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Response of Wheat Plant to Foliar Application of Organic Acids under Saline Conditions

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ABSTRACT

A pot experiment was conducted in winter season of 2015-2016 at the experimental farm, Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt to study the interaction effect between some kinds of organic acids (Humic acid 200 mg.L-1, Ascrobic acid, Salicylic acid and Glycine at rate of 330 mg.L-1), and irrigation water having different salinity levels (0.4, 2.12, 4.82 and 9.11 dS.m-1) on wheat (Triticum aestivum l.) Suds 12 variety grown on clayey soil. The experimental design was split plot design with two factors in three replicates .The obtained results can be summarized as follow ; the dry weight of grain (g.pot-1) was decreased with increasing water salinity levels from 0.4 dS.m-1 (tap water) till 9.11 dS.m-1 by 0.2.12; 7.73 and 12.34 compared to control (tap water, 0.4 dS.m-1). It could be arranged the organic acids for increasing straw dry weight in the following order Sa> Aa> Ga> Ha. Whereas , it could be arranged the organic acids for 100 grains weight in the following order Sa> Aa> Ga> Ha. Also, it was found that foliar application of Ga (330 mg/l) under normal conditions and all studied levels of salinity gave an increase in plant height compared to the other organic acids. The majority data of the studied nutrients content were not significantly affected by all studied factors and/or salinity levels except for Na and N content in straw and P content in grain. There was a decreasing effect in nutrients content due to increasing salinity levels except for sodium content in both straw and grain. A significant increase in Na content under the different studied salinity levels was found in both straw and grain of wheat plant, where the highest Na% in straw was 2.04% (S3A2) which was gained with ascorbic acid with salinity level=9.11 dS.m-1. Whereas, the highest mean value of Na% in grain was 0.24% (S3A3). The highest N content in straw was gained with Sa (2.38%), whereas, it reached 3.778% in grain using Aa (ascorbic acid with 330 mg/L). The highest mean value of P% in grain was 0.639% (S0A2) which was obtained with the treatment of (Aa) ascorbic acid + (tap water) salinity level of 0.4 dS.m-1 .The highest mean value of P% in straw was 0.065% (S0A2). So the highest accumulation of P was gained with the treatment of (Aa) ascorbic acid + (tap water) salinity level of 0.4 dS.m-1, but the highest accumulation of K was gained with the treatment of Ga (glycine acid treatment)+ salinity level of 9.11 dS.m-1. Finally, it is recommended to use Sa (salicylic acid) and/ or Ga (glycine acid) with concentration of 330 ppm which may increase the ability of wheat plant to grow efficiently and successfully under the stressed saline conditions

Keywords : Wheat; humic acid; salicylic; ascorbic; glycine acid ; saline soil; salinity; diluted seawater and protein.

INTRODUCTION

Egypt is one of the countries which facing great challenge such as limited water resources mainly by its fixed share of the Nile water, increasing population, limited cultivated area, increasing imported products such as wheat and in general aridity conditions

Currently, the total requirements of all secio-economic sectors from water are estimated at 80 BCM/yr. The agriculture sector alone requires about 80% of this amount. So, the use of different types of waters having different levels of salinity become necessary to close the gab between resources and needs of water. Using marginal water or diluted saline sea water are of importance for obtaining food security especially wheat crop needs.

Wheat is one of the most widely cultivated and important valuable cereal crops. It is considered as the main source of food (bread) , so it is very necessary to improve and increase the annual wheat production by using different management ways (FAO, 2009) . Concerned the irrigation water quantity and quality and also, treating plants with different materials to minimize the salinity hazard for obtaining high production of wheat with a good quality.

Gupta (1992) concluded that the threshold salinity of irrigation water for wheat was 7 dS.m-1 . Allen *et al*(1998) found that salinity water reduce evapo-transpiration in plants by making the soil water less available for using by plant roots. Salinity reduces plant growth by suppressing rate of leaf elongation which cause enlargement in leaves and reduction of cell division (Allen *et al*1998 and Heidarpour *et al*2009) . The inherent ability of the crops to resist the effects of elevated salt concentration around their root zone solutions and still produce a reasonable quantity of agricultural product defines the magnitude of the crop tolerance or resistance to salinity (Steppuhn *et al*2005). Salinity exerts negative impacts on wheat plant with an ultimate decline in the dry weight and the uptake of nutrients except for Na. (Aldesuquy and Ibrahim, 2002; Ghane *et al*2011).

