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Research Article

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Individual and combined effects of antioxidant and salinity on germination characters of rice

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ABSTRACT

A germination experiment was carried out in rice to study the role played by various antioxidants on germination parameters under salt stress in some rice cultivars. The results indicated that the highest germination percentage, rate (days), index and speed were recorded in Sakha 106 cultivar. An increase in the concentration of salt from 100 mM to 300 mM resulted in a reduction in these parameters. Pretreatment of the seeds with Humic acid at 500ppm increased these studied parameters. All studied characters were affected by the interaction between rice cultivars, salinity concentrations and antioxidants. In general, the study suggested that antioxidant pretreatment in rice seeds can be considered as a potential tool to enhance germination parameters under salinity stress, especially in rice Sakha 106 cultivars.

KEYWORDS: Rice cultivars, antioxidants, salinity levels, germination parameters

INTRODUCTION

Rice (*Oryza sativa* L.) is one among the widely cultivated and used cereal crops in the world. The cultivation of rice is greatly inhibited by salinity in Egypt [1]. Salinity is a serious threat to rice production in North Delta, Egypt. 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 [2].

There are numerous studies about salinity tolerance and mechanisms in many plants and also in rice cultivars [3-8]. Treatments of seeds of Giza 177 and Sakha 103 cultivars with salicylic or ascorbic acid induced one Esterase3 isoenzymes. Pre-sowing rice seed of Sakha 104 cultivar with Ascorbic produced the highest germination percentage, speed germination index and germination rate compared with other two cultivars under salinity condition [9].

There are reports about increased proline and antioxidant metabolism under salinity, which confers salinity tolerance to the plants [10-12]. The present study undertaken with the aim to study the role played by various antioxidant components in the salt tolerance mechanism of some rice cultivars.

MATERIALS AND METHODS

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 replication 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 15 mM, 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.

The germination parameters like final germination percentage, germination rate, germination index and energy of germination were estimated by following standard methods [13-16].

Statistical Analysis

The data collected were analyzed, statistically by the analysis of variance technique using the MSTAT–C statistical package

as described [17]. Lest significant differences test (LSD) for 5 % level of probability used for comparisons between treatment means [18].

RESULTS AND DISCUSSION

Cultivar Performance

Results in Table 1 showed that studied rice (*Oryza sativa* L.) cultivars significantly affected the germination parameters. Sakha106 cultivar surpassed other cultivars in averages of final germination percentage, germination rate, germination index and germination speed. While, Sakha104 cultivar showed the least values. The highest final germination percentage in Sakha106 cultivar it was 89.77% while the lowest in Sakha 104 cultivar it was 71.60%. It could be noticed that, Sakha106 cultivar surpassed Egyptian hybrid 1, Giza 178, Sakha 101 and Sakha 104 cultivars in final germination percentage by 15.41, 17.57, 18.76 and 20.24% respectively. Highest Germination rate was in Sakha106 cultivar it was 3.68% while the lowest was in Sakha 104 cultivar it was 2.82%. It could be observed that, Sakha106 cultivar surpassed Giza 178, Egyptian hybrid1, Sakha 101and Sakha 104 by 15.76, 16.30, 20.38 and 23.36%, respectively. There were significant differences in germination index among all studied cultivars. The highest germination index, which was 92.26% in Sakha106 cultivar, while, the lowest germination index was 81.60% in Sakha 104. Sakha106 cultivar surpassed, Egyptian hybrid1, Sakha 101, Giza 178, and Sakha 104 cultivars in germination index by 6.48, 11.46, 11.52 and 11.55 %, respectively. The results showed that there were significant differences due to Cultivars in germination speed. Sakha 106 recorded the highest germination speed, which was 47.20%. %.While, the lowest germination speed was obtained from Sakha 104, which was 41.27%. Sakha 106 cultivar surpassed Giza 178, Sakha101, Egyptian Hybrid1, and Sakha101cultivars in germination speed by 9.59, 10.52, 11.02 and 12.56%, respectively. Similar conclusion was obtained from results of [19-22].

Salinity Stress Effects

Table 2 shows that salt level significantly affected final germination percentage, germination rate, germination index and germination speed in rice cultivars. Our results are in accordance with previous studies [23, 24, 25, 26].

