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REGULAR ARTICLE

INFLUENCE OF ANTIOXIDANTS AND SALINITY STRESS ON SEED VIABILITY CHARACTERS OF SOME WHEAT CULTIVARS

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ABSTRACT

To explore the impact of antioxidants types and levels prim on seed germination characters of some bread wheat cultivars under salinity stress. An experiment accompanied in seed science lab during November and December 2016, to study the response of antioxidants seed prim of some bread wheat cultivars to germinate under salinity levels. The highest of final percentages of germination (96.8 %), higher percentages of germination energy (58.11 %), highest values of germination index (0.970) and a smaller amount of germination time (2.29 d) obtained from sown Misr 1 variety. The results showed that maximum of percentages of germination (91.15 %) and germination index (0.951) obtained from soaking in humic acid. The maximum percentages of energy of germination (41.21 %) and the less mean germination time (2.77 d from soaking grains in ascorbic acid compared with without antioxidants. Increasing antioxidant concentrations to 200 ppm produced the highest percentages of germination (91.61 %), energy of germination (37.63 %), germination index (0.953) and the lowermost of mean germination time (2.97 d) compared with without antioxidants and level of 100 ppm. Increasing salinity to 160 mmol during germination of wheat cultivars significantly reduced percentages of germination by 18.5 %, energy of germination by 96.7 %, germination index by 18.6 % and mean germination time by 53.5 % compared with without salinity (control). Whereas, for reducing the gap between production and consumption, it could be recommended that soaking bread wheat in humic acid or ascorbic acid at 200 mmol under salinity stress enhanced seed viability and advise to sown under saline new reclaimed soil.

Keywords: Wheat cultivars, Antioxidants, Salinity levels, Germination parameters

INTRODUCTION

Salinity as abiotic stress influenced wheat production of arid and semi-arid area in Egypt and Libya, under drought and salinity soil conditions. Salinity affected by seed germination, seedling establishment and plant growth. More than 900 million hectares of land worldwide, about 20 % of the total agricultural land [1]. To overcome the shortage of wheat production of Egypt, to reducing the requirement on imported bread wheat through enhancing the production of grain yield per untie area by planting the modern cultivars tolerant to salinity in new reclaimed soil or irrigated with saline water and with drought.

An abiotic stress signal transduces via ABA, calcium and hydrogen peroxide, which might induce antioxidant enzymes and pathways [2]. Seed priming with various agents can provide stress tolerance and high germination percentage in plants [3, 4]. The highest seed percentage germination and rate recorded from prime seeds with 0.00001 mmol Salicylic acids [5]. Salicylic acid at low levels of salinity stress reduced germination time. Soaking seed in increased seed germination percentage salicylic with 0.7 mmol, the best results obtained from low levels of stress [6]. Enhancement of seed germination observed with humic acid application under drought stress [7].

The most tolerant to salinity recorded from Sakha 8, Sakha 93 and Kharchia varieties. Genotypes differed from salt tolerance observed as Sids 1, Gemmieza 7 and Westonia. Drysdale and Sakha 69 ranked as moderate tolerant. However, the rest genotypes recorded the lowest to salinity tolerance [8]. At higher levels of salinity inhibits percentage of germination or encourages a state of dormancy at low levels [9]. The more sensitive to the germination stage recorded from Zarlasht cultivar [10]. HD-2689 cultivar recoded the greatest germination percentage of all the treatments and HOW-234 cultivar recorded the highest at 150 mmol salinity level [11]. The highest tolerance cultivars to salinity recorded from Hamoon, Sorkhtokhm and Bolani cultivars than the others [12]. Salinity increased the activity of antioxidant enzymes, but inhibit the antioxidant enzyme activities at high concentration or long-term of salt stress [13]. The highest tolerant to salinity were MBB cultivar and Waha cultivar recorded the lowest [14]. Salinity caused adverse effects on native seed than in breeder varieties [15]. Salinity level as

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low as 4 dSm^{-1} and Zare cultivar recorded the highest germination percentage, however, the germination percentage of Pishgam, Zare, Sivand, Gascogen and Parsi cultivars were much reduced at moderate (8 dSm^{-1}) and higher (20 dSm-1) salinity levels [16-18]. The aims of this study were to estimate the effects of salinity and antioxidants on seed germination characters of some bread wheat cultivars.

