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Evaluation of Some Rice Cultivars to Salt Tolerance under Antioxidant Using Physiological Indices

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Abstract— *Salinity is considered as one of important physical factors influencing rice production. Soil salinity harmful influenced germination characters of rice cultivars Salinity is the main limiting factor that adversely affecting germination, growth and yield of rice. A laboratory experiment accompanied in the Giza Central Seed Testing Laboratory of Central Administration for Seed Certification (CASC), Ministry of Agriculture Egypt during May and June 2017. In order to investigate the salt tolerance of rice cultivars using some physiological parameters, i.e. germination stress, tolerance index, promptness index, shoot length, stress tolerance index, root length stress and tolerance index. Sakha 106 surpassed other cultivars promptness index, germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, Shoot dry fresh stress index, root dry stress index. Sown Sakha 106 cultivar exceeded Sakha 104 cultivar by 34.64% in germination stress tolerance index and 14.90 % in shoot height stress index and 30.26% in root fresh stress index. Sakha 106 cultivar exceeded Sakha 101 cultivar by 22.15 % in root dry stress index. Sakha 106 cultivar exceeded Giza 178 cultivar by 8.97 % in root height stress index and by 26.58 % shoot fresh stress index and by 20.70 % in shoot dry stress index. Humic acid at 500 ppm surpassed other antioxidants in germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry stress index and root dry stress index. Salinity level of 100 mM exceeded all salinity concentration in germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index, shoot fresh stress index, shoot dry fresh stress index, root fresh stress index. Increasing salinity concentration up to 300 mM decreased germination stress tolerance index, shoot length stress index, root length stress index, root fresh stress index, shoot fresh stress index, shoot dry stress index and root fresh stress index by 52.4, 38.6, 40.4, 39.5, 47.6 and 49.8 %, respectively. In general, in order to maximize physiological indexes parameters by priming seeds of Sakha 106 cultivar in Humic acid at 500 ppm. It can be used in breeding program to boost production in Egyptian territory.*
***Keywords*— Rice cultivars, Antioxidants, Salinity levels, Physiological indices parameters.**

I. INTRODUCTION

Soil salinity is the important abiotic stress problem in Egypt and the World. Rice genotypes differ in their salt tolerance due to their genetic and salts in the soil. Higher salinity level inhabits seed germination and root emergence due to osmotic effect, which is deleterious and prevents the plant in maintaining their proper nutritional requirements necessary for their healthy growth. To increase grain yield production of rice through cultivating modern rice cultivars in new reclaimed soil, which suffers from salinity also, clay soil as old soil gains salinity from irrigation salinity water and with drought.

Genetic variations among genotypes of wheat provide a practical for screening to salt tolerant cultivars for improving breeding program. Salinity mainly causes hyper-osmotic stress and hyper-ionic toxic effects, which leads to germination inhibition and seedling growth[1]. The relative shoot growth and chlorophyll content significantly reduced at 250 mM of NaCl through stomatal and non-stomatal factors[2] .The accessions with high GSTI, cell membrane stability (less % injury), PHSTI, DMSTI and low RSD were more salt tolerant than the others, thus seem promising for getting good productivity in salt-affected areas[3]. The variation among the genotypes for the physiological indices at germination and early seedling has been analyzed in many crop plants[4] . The physiological parameters tried in the present study are useful to screen large quantity of sorghum germplasm for salt tolerance leading to selection of suitable lines that can recommended for different saline areas to improve yields[5] . Osmotic adjustment can be an important component of drought resistance in wheat within a relevant environmental context[6] . Root growth was different among cultivars even when treated with normal water. The cultivar C3 (mix white and red seeds) was observed as more salt tolerant and cultivar C4 was more salt sensitive on the basis of the germination-ability and shoot development. Cultivar C3 observed to produce better seeds compared with the other cultivars[7] . The SARC-I (V5), Sehar-2006 (V8) and Shafaq-2006 (V9) genotypes were found tolerant to salinity because of better growth, lower NaCl relative toxicities, leaf Na^+, higher tolerance indices, photosynthetic rate, total chlorophyll contents, transpiration rate, stomatal conductance and leaf K^+ concentration[8] . Physiological indices can use to screen the wheat germplasm for salt tolerance. Tolerant genotypes can directly recommend for cultivation on salt affected soils or can used to develop high yielding salt tolerant wheat cultivars[9] . Therefore, the goals of this investigate aimed to study the salt tolerance of wheat cultivars using some physiological parameters, *i.e.* germination stress, tolerance index, promptness index, shoot length, stress tolerance index, root length stress and tolerance index. Salt total and salt ranking tolerance indices grouped the wheat entries into tolerant i.e. Bayraktar 2000, Gerek 79, İkizce 96, Gün 91, Demir 2000, and Momtchil and susceptible ones i.e. Population-4, Population-14, Population-15, Population-9, Population-11, and Population-10[10] . Screening at seedling stage along with other morphological, physiological parameters and stress indices do provide useful clues about the salt tolerance potential of rice genotypes[11] . Sown Sids-13 cultivar appeared to the most tolerant cultivar shadowed by Misr-1, Misr-2, Gimmeza-9, Gimmeza-11, Sids-12, Sakha-93, Sakha-94, and Giza-186 cultivars and the last rank was Shadwell-1 cultivar with the maximum sensitivity[12] . Soaking of Gemmiza 12 or Misr 1 cultivars in concentration of 200 ppm of ascorbic acid for 12 h under salinity stress for enhance physiological indices of wheat[13] . The objective of present study was to evaluate rice cultivars under NaCl stress, antioxidants and physiological indices. Our study is an attempt to compare the usefulness of several stress indices for identification of cultivars with better performance at different levels of salt stress.