Antioxidants Effects

Table 3 shows the results of final germination percentage in rice under treatment with antioxidants. Humic acid, Ascorbic acid, Folic acid and Salicylic acid significantly exceeded which were 80.87, 78.13, 76.74 and 71, respectively when compared with the control, which was 77.77. It could be noticed that, humic acid surpassed Ascorbic acid, control, Folic acid and Salicylic acid in final germination percentage by 3.38, 3.83, 5.44 and 12.20% respectively. Humic acid, Ascorbic acid, Folic acid and Salicylic acid significantly exceeded significant differences between them, which were 3.27, 3.23, 3.20 and 2.92%, respectively compared with the control, which was 2.99%. It could be observed that humic acid surpassed Ascorbic acid, Folic acid, control and Salicylic acid in germination rate by 1.22, 2.14, 8.56 and 11.98%, respectively. Results indicated that, there were significant differences in germination speed between humic acid, Ascorbic acid, Folic acid, and Salicylic acid. Significantly exceeded which were 45.67, 44.33, 43.80 and 41.00 respectively compared with the control, which was 39.57. It could be noticed that humic acid surpassed Ascorbic acid Folic acid, and Salicylic acid compared with the control treatment in germination speed by 2.93, 4.09, 10.22 and 13.35%, respectively. These responses are in accordance with previous studies [27-30].

Interaction Effects

Interaction between cultivars and salinity effect

With respect to the interaction effects data illustrated in Figures 1-4 clearly showed that germination parameters were significantly affected by the interaction between studied cultivars and salinity. our results are in agreement with previous studies [31-34].

Interaction between cultivars and antioxidant effect

With respect to the interactions between antioxidants and cultivars in Figures 5-8 clearly showed that final germination percentage, germination rate, germination index and germination speed were significantly affected by the interaction between studied cultivars and antioxidant. The highest germination speed was produced from Sakha 106 cultivar, which was 49.00 and 47.67, respectively with pretreatment by Ascorbic acid at 100 ppm and humic acid at 500 ppm, compared with the control treatment. It could be stated that Sakha 106 cultivar surpassed in these

Table 1: Variations in final germination percentage %, Germination rate, Germination index (%) and Germination speed (%) among rice cultivars

Characters Treatments	Final germination percentage (%)	Germination rate (days) (%)	Germination index (%)	Germination speed (%)
A- Cultivars				
Giza 178	74.00	3.10	81.63	42.67
Egyptian Hybrid 1	75.93	3.08	86.28	42.00
Sakha 101	72.93	2.93	81.68	42.23
Sakha 104	71.60	2.82	81.60	41.27
Sakha 106	89.77	3.68	92.26	47.20
LSD at 5%	0.75	0.07	1.10	0.80

paramters under pretreatment by humic acid at 500ppm and Ascorbic acid at 100 ppm than the other studied cultivars. Similar conclusion was observed by previous researchers [35-38].

Table 2: Effect of increasing salt concentration on germination parameters of rice

Characters Treatments	Final germination percentage (%)	Germination rate (days) (%)	Germination index (%)	Germination speed (%)
B- Salinty levels				
0 mM	86.45	3.46	95.59	49.33
100 mM	82.56	3.18	91.27	44.24
200 mM	72.99	3.13	80.59	41.33
300 mM	65.39	2.72	72.17	37.39
LSD at 5%	0.67	0.06	0.35	0.71

Interaction between antioxidants types and salinity levels effect

Means of, the interactions between Salinity and Antioxidants as shown in Figure. 9 showed that the interactions between Salinity and Antioxidants significantly affected final germination percentage. The results clearly indicated that highest final germination percentage was in control treatments and 0mM salinity it was 90.4%, increasing salinity levels from 100, 200 and 300 mM of NaCl reduced final germination percentages by 82.13, 73.47 and 65.07 respectively. The others antioxidants as humic acid at 500 ppm, Ascorbic acid at 100 ppm, Folic acid at 15 mM and Salicylic acid at 100 ppm. It could be observed that, all Antioxidants under salinity levels as 100, 200 and 300

