكنة فى اتجاه واحد لإنتاج بذور ثلاث هجن تحت الصوب بمزرعة بحوث الخضر بقها – محافظة القليوبية اثناء العروة الصيفية المتأخرة لعام ٢٠١٧. زُرعت هذه الهجن الثلاث بجانب آبائهم بالإضافة للهجين Gal 23، الذى أُستخدم ككنترول، فى حقلين يتم ريهم بنظام الرى بالتنقيط بمدينة السادات – محافظة المنوفية، احداهما يُروى بماء جوفى يصل تركيز الأملاح به إلى ٩٥٥ جزء فى المليون (أُستخدم كحقل كنترول)، والأخر يُروى بماء جوفى يصل تركيز الأملاح به إلى ٢٧٦٠ جزء فى المليون (أُستخدم كحقل لتقييم التحمل للملوحة) اثناء العروة الصيفية المبكرة لعام ٢٠١٨. أظهرت نتائج تقييم هذه الهجن تحت ظروف الملوحة مقارنة بحقل الكنترول ان الهجين RIL 309 × RIL 307 أظهر مستوى عالى من التحمل للملوحة، والهجين RIL 305 × RIL 309 أظهر مستوى متوسط من التحمل للملوحة، بينما أظهر الهجين RIL 305 × RIL 307 مستوى منخفض من التحمل للملوحة. أخيراً، لم تتأثر كل الصفات المقيسة تحت ظروف التعرض للملوحة مقارنة بحقل الكنترول فى الهجين RIL 309 × RIL 307. هذا دل على ان هذا الهجين يمكن زراعتة فى المناطق التى تحتوى أراضيها على نسبة عالية من الأملاح.

المجلة المصرية لتربية النبات ٢٤(٢): ٣٨٩- ٤١٢ (٢٠٢٠)