II. MATERIALS AND METHODS

2.1. Treatments and Experimental Design:

A laboratory experiment conducted in the Giza Central Seed Testing Laboratory of Central Administration for Seed Certification (CASC), Ministry of Agriculture Egypt during May and June 2017, to study the response of antioxidants seed prim of some bread wheat cultivars to germinate under salinity levels. A factorial experiment in Randomized Complete Block Design in four replications used. The five rice cultivars, Giza 178, Egyptian Hybrid 1, Sakha 101, Sakha 104 and Sakha 106 cultivars include the first factor. The second factor includes the four salinity levels 0, 100, 200 and 300 mM. The four types of antioxidants, Salicylic acid 100 ppm, Folic acid 15mM, Ascorbic acid 100 PPM and Humic acid 500 PPM includes the third factor. Selected cultivars obtained from Rice Research Institute at Sakha, ARC, Ministry of Agriculture, Egypt. Rice cultivars stored under normal conditions in paper bags. Each cultivar was prim in the antioxidants at above concentrations of 24 hours. Each cultivar irrigated with sodium chloride solution as above concentrations under the chamber condition at 28±1ºc with darkness. Thereafter, seeds moistened with distilled water under control treatments. The prim seeds in antioxidants and non-primed seed of study cultivars sown in Petri dishes used fifty seeds per each treatment for each cultivar allowed to germinate on Petri dishes moistened with a water solution at three different NaCl concentrations except the control. The experiment consisted of 400 Petri dishes arranged in a factorial experiment in Randomized Complete Block Design (RCBD) at 4 replications placed in a growth chamber for 14 days at 28±1 ºc for germination according to[14].

2.2. Studied Characters:

Physiological indices:

To calculate the germination stress tolerance index (GSI), promptness index (PI) was estimated using following formula[3].

$$\textbf{Promptness index}\ (PI) = nd1\ (1.00) + nd2\ (0.75) + nd3\ (0.50) + nd4\ (0.25)$$

Where nd1, nd2, nd3 and nd4 = Number of seeds germinated on the 1st, 2nd, 3rd and 4th day, respectively.

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The germination stress tolerance index (GSI) calculated in terms of percentage as follows:
1-Ggermination stress tolerance index (GSTI) = It calculated according the following formula:

$$\textbf{GSTI} = \frac{\text{PI of stress seeds}}{\text{PI of control seeds}} \times 100$$

After 14 days of the experiment, shoot and root lengths and fresh weights were calculated. The plants dried at 70oC for two days and their dry weight recorded. Root and shoot length stress tolerance index (RLSI, SLSI) and fresh and dry matter stress tolerance indices (FMSI, DMSI) calculated according to the following formula:
2- Seedlings height stress index (PHSI): It calculated according the following formula:

$$\textbf{PHSI} = \frac{\text{Seedlings height of stressed seeds}}{\text{Seedlings height of the control}} \times 100.$$

3- Root length stress index (RLSI) = It calculated according the following formula:

$$\textbf{RLSI} = \frac{\text{Seedlings length of stressed seeds}}{\text{Seedlings length of the control}} \times 100.$$

4- Shoot fresh stress index (SFSI) = It calculated according the following formula:

$$\textbf{SFSI} = \frac{\text{Shoot fresh weights of stressed seeds}}{\text{Shoot fresh weights of the control}} \times 100.$$

5- Root fresh stress index (RFSI) = It calculated according the following formula:

$$\textbf{RFSI} = \frac{\text{Root fresh weights of stressed seeds}}{\text{Root fresh weights of the control}} \times 100.$$

6- Shoot dry stress index (SDSI) = It calculated according the following formula:

$$\textbf{SDSI} = \frac{\text{Shoot dry weights of stressed seeds}}{\text{Shoot dry weights of the control}} \times 100.$$

7- Root dry stress index (RDSI) = It calculated according the following formula:

$$\textbf{RDSI} = \frac{\text{Root dry weights of stressed seeds}}{\text{Root dry weights of the control}} \times 100.$$

2.3. Experimental analysis:

The data collected was analysis, statistically by the analysis of variance technique using the MSTAT–C statistical package programmed as described by a procedure of[15]. Lest significant differences test (LSD) for 5 and 1 % level of probability was used for comparing between treatment means, according to[16] MSTAT-C computer based data analysis software[17].

III. RESULTS AND DISCUSSION

3.1. Cultivar Performance:

The results presented in Tables 1 and 2 showed a significant effect by studied rice cultivars in germination stress tolerance index, shoot length stress index, Root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index. Sakha 106 surpassed other cultivars promptness index, germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root dry stress index. Sown Sakha 106 cultivar exceeded Sakha 104 cultivar by 34.64% in germination stress tolerance index and 14.90 % in shoot height stress index and 30.26% in root fresh stress index. Sakha 106 cultivar exceeded Sakha 101 cultivar by 22.15 % in root dry stress index. Sakha 106 cultivar exceeded Giza 178 cultivar by 8.97 % in root height stress index and by 26.58 % shoot fresh stress index and by 20.70 % in shoot dry stress index.