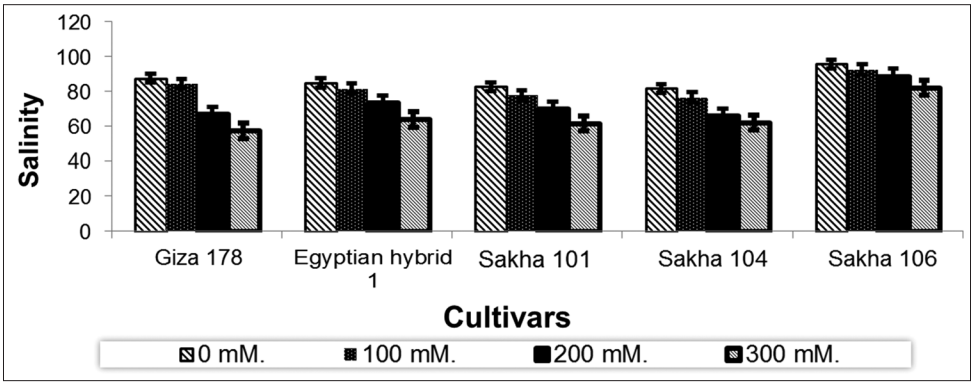

Figure 1: Percentage of final germination as affected by the interaction between cultivars and salinity levels of NaCL.

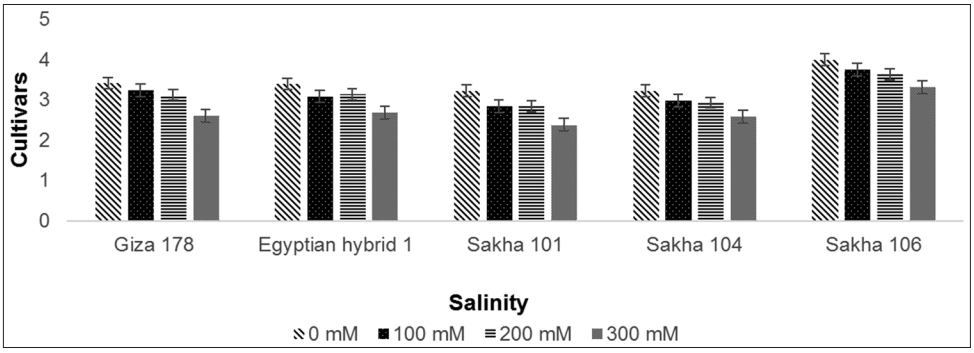

Figure 2: Means of germination rate % for the interactions between cultivars and salinity levels of NaCL.

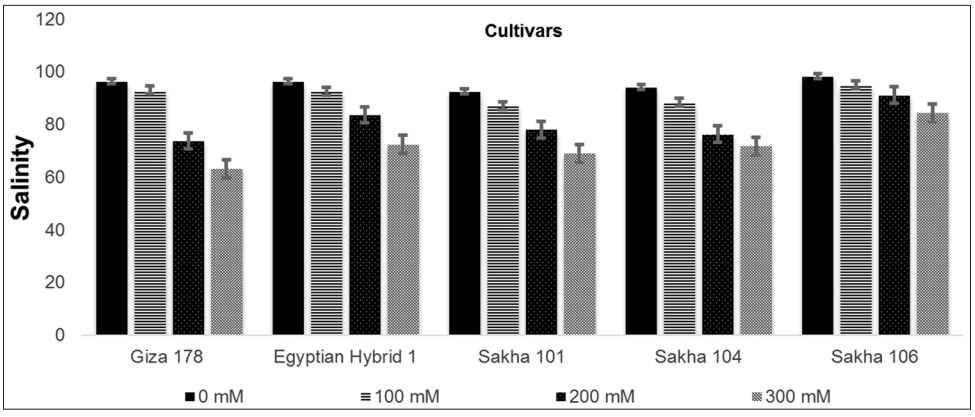

Figure 3: Means of germination index % for the interactions between cultivars and salinity levels of NaCL.