MATERIALS AND METHODS

Treatments and experimental design

In seed lab, Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt a laboratory experiment organized during November and December 2016, to study the reaction of antioxidants seed prim of some bread wheat cultivars to germinate under salinity levels. A factorial experiment in RCBD in four replication used. The four bread wheat cultivars, Miser-1, Miser-2 and Gemmiza-12 includes the first factor. The three types of antioxidants, Salicylic acid, Ascorbic acid and humic acid includes the second factor. The three concentrations of study antioxidants 0, 100 and 200 ppm include the third factor. The fourth factor include the five salinity levels 0, 40, 80, 120 and 160 Mm. Selected cultivars obtained from wheat section, Field Crop Institute, ARC and stored under normal conditions in paper bags. Each cultivar was prim in the three antioxidants at above concentrations of 12 h. Each cultivar irrigated with sodium chloride solution as above concentrations under the chamber condition at 25±1°c 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 five different NaCl concentrations except the control. The experiment consisted of 720 Petri dishes arranged in a factorial experiment in Randomized Complete Block Design (RCBD) at four replications the roll paper placed in a growth chamber for 12 d at 25-±1 °c for germination according to [19rules.

Studied characters

The bread wheat seed of study cultivars subjected for determination of germination characters in the laboratory experiment. Germination characters were estimated as follows:

1-The Germination Percentage [20, 21], energy of germination (EG) [21], germination Index (GI) [22] and mean germination time (MGT) [21] were calculated by standard methods.

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 [23]. The lest significant differences test (LSD) for 5 and 1 % level of probability used for comparing between treatment means, according to [24].

RESULTS AND DISCUSSION

Cultivars performance

The results obtainable in table (1) clearly exposed that wheat varieties significantly differed in percentages of germination and energy of germination, germination index as well as mean germination time. The highest of final percentages of germination (96.8 %), higher percentages of germination energy (58.11 %), highest values of germination index (0.970) and a smaller amount of germination time (2.29 d) obtained from sown Misre 1 variety. However, the lowest values of percentages of germination and energy of germination recorded from sown Misre 2 variety and the highest germination index and the longest of mean germination time recorded from sown Sakha 94 variety. Zarlasht cultivar appeared to be more sensitive to the germination stage [10]. HD-2689 cultivar recoded much germination percentage of all the treatments and HOW-234 cultivar recorded the highest at 150 mmol salinity level [11]. Cultivars genetically differed from their resistance to salinity [25, 26]. Similarly, other researchers [27, 28, 29]. found conclusions**.**

Antioxidants effects

The results accessible in table (1) clearly exposed that antioxidant types significantly differed in percentages of germination and energy of germination, germination index as well as mean germination time. The results showed that maximum of percentages of germination (91.15 %) and germination index (0.951) were obtained from soaking in humic acid. The maximum percentages of energy of germination (41.21 %) and the less mean germination time (2.77 d from soaking grains in ascorbic acid compared with without antioxidants. The results showed that maximum of percentages of germination (89.33 %) and energy of germination (28.75 %), germination index (0.933) and highest mean germination time (3.31 d) recoded from soaking grains in salicylic acid. Salicylic acid at low levels of salinity stress reduced germination time. Soaking seed in increased seed germination percentage salicylic with 0.7 mmol, the best results obtained from low levels of stress [6]. These explanations are reliable with those of [30], who reported that humic acid application partly reduced the final germination percentage, the inhibiting effect of salt on percentage of germination lessened in variable degrees by soaking in humic acid. Similarly, [31] reported conclusion on salicylic acid.