(73.16%), shoot dry fresh stress index (70.68%), root dry stress index (63.98%) compared with the control and other antioxidants.

Table 1: Means of promptness index, germination stress tolerance index, and shoot height stress index as affected by cultivars, antioxidants and salinity levels.

Characters / Treatments	Promptness index (PI)%	Germination stress tolerance index %	Shoot Height stress index %	Root Height stress index (RLSI) %
A- Cultivars:				
Giza 178	3.59	53.40	70.96	68.18
Egyptian Hybrid 1	3.46	60.21	81.92	74.90
Sakha 101	3.13	52.29	76.43	70.31
Sakha 104	3.29	50.62	70.12	74.11
Sakha 106	6.25	77.45	82.40	69.27
LSD at 5%	0.06	0.84	0.72	0.95
B- Antioxidants:				
Control	4.26	63.84	78.08	73.58
Humic acid at 500 ppm.	5.05	76.40	80.92	74.22
Ascorbic acid at 100 ppm	3.35	49.50	76.93	69.61
Folic acid at 15 mM	3.93	58.30	73.10	70.56
Salicylic acid at 100 ppm.	3.13	45.92	72.81	68.80
LSD at 5%	0.06	0.85	0.72	0.95
Interaction effects:				
A * B	*	*	*	*
C: Salinity Stress				
0 mM	5.27	78.89	93.46	91.25
Characters / Treatments	**Promptness index (PI)%**	**Germination stress tolerance index %**	**Shoot Height stress index %**	**Root Height stress index (RLSI) %**
100 mM	4.44	66.44	80.81	74.69
200 mM	3.55	52.30	73.88	65.18
300 mM	2.52	37.55	57.31	54.30
LSD at 5%	0.05	0.75	0.64	0.85
Interaction effects:				
A * C	N.S.	N.S.	N.S.	*
B * C	N.S.	N.S.	N.S.	N.S.
A * B * C	N.S.	N.S.	N.S.	N.S.

3.2. Antioxidants Effects:

Results presented in Tables 1 and 2 indicated that germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index were significantly affected by studied antioxidants, while, Shoot Fresh Weight non-significant effected by studied antioxidants. Humic acid at 500 ppm surpassed other antioxidants in Germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index. Soaking in Humic acid at 500 ppm recorded the highest percentages of germination stress tolerance index (76.40%), shoot length stress index (80.92%), root length stress index (74.22%), shoot fresh stress index (76.79%), root fresh stress index (73.16%), shoot dry fresh stress index (70.68%), root dry surpassed other antioxidants in Germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index. Soaking in Humic

3.3. Salinity Stress Effects:

The results indicated that germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry stress index, root dry stress index was significantly affected by studied salinity concentration as shown in Tables 1 and 2. The results showed that salinity level of 100 mM exceeded all salinity concentration in germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index, shoot fresh stress index, shoot dry fresh stress index, root fresh stress index. Increasing salinity concentration up to 300 mM decreased germination stress tolerance index, shoot length stress index, root length stress index, root fresh stress index, shoot fresh stress index, shoot dry stress index and root fresh stress index by 52.4, 38.6, 40.4, 39.5, 47.6 and 49.8 %, respectively

Table 2: Means of root fresh stress index, root height stress index, shoot dry stress index, root dry stress index and shoot fresh stress index as affected by cultivars, antioxidants and salinity levels.

Characters / Treatments	Root fresh stress index (RFSI) %	Shoot fresh stress index (SFSI) %	Shoot dry stress index (SDSI) %	Root dry stress index (RDSI) %
Giza 178	72.20	83.62	71.73	61.39
Egyptian Hybrid 1	71.60	76.57	70.77	63.20
Sakha 101	79.11	70.08	61.46	67.42
Sakha 104	50.83	67.78	64.74	56.93
Sakha 106	72.89	61.52	56.88	52.48
LSD at 5%	1.08	0.66	1.84	1.74
Control	72.69	74.14	67.30	63.15
Humic acid at 500 ppm.	73.16	76.79	70.68	63.93
Ascorbic acid at 100 ppm.	69.98	75.64	67.47	61.88
Folic acid at 15 mM	64.48	65.12	66.70	58.60
Salicylic acid at 100 ppm.	66.32	67.86	53.44	53.07
LSD at 5%	1.08	0.66	1.84	1.74
A * B	*	*	*	*
0 mM	87.77	87.36	89.24	86.32
100 mM	72.50	74.94	67.30	61.12
200 mM	63.95	66.70	57.26	50.41
300 mM	53.03	58.65	46.68	43.28
LSD at 5%	0.34	0.59	1.64	1.56
A * C	*	*	*	*
B * C	N.S.	N.S.	N.S.	N.S.
A * B * C	N.S.	N.S.	N.S.	N.S.