Table 3: Effect of antioxidants concentration on germination parameters of rice

Characters Treatments	Final germination %	Germination rate (days) (%)	Germination index (%)	Germination speed (%)
C – Antioxidants				
Control	77.77	2.99	85.92	39.57
Humic acid at 500 ppm	80.87	3.27	89.36	45.67
Ascorbic acid at 100 ppm	78.13	3.23	86.34	44.33
Folic acid at 15 mM	76.47	3.20	84.51	43.80
Salicylic acid at 100 ppm	71.00	2.92	78.39	41.00
LSD at 5%	0.75	0.07	1.10	0.80

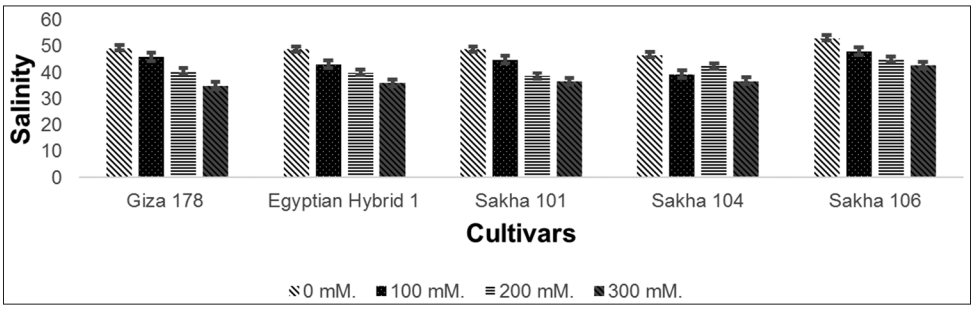

Figure 4: Means of germination speed % for the interactions between Cultivars and Salinity levels of NaCL.

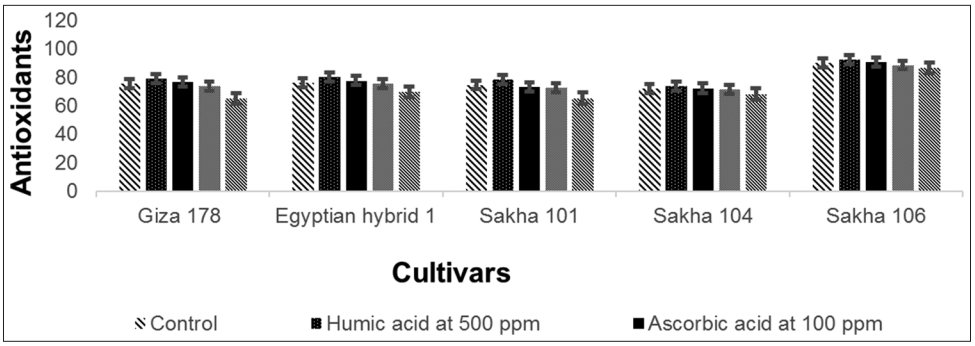

Figure 5: Means of final germination percentage % for the interactions between cultivars and antioxidants concentrations.

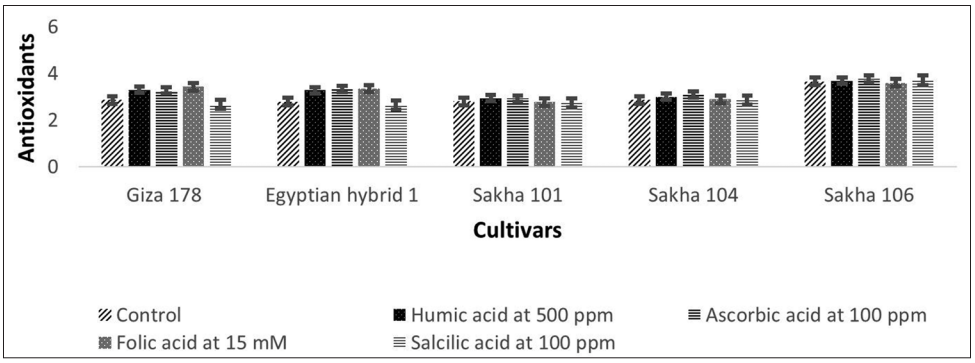

Figure 6: Means of germination rate % for the interactions between cultivars and antioxidants concentrations.

highest results than the control treatments. These results are in agreement with those reported [39-43].