Antioxidants concentrations effects

Mean percentages of germination and energy of germination, germination index as well as mean germination time significantly influenced by antioxidant concentrations as revealed in table (1). Increasing antioxidant concentrations to 200 ppm produced the highest percentages of germination (91.61 %), energy of germination (37.63 %), germination index (0.953) and the lowermost of mean germination time (2.97 d) compared with without antioxidants and level of 100 ppm. Whilst, the lowest percentages of germination and energy of germination, germination index as well as the highest mean germination time recorded from without antioxidants (the control). Seeds prim with 50 ppm Ascorbic acids and 50 ppm SA not only improved final germination count, but also reduced the germination time for saline conditions [3], who reported that prim seeds with 0.00001 mmol SA had the highest germination percentage and rate. The results are similar to those reported by other researchers [6, 7, 32].

Salinity stress effects

Mean percentages of germination and energy of germination, germination index as well as mean germination time significantly influenced by salinity concentrations as revealed in table (1). Increasing salinity to 160 mmol during germination of wheat cultivars significantly reduced percentages of germination by 18.5 %, energy of germination by 96.7 %, germination index by 18.6 % and mean germination time by 53.5 % compared with without salinity (control). A similar conclusion reported by [15, 17, 18, 29, 33].

Interaction effects

Interaction between cultivars and antioxidants types effect

The between cultivars and antioxidants types significantly affected percentages of germination and energy of germination, germination index as well as mean germination time. The results graphically demonstrated in Figs. 1, 2, 3 and 4 clearly indicated that the highest percentages of germination (97.5 %) and energy of germination (61.2 %), germination index (0.975) as well as mean germination time (2.2 d). Whilst, the deepest percentages of germination (80.6 %) produced from sown Misr 2 variety and soaking in ascorbic acid. The lowest percentages of energy of germination (14.26 %) produced from sown Misr 2 variety and soaking in salicylic acid. Our results are in agreement with previous findings [27].

Interaction between cultivars and antioxidant concentration effect

With respect to the interaction between cultivars and antioxidants concentrations significantly affected percentages of germination and mean germination time, but insignificantly affected percentage of germination and germination index. The results graphically demonstrated in Figs. 5 and 6 indicated that highest energy of germination (60.7 %), and the lowest of mean germination time (2.2 d) recorded from soaking Misr 1 variety in 200 mmol of antioxidants. However, the less percentages of germination (20.2 5) from without antioxidant soaking of Misr 2 variety and the highest of mean germination time produced from without antioxidant soaking of Sakha 94 variety. Prim seeds with 0.00001 mmol SA had the highest germination percentage and rate [5]. The important of salicylic acid at low levels of stress, reducing the time of germination.

Interaction between cultivars and salinity levels effect

Regarding, the interaction between cultivars and salinity levels significantly affected percentages of germination and mean germination time, but insignificantly affected energy of germination and germination index. The results graphically demonstrated in Figs. 7 and 8 indicated that highest percentage of germination (99.7 %) produced from sown Sakha 94, Misr 1 and Misr 2 under the control (without salinity) and the lowest mean germination time (1.37) obtained from the control of Misr 1 variety. Whilst, lowest percentage of germination from treated Gemmiza 12 variety with highest salinity level of 160 mmol and the highest mean germination time (5.6) obtained from treating Sakha 94 variety with highest salinity level of 160 mmol. Hamoon, Sorkhtokhm and Bolani cultivars were more tolerant to salt stress than the others were. [12]. Salinity increased the activity of antioxidant enzymes, but inhibit the antioxidant enzyme activities at high concentration or long-term of salt stress [13]. Salinity reduced germination percentages and increased $Na^{+}$and Cl^{-}concentration in shoots. Sakha 93 and Gemmieza 7 cultivars exceeded Giza 168 cultivar under salinity and water stress [33]. The highest tolerant to salinity were MBB cultivar and Waha cultivar recorded the lowest [14].