Humic acids are important soil components that can enhance nutrient availability; foliar application of humic acid increased the uptake of P, K, and Na. Although the effect of interaction between salt and humic acid application was found statistically to be significant, the interaction effect between salt and foliar humic acid treatment was not significant, (Khaled and Fawy , 2011). Erdal *et al*(2000) found that the dry weight, plant P concentration and P uptake increased with humic acid application.

Irrigation with low water quality having saline and/or sodic water would decreased growth and yield of wheat plant. Also, it was found that salinity stress marginally decreased rate of photosynthesis. So, using organic acids such as humic acids (Ha), Salicylic Acid (Sa), Ascorbic acid (Aa) and Glycin acid (Ga) which are considered as plant growth hormones or antioxidant would help in counteract this harmful effects and promote growth, Mittova, *et al*(2004) and Murtaza, *et al*(2006)

Salicylic acid (Sa) has a key role in many physiological processes of plants and stimulates specific responses against various biotic and abiotic stresses , in some plants. Foliar application with salicylic acid was not significant at different concentrations on measured traits, as well as interactive effects between drought or salinity stress and different levels of salicylic acid, without any significant difference observed (Khatiby*, et al.* , 2016) .

Treating wheat plants with ascorbic acid up to 400 mg.L-1 improve wheat , it increased plant height , number of tillers and spikes , flag leaf area , grain index, grain and straw yield per plant as well as some biochemical constituents, Bakry, *et al*., (2013) and El-Awadi *et al*(2014)

Afzal, *et al*., (2006) concluded that the effects of hormonal priming with salicylic acid (Sa), or ascorbic acid on wheat plant has reduced the intensity of the effect of salinity, but the treatments of 50 mg.L-1 Sa and 50 mg.L-1 ascorbic acid gave the best results on seedling growth and fresh and dry weights of wheat plant under normal and saline conditions.

Arafa *et al*., (2009) stated that the harmful effects of salinity on the ultra-structure of leaf mesophyll cells of sorghum plant was reduced due to both grains presoaking in Glycine betaine or presoaking plus spraying with Glycine as compared to untreated plants grown under saline conditions. However, Glycine betaine (Gb) applied as presoaking plus spraying showed the most beneficial effects in this respect

Water stress due to water salinity or drought reduced wheat dry weight, yield and biochemical aspects of grains. So, the beneficial effect of spraying with Gb and Sa in addition to grain presoaking in Glycerin Betaine and Salicylic Acid was assessed on wheat plant . It was found that, the spraying these chemicals appeared to alleviate the negative effects of water stress on wheat productivity and the biochemical aspects of yielded grains. Gb + Sa treatment gave the most obvious effect. Aldesuquy, et al(2012)

Hu and Hu (2012) reported that the foliar application of glycerin (Ga) would reduce the adverse effect of salinity pressure on perennial ryegrass (Lolium perenne). Salt stress increased Na+ and decreased K+ content, which resulted in a higher Na+/ K+ ratio in perennial ryegrass. Application of 20 mM Ga deacresed Na+ accumulation, whereas the K+ content was increased significantly in shoot , which led to a higher K+/ Na+ ratio under saline conditions. These results indicated that glycine betaine (Gb) enhanced salt tolerance in perennial ryegrass which was mainly related to alleviation of cell membrane damage by reduction oxidation of membrane lipid and enhancing the ion homeostasis under salt stress.

Reddy, *et al*(2013) stated that glycine betaine Gb application allowed maize plants in the mildly stressed treatment to counteract water limitation and enhance growing which resulted in increased biomass in relation to the untreated mildly stressed plants

Heshmat, *et al*(2012) stated that glycine betaine Gb, could overcome the adverse effects of salt stress on wheat by improvement of growth vigor of root and shoot, leaf area , retention of pigments content, increasing the concentration of soluble sugars and soluble nitrogen as osmoprotectants , keeping out the polysaccharides concentration and/or stabilization of essential proteins in wheat plants.

Aldesuquy (2014) found that grain presoaking in salicylic acid (Sa) or foliar application with glycine betaine (Gb) alleviated the salt stress by keeping water within leaves and consequently recover the turgidity of stressed plants by restricting the transpiration rate , stomatal closure, decreasing the ABA level and enhancing the growth promoters.