3.4. Interaction Effects:

3.4.1. Interaction between cultivars and antioxidants effect:

The results indicated that germination stress tolerance index, shoot length stress index, root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index was significantly affected by the interaction effect between studied cultivars and antioxidants concentrations as illustrated in Figs. 1, 2, 3, 5, 6 and 7. The results indicated that the highest promptness index (4.88%), germination stress tolerance index (81.25%), root length stress index (80.29%), were gotten from soaking Sakha 106 cultivar in Humic acid at 500 ppm as illustrate in Figs 1, 2, 3, and 4. However, the lowest. promptness index (2.52%), germination stress tolerance index (37.34%) and root length stress index (60.16%) were gotten from soaking Giza 178 cultivar in Salicylic acid at 100 ppm. The highest root fresh stress index (88.97%) and root dry stress index (76.15) was obtained from soaking Sakha 106 cultivar in Humic acid at 500 ppm as demonstrated in Fig. 5 and 8. The highest shoot dry stress index (95.5%) and shoot dry stress index (81.38%) was obtained from soaking Egyptian hybrid 1 cultivar in Humic acid at 500 ppm as illustrated in Fig. 6 and 7. The highest root fresh stress index was obtained from the interaction between Sakha 106 cultivar with seed soaking in ascorbic acid at 100 ppm.

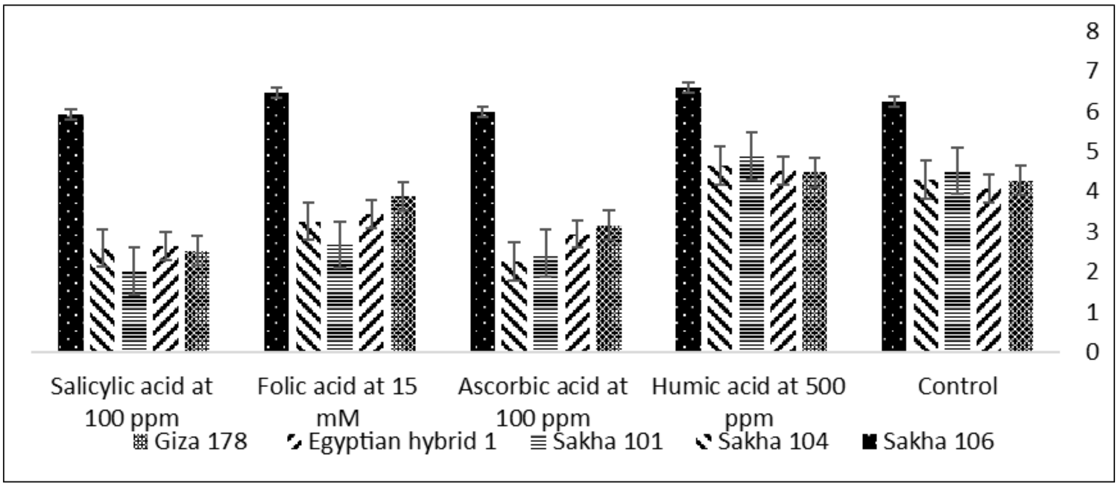

Fig 1. Means of promptness index as affected by the interaction between cultivars and antioxidants.

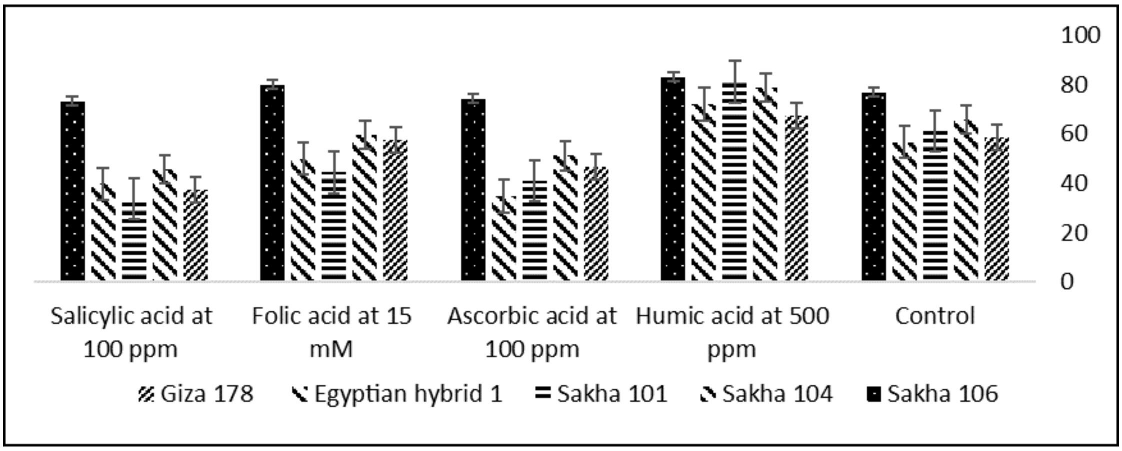

Fig. 2. Means of germination stress tolerance index as affected by the interaction between cultivars and antioxidants.