Interaction between antioxidants types and concentration effect

The interaction between antioxidants types and concentration significantly affected percentages of germination and mean germination time, but insignificantly affected energy of germination and germination index. The results graphically demonstrated in Figs. 9 and 10 showed that the highest percentages of germination (93.0 %) obtained from soaking in humic acid at 200 mmol and the lowest mean germination time (2.6 d) obtained from soaking in ascorbic acid at 200 mmol. Whereas, the less percentages of germination and highest of mean germination time were recorded from without antioxidants at the control. Seeds prim with 50 ppm Ascorbic acids and 50 ppm SA not only improved final germination count, but also under saline conditions reduced time of germination [3]. Potassium humate or deproteinised leaf juice with potassium humate simulated for getting largest seed germination of wheat [4]. All studied antioxidant enzymes were limiting factors of these genotypes and these reasons led to the salt sensitivity in DN-27 cultivar [27].

Interaction between antioxidants types and salinity levels effect

The interaction between antioxidants types and salinity levels significantly affected percentages of germination and mean germination time, but insignificantly affected energy of germination and germination index. The results graphically demonstrated in Figs. 11 and 12 showed that the highest percentages of germination and the less mean germination time were recorded from soaking in all studied antioxidants and without salinity stress. While, the lowest percentages of germination (73.5) and the higher mean germination time (4.5) were recorded from soaking in Salicylic acid at higher salinity level of 160 mmol. The important of salicylic acid at low levels of stress, reducing the time of germination. Seed soaking in salicylic acid at low levels of 7 mmol produced the highest percentage of germination [6]. Humic acid application partly reduced the final germination percentage, the inhibiting effect of salt on the seed germination alleviated in varying degrees by HA pretreatment [30].

Interaction among antioxidants concentrations and salinity levels effect

The interaction between antioxidants concentrations and salinity levels insignificantly affected percentages of germination, energy of germination, germination index and mean germination time.

Interaction between cultivars x antioxidants types x antioxidants concentration effect

The interaction among cultivars x antioxidants types x antioxidants concentration insignificantly affected percentages of germination, energy of germination, germination index and mean germination time.

Interaction between cultivars x antioxidants types x salinity level effect

The interaction among cultivars x antioxidants types x salinity level insignificantly affected percentages of germination, energy of germination, germination index and mean germination time.

Interaction among antioxidants types x antioxidants concentrations x salinity level effect

The interaction among antioxidants types x antioxidants concentrations x salinity level insignificantly affected percentages of germination, energy of germination, germination index and mean germination time.

Interaction among cultivars, antioxidants types x antioxidants concentrations x salinity level effect

The interaction among cultivars, antioxidants types x antioxidants concentrations x salinity level insignificantly affected percentages of germination, energy of germination, germination index and mean germination time.

Table 1: Final germination and germination energy %, as affected by antioxidants types and levels and salinity concentrations of some wheat cultivars as well as their interactions

Characters Treatments	Final germination percentage	Germination energy percentage	Germination index	Mean germination time
A-Cultivars:				
Sakha 94	91.02	30.60	0.912	3.77
Misr 1	96.80	58.11	0.970	2.29
Misr 2	80.91	21.26	0.936	3.03
Gemmiza 12	92.51	36.75	0.961	2.86
F. test	*	*	*	*
LSD at 5 %	0.78	1.05	0.008	0.05
B-Antioxidants types:				
Humic acid	91.15	40.08	0.951	2.89
Salicylic acid	89.33	28.75	0.933	3.31
Ascorbic acid	90.45	41.21	0.949	2.77
F. test	*	*	*	*
LSD at 5 %	0.67	0.91	0.007	0.04
C-Antioxidants levels:				
Control	88.85	35.35	0.934	3.02
100 ppm	90.46	37.06	0.946	2.98
200 ppm	91.61	37.63	0.953	2.97
F. test	*	*	*	*
LSD at 5 %	0.67	0.92	0.007	0.03
D-Salinity concentrations:				
0 mmol	95.50	65.61	1.000	2.00
40 mmol	94.88	57.33	0.993	2.24
80 mmol	92.69	38.88	0.969	2.81
120 mmol	90.69	19.47	0.947	3.58
160 mmol	77.77	2.11	0.814	4.31
F. test	*	*	*	*
LSD at 5 %	0.87	1.17	0.009	0.06