With respect to, the interactions between Salinity and Antioxidants as shown in Figure. 11 showed that the interactions between Salinity and Antioxidants significantly affected germination index. The results clearly indicated that highest germination index in Humic acid at 500 ppm was in 0 mM of salinity it was 99.10%, increasing salinity levels from 100, 200 and 300 mM of NaCl reduced germination index the lowest was 64.73 in Salicylic acid at 100 ppm in 300 mM of NaCl. In this respect, previous study [44] reported that Ascorbic acid is a major primary antioxidant, and Salicylic acid is an endogenous growth regulator of phenolic nature.

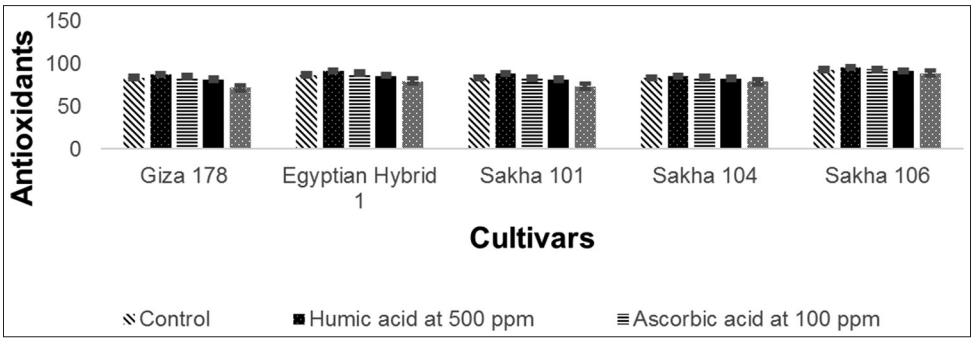

Figure 7: Means of germination index % for the interactions between cultivars and antioxidants concentrations.

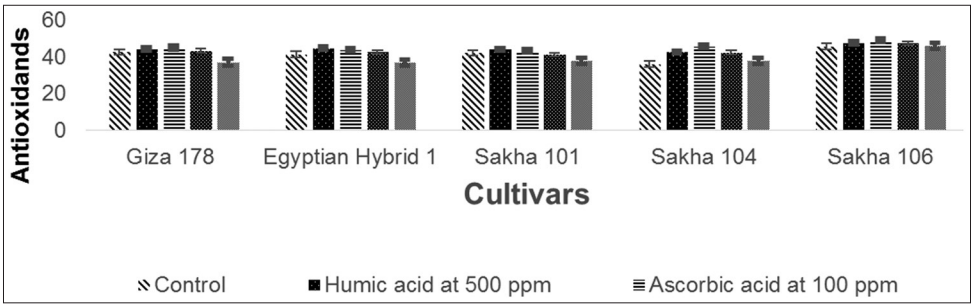

Figure 8: Means of germination speed % for the interactions between cultivars and antioxidants concentrations.

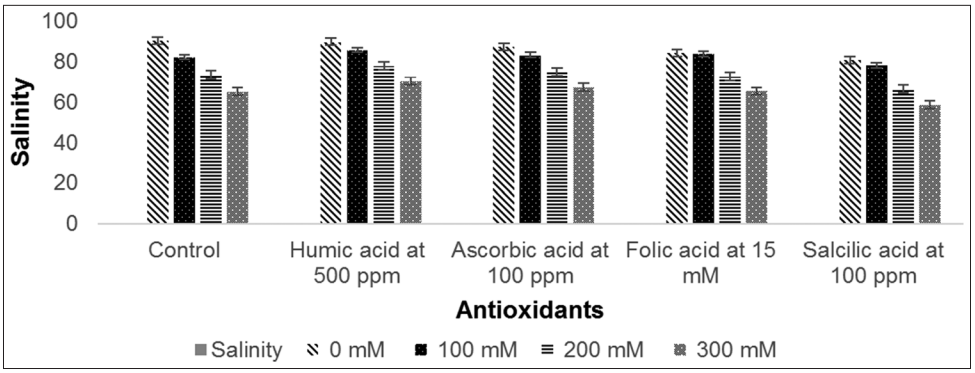

Figure 9: Means of final germination percentage % for the interactions between salinity levels of NaCL and antioxidants concentrations.