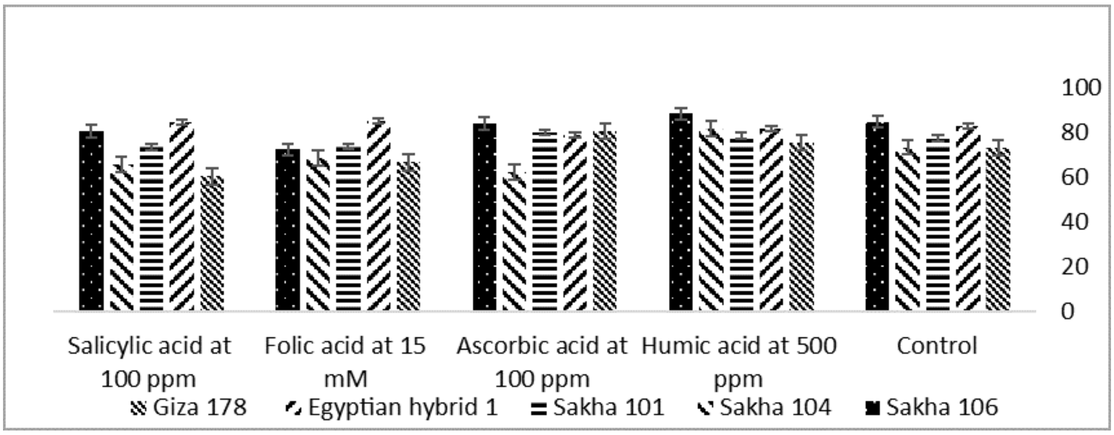

Fig. 3. Means of shoot height stress index as affected by the interaction between cultivars and antioxidants.

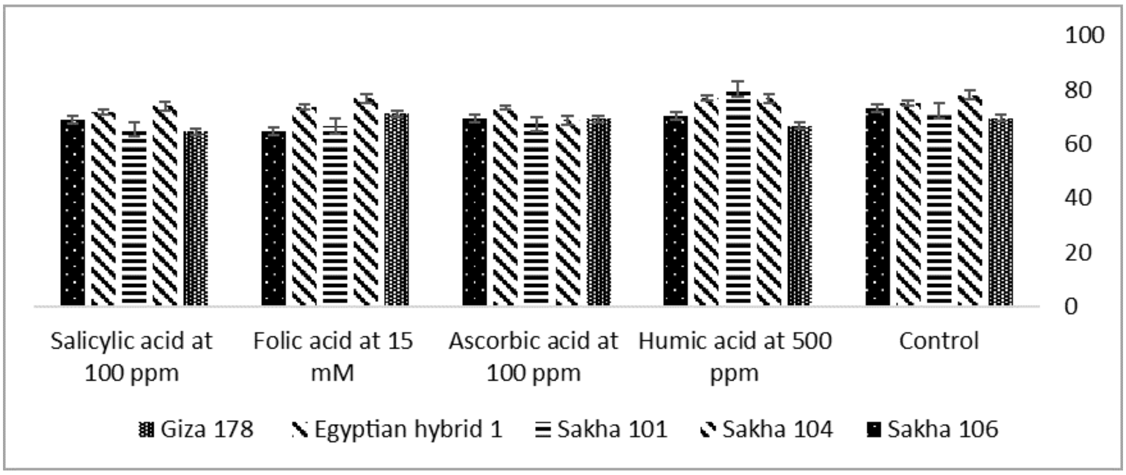

Fig. 4. Means of root height stress index as affected by the interaction between cultivars and antioxidants.

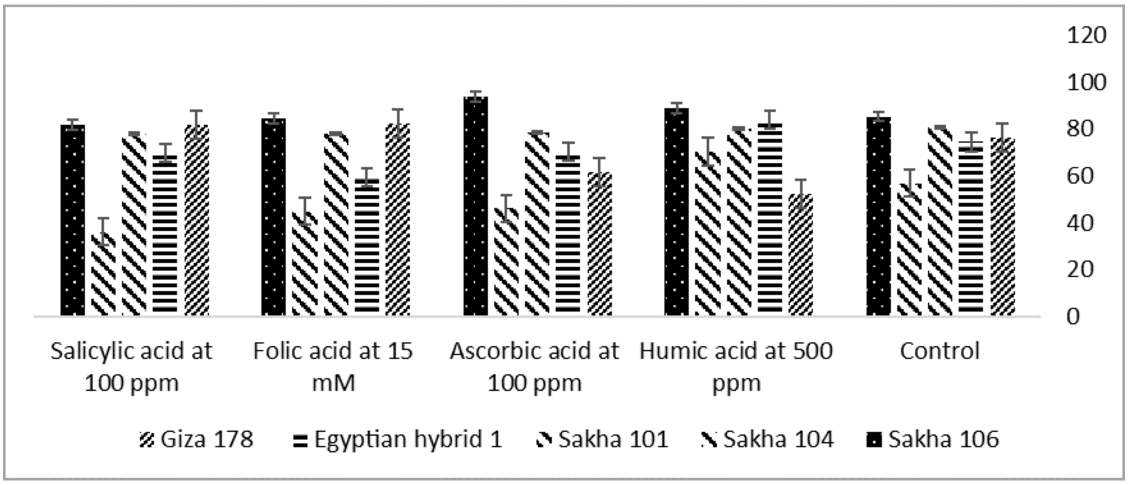

Fig. 5. Means of root fresh stress index as affected by the interaction between cultivars and antioxidants.