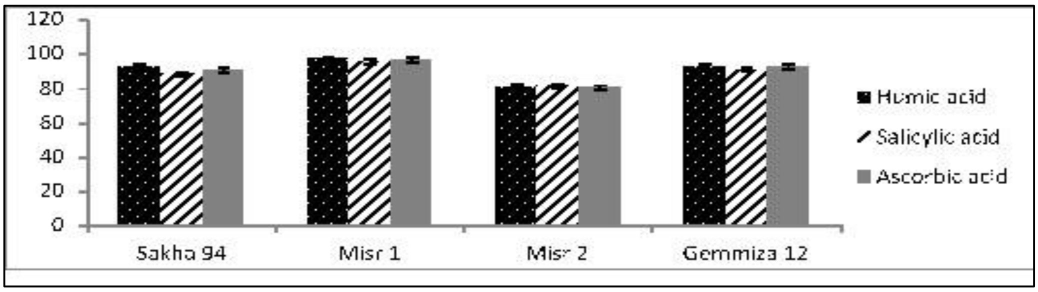

Fig. 1: Percentages of final germination as influenced by the interaction between wheat cultivars and antioxidants types

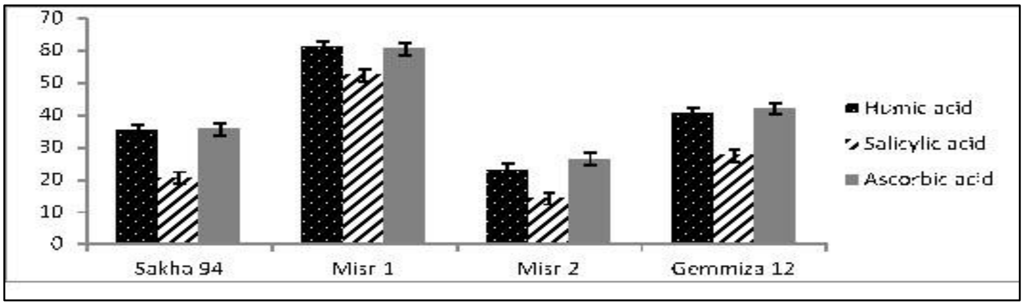

Fig. 2: Averages of germination energy % as influenced by the interaction between wheat cultivars and antioxidants types

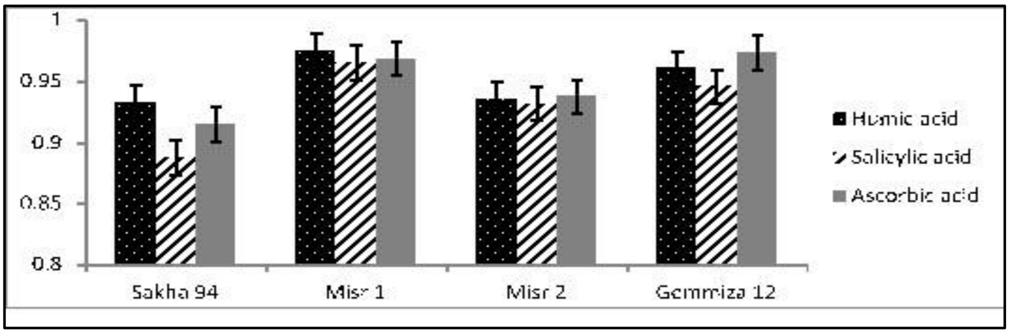

Fig. 3: Averages of germination index as influenced by the interaction between wheat cultivars and antioxidants types