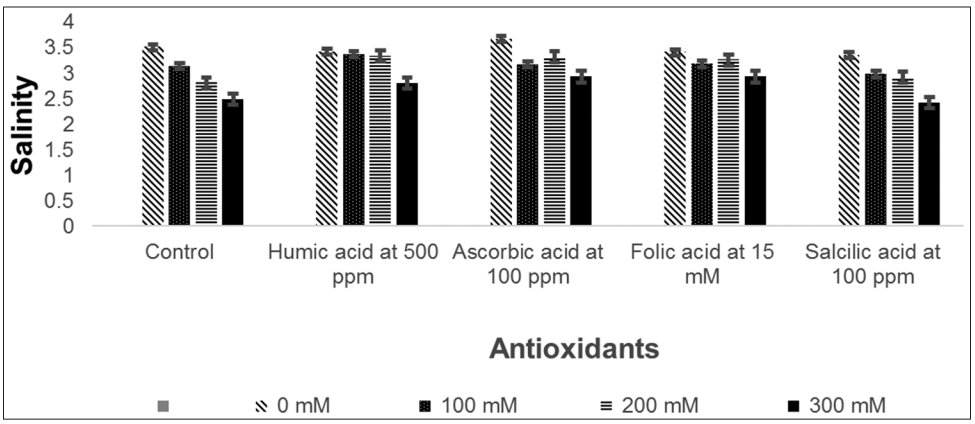

Figure 10: Means of germination rate % for the interactions between salinity levels of NaCL and antioxidants concentrations.

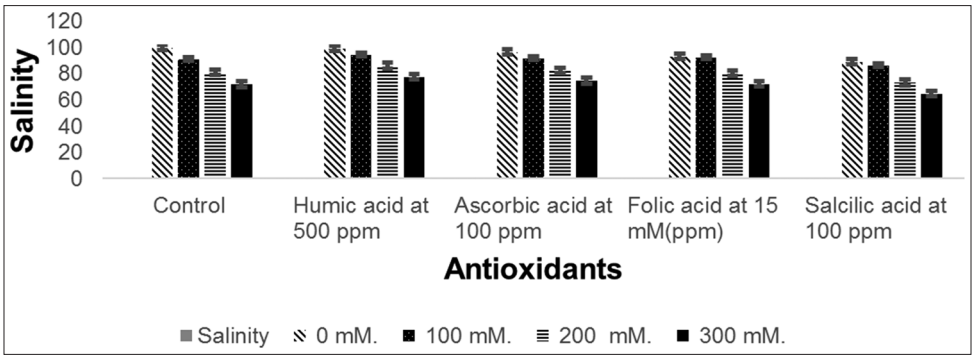

Figure 11: Means of germination index % for the interactions between salinity levels of NaCL and antioxidants.

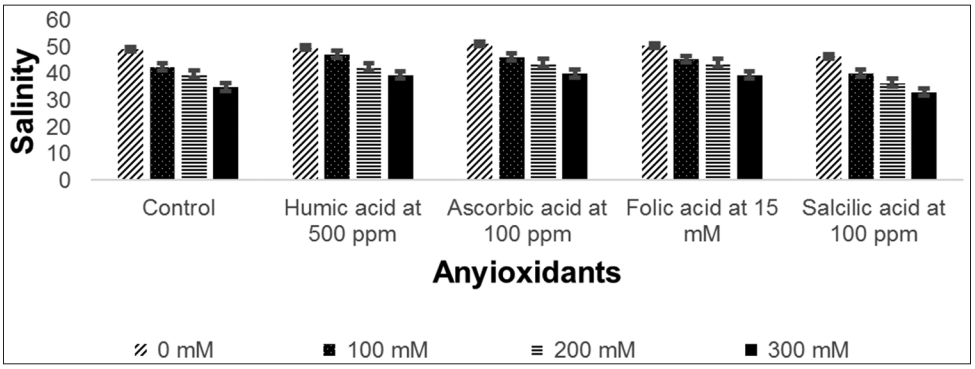

Figure 12: Means of germination speed % for the interactions between salinity levels of NaCL and antioxidants concentrations.

CONCLUSION

Maximizing germination characters of rice under saline soil condition of Egypt, it could be recommended that priming seed of Sakha 106 cultivar in humic acid at concentration of 500 ppm or Ascorbic acid at 100 ppm under salinity stress and used in breeding program for enhancing rice production.

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