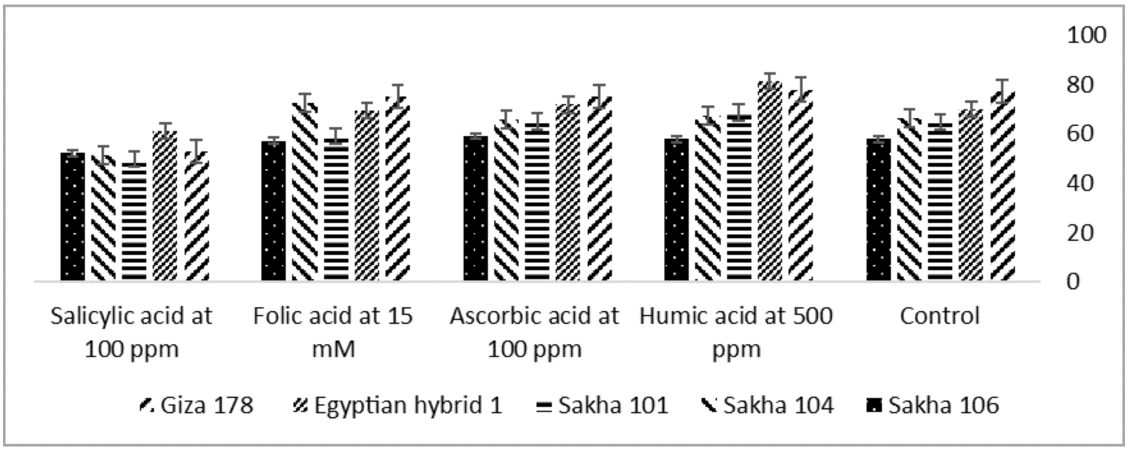

Fig. 6. Means of shoot dry stress index as affected by the interaction between cultivars and antioxidants.

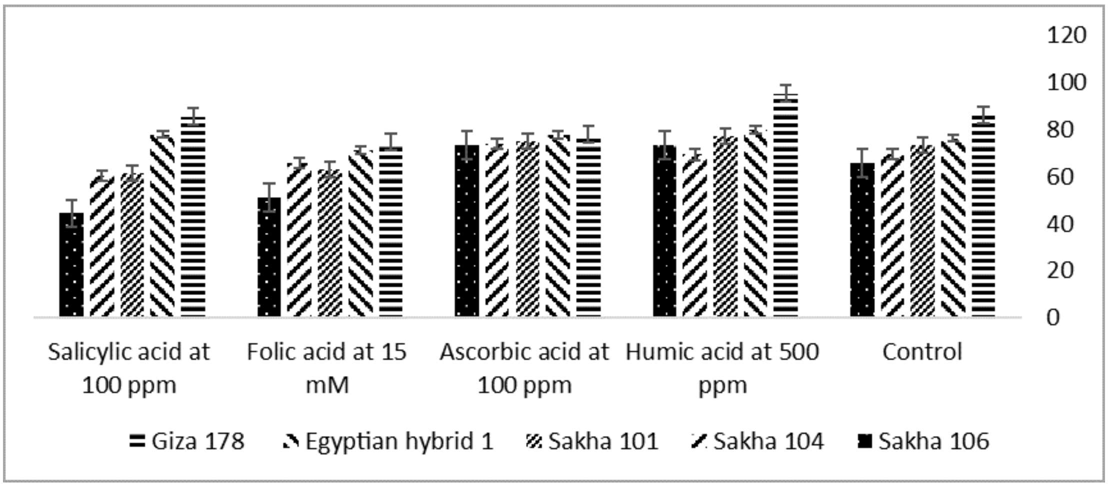

Fig. 7. Means of shoot fresh stress index as affected by the interaction between cultivars and antioxidants.

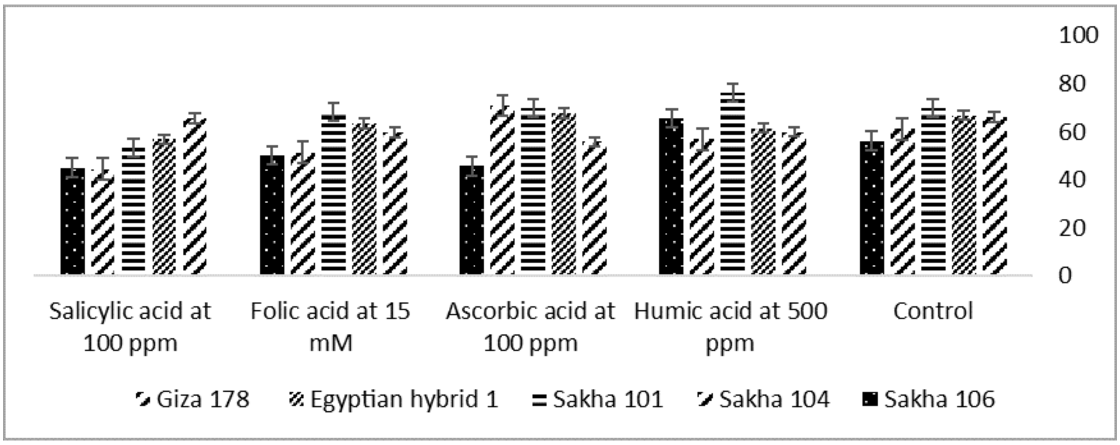

Fig. 8. Means of root dry stress index as affected by the interaction between cultivars and antioxidants.