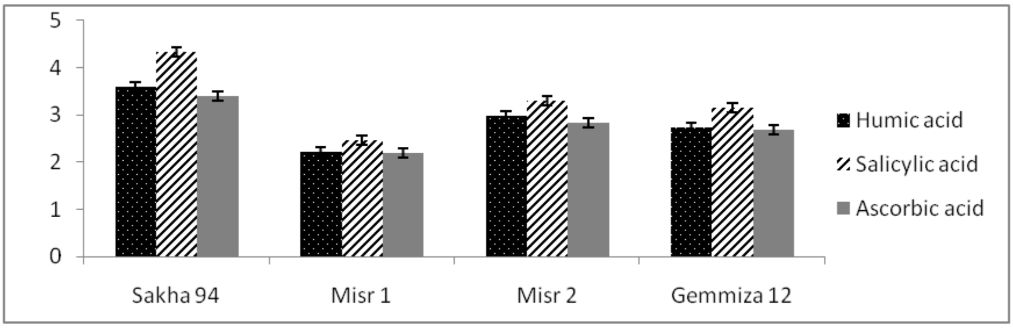

Fig. 4: The mean of germination time as influenced by the interaction between wheat cultivars and antioxidants types

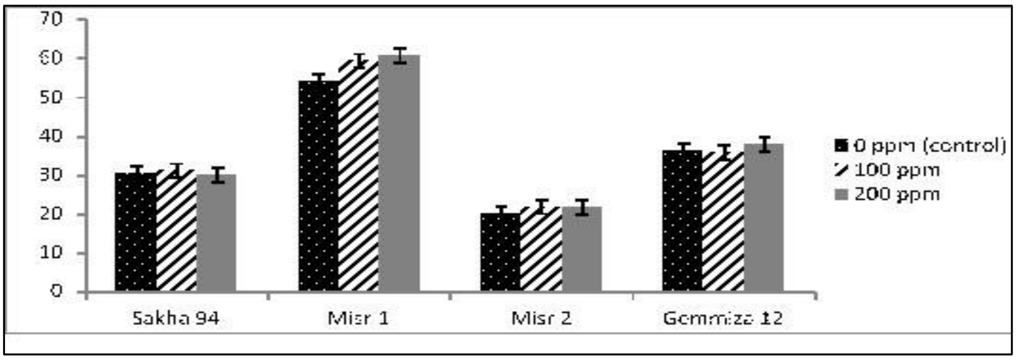

Fig. 5: Mean of germination energy % as influenced by the interaction between wheat varieties and antioxidants levels

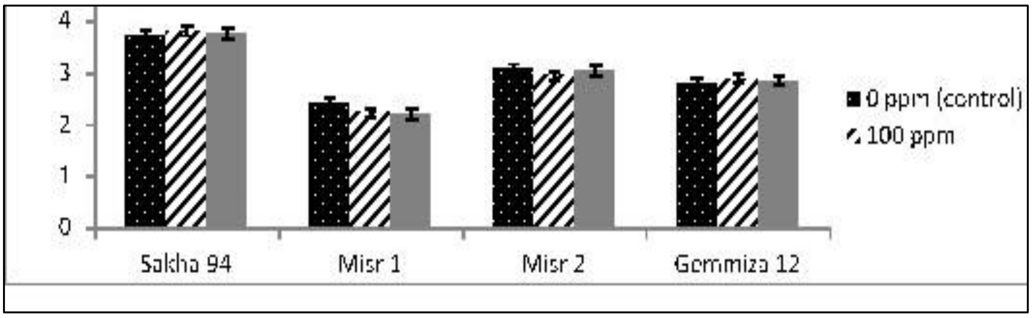

Fig. 6: The mean of germination time as influenced by the interaction between wheat varieties and antioxidants levels