3.4.2. Interaction between cultivars and salinity levels effect:

The results indicated that root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index and root dry stress index were significantly affected by the interaction effect between studied cultivars and salinity concentrations (Tables 1 and 2). While, germination stress tolerance index and shoot length stress index were insignificantly affected. The tallest root length stress index (96.40%) was recorded from without soaking of Sakha 104 cultivar, while the lowest percentages (50.51%) produce from soaking Giza 178 cultivar in 300 mM as demonstrated in Fig. 9. The highest percentages of root fresh stress index (98.48%)

was obtained from without soaking of Sakha 106 cultivar, while, the lowest percentages (30.56%) was obtained from Sakha 104 cultivar and 300 mM as illustrated in Fig. 10. The highest percentages of shoot fresh stress index (90.33%) and shoot dry stress index (90.33%) was obtained from without soaking Egyptian Hybrid 1 and the lowest from Soaking Sakha 106 or Sakha 104 cultivars in 300 mM as illustrated in Figs 11 and 12. The highest root dry stress index (91.38%) was obtained from without soaking Sakha 101 cultivar and the lowest percentages (33.24%) was obtained from soaking in with salinity level of 300 mM of Na Cl as demonstrated in Figs 13.

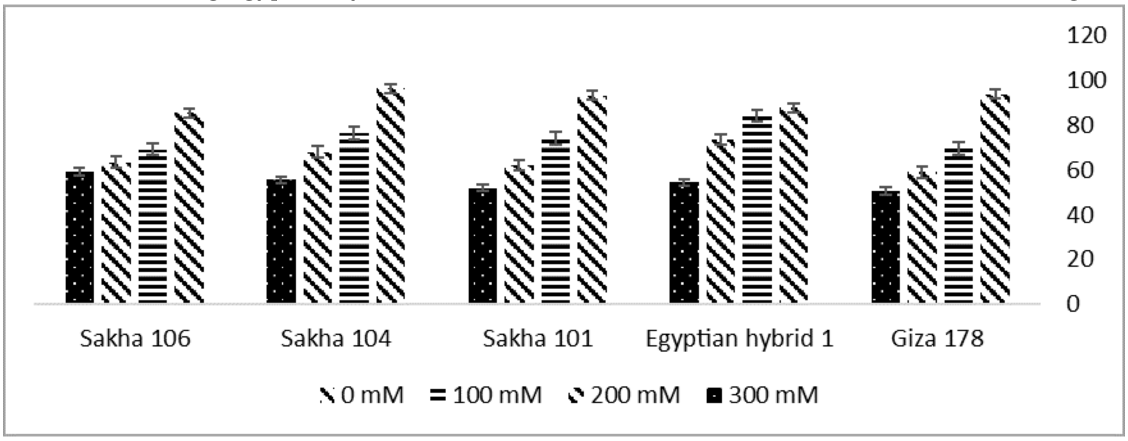

Fig. 9. Means of root height stress index as affected by the interaction between cultivars and salinity stress.

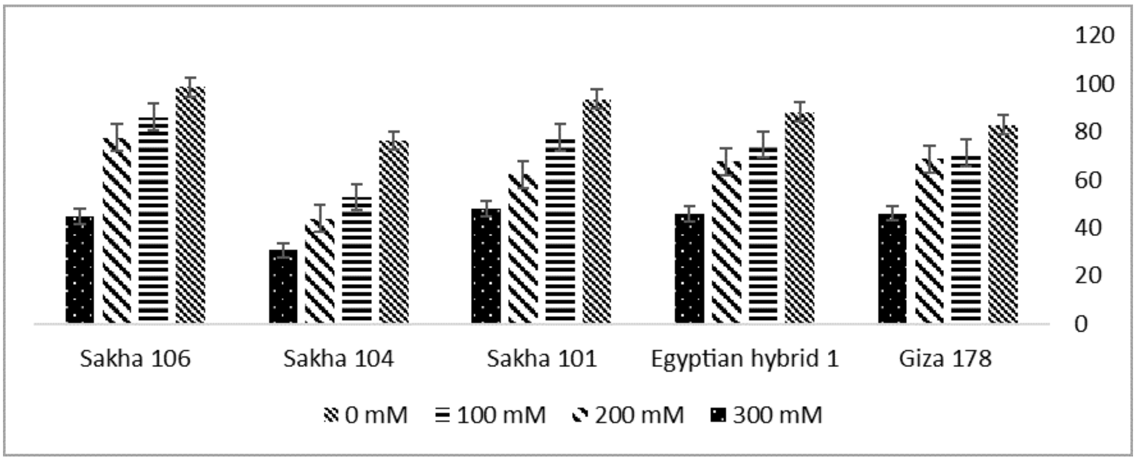

Fig. 10. Means of root fresh stress index as affected by the interaction between cultivars and salinity levels.