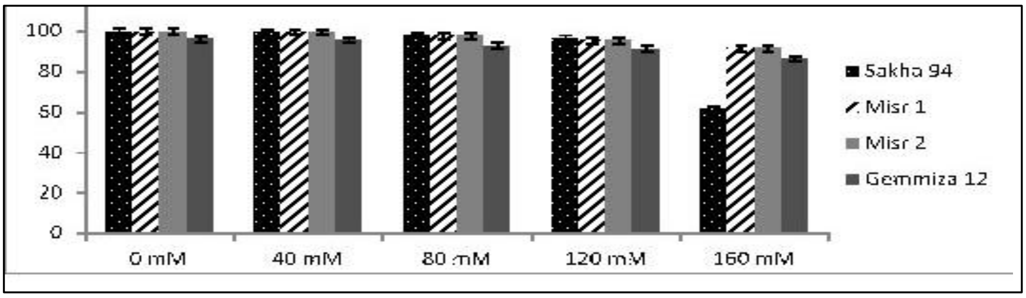

Fig. 7: Percentages of final germination as affected by the interaction between wheat varieties and salinity concentrations

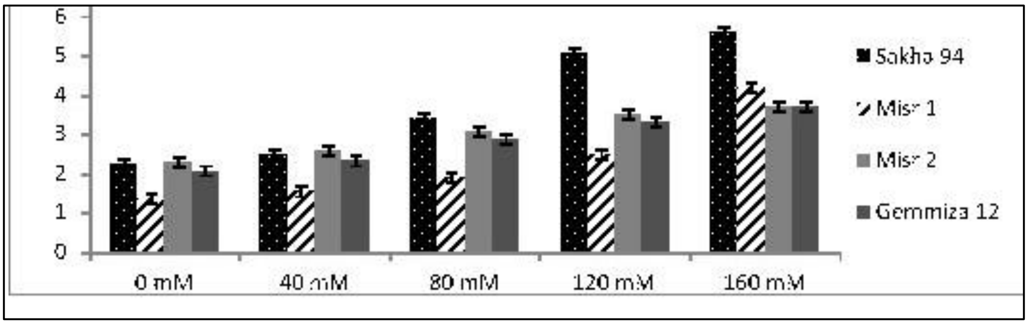

Fig. 8: Average of germination time as influenced by the interactive of wheat varieties and salinity concentrations

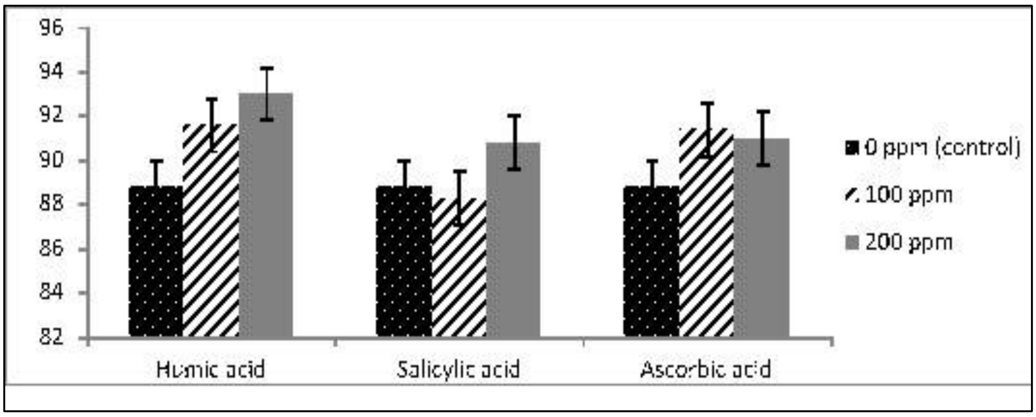

Fig. 9: Percentages of final germination as influenced by the interactive of antioxidants types and levels

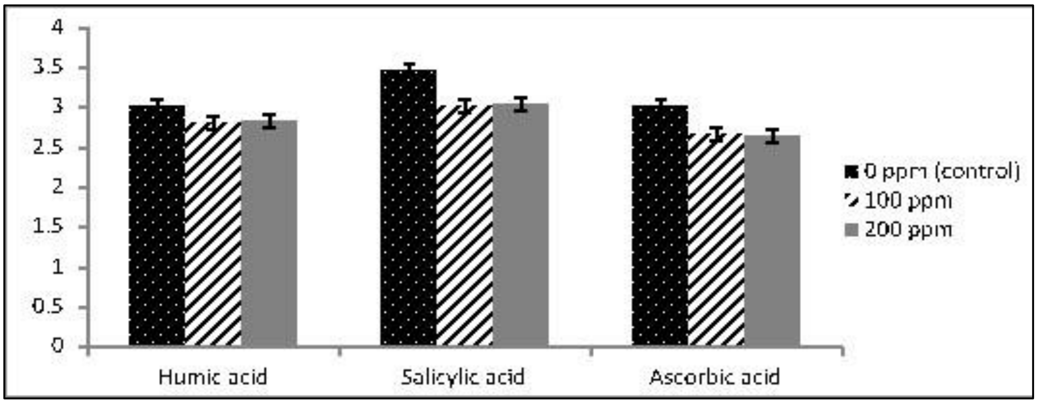

Fig. 10: Averages of mean germination time as influenced by the interaction between antioxidants types and levels

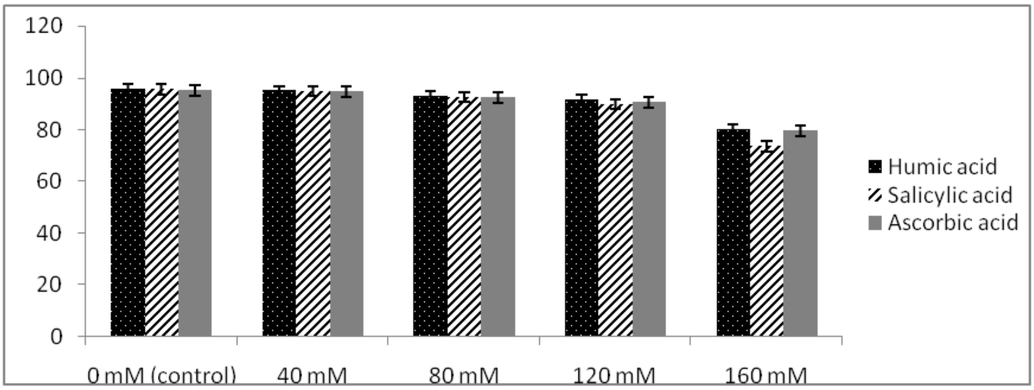

Fig. 11: Averages of final germination % as influenced by the interaction between antioxidants types and salinity concentrations

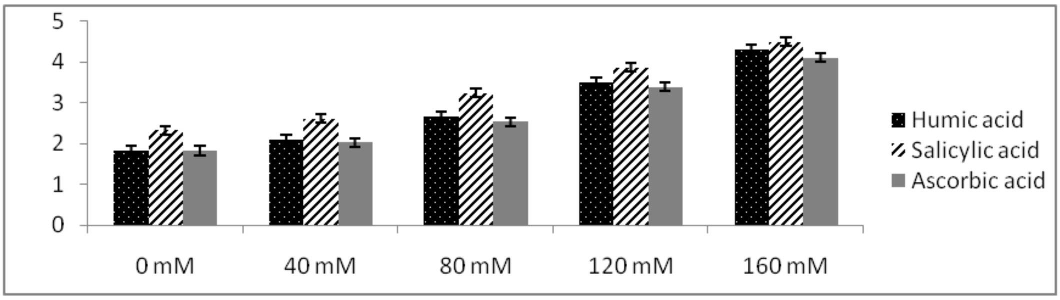

Fig. 12: Averages of mean germination time as influenced by the interaction between antioxidants types and salinity concentrations

CONCLUSION

Accordingly, for reducing the gap between production and consumption, it could be recommended that soaking bread wheat in humic acid or ascorbic acid at 200 mmol under salinity stress enhanced seed viability and advise to sown under saline new reclaimed soil

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