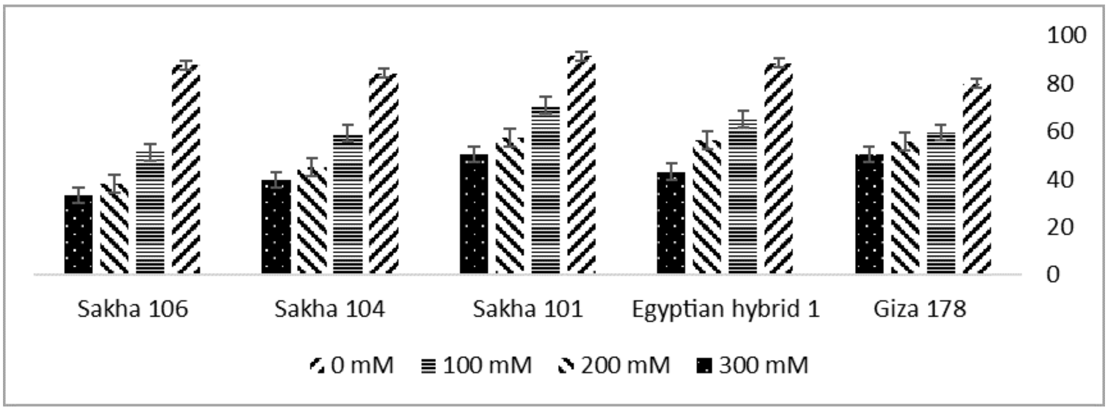

Fig. 11. Means of shoot dry stress index as affected by the interaction between cultivars and salinity stress.

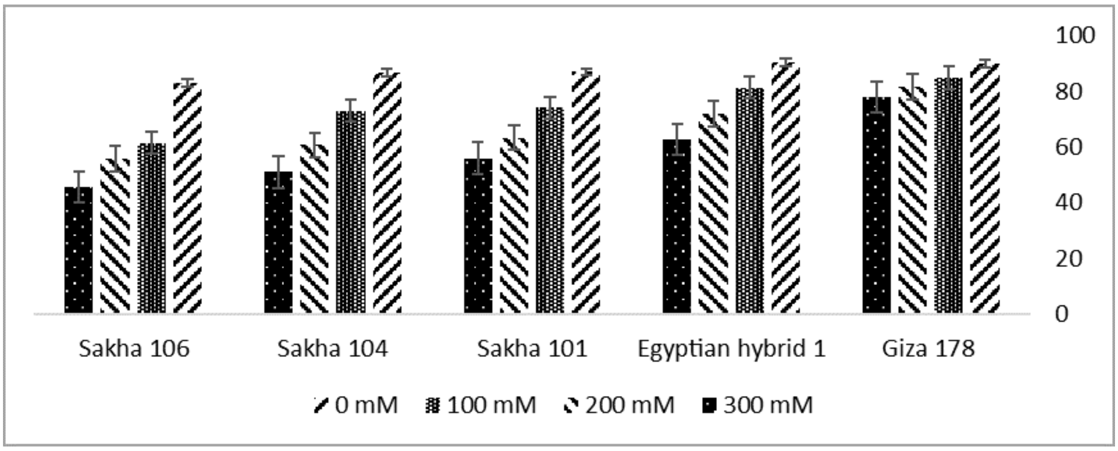

Fig. 12. Means of shoot fresh stress index as affected by the interaction between cultivars and salinity stress.

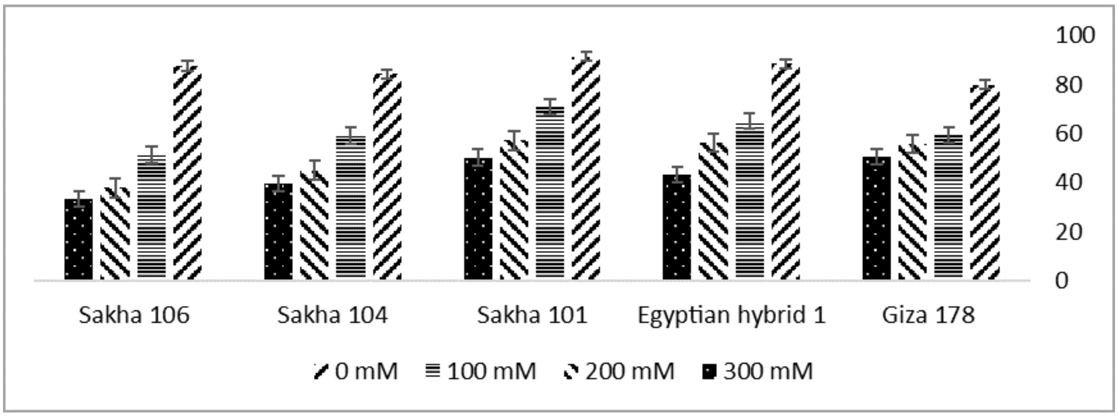

Fig. 13. Means of root dry stress index as affected by the interaction between cultivars and salinity levels.

3.4.3. Interaction between antioxidants and salinity levels effect:

With reference to the interaction effect between antioxidants and salinity levels on germination stress tolerance index, shoot length stress index, Root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index insignificantly affected as offered in Table 1 and 2.

3.4.4. Interaction between cultivars x antioxidants x salinity level effect:

The interaction effect between cultivars, antioxidants and salinity levels on germination stress tolerance index, shoot length stress index, Root length stress index, shoot fresh stress index, root fresh stress index, shoot dry fresh stress index, root fresh stress index insignificantly affected as illustrated in Tables 1 and 2.

IV. CONCLUSION

It could be concluded that in order to maximize physiological indexes parameters by priming seeds of Sakha 106 cultivar in Humic acid at 500 ppm. It can be used in breeding program to boost production in Egyptian territory.

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