Khadouri (2015) showed that Glycine betaine (Gb) has significant increment in growth parameters, biochemical contents and mineral nutrients concentrations.

Osman and Salim (2016) found that application of Sa at 1 mM and Gb at 5 mM, increased leaves and pods no./plant, pod moisture %, and pod fresh weight, which reflected on increasing yield.

This study aims to use some strategies and practices to overcome water stress and shortage by all means. So, this experiment was done to study the effects of using saline irrigation levels with spraying some organic acids on growth, yield and chemical composition of wheat plant.

MATERIALS AND METHODS

In the winter season 2015-2016, a pot experiment was conducted at the experimental farm, Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt to investigate the growth of wheat (triticum aestivum L., cv. Suds 12 variety) and chemical composition as affected by spraying some organic acids under the condition of salinity.

The experiment was carried out using plastic containers (diameter 25 cm and a depth of 30 cm) filled with 8 kg air dry soil form the experimental farm. Some soil characteristics are shown in Table 1. The date of planting wheat grains is November 16. Ten wheat grains were planted in each pot. The experimental design used was the design of the spilt plot with three replicates. The main plots were allocated to four levels of water salinity, while the spraying application of the four organic acids were presented in the sub-main plots.

Table 1. Some chemical and physical characteristics of the experimental soil.

Soil characteristics	Values
Sand (%)	21.5
Silt (%)	38.3
Clay (%)	40.2
Soil texture	Clay
Saturation (%)	59.3
Calcium carbonate (%)	2.9
OM(%)	0.95
F.C. %	29.7
pH*	7.94
EC** (dS.m-1)	0.85
Available - N (mg. Kg-1 soil)	45.7
Available - P (mg. Kg-1 soil)	6.34
Available - K (mg. Kg-1 soil)	235

***in soil paste. **in (1: 2.5)soil extract.**

Thus, the experiment included 16 treatments as follow; S0: irrigation with fresh water (tap water) with salinity of 0.4 dS.m−1 (control); S1; S2 and S3: irrigation by synthetic saline water (prepared by mixing sea water with fresh water) to obtain electrical conductivity (EC) of 2.12; 4.82 and 9.11 dS.m−1, respectively. Whereas, four different kinds of organic acids (A1= Humic acid 200 mg.L-1, A2= Ascrobic acid, A3= Salicylic acid and A4= Glycine at rate of 330 mg.L-1)

Synthetic saline water was prepared by diluting sea water with tap water to obtain different salinity levels (0.4, 2.12, 4.82 and 9.11 dS.m-1). The concentrations of cations and anions were determined in sea water according to the methods described by Hesse (1971), the chemical analysis of sea water is mentioned in Table 2. Irrigation with the different saline levels was carried out every 7 days until reaching the soil moisture of field capacity by weight.

The four different kinds of organic acids were obtained as a pure powder from El-Gomhoria Company except for humic acid which was in a liquid form. A stock solution were prepared in the mentioned dose above for all organic acids, and they were sprayed after 4 weeks and 7 weeks from sowing date.

Super phosphate (7% P) was added 15 days before planting, Super phosphate fertilizer was applied at a rate of 100 kg.fed-1. While, nitrogen fertilization is applied in two equal doses after two weeks and one month from the date of cultivation, using ammonium sulfate fertilizer (20.5% N) at the rate of 340 kg.fed-1. Whereas, potassium sulfate (39.8% K) was applied at a rate of 50 kg.fed-1 .

Wheat plants were harvested at the end of April. All plants were collected from each pot, weighed and transferred to the soil laboratory , where they were air dried , then dried at 70 o C in the oven till constant weight. The weight of 100 grains were determined for each treatments. Samples of oven dry grain and straw were grained in in mild stainless steel. Then, a sample of 0.2 g of the plant was then digested in a mixture of concentrated sulfuric acid and percloric acid (H2SO4 and HCLO4) by the procedure of Chapman and Pratt (1961) to determine the percentage of total N,P,K and Na in straw and grain of wheat plant.

Table 2. Chemical analysis of the sea water

pH value	EC. dS.m-1	Ctions meq.L-1				Anions meq.L-1			
		Ca ++	Mg ++	Na +	K +	CO3--	HCO3-	Cl-	SO4--
7.74	61.22	3.2	143	465	1.0	0.0	2.2	594	16.0

Plant analysis:

Total nitrogen in the digestion of the plant sample was determined by micro-Kjeldahl method as described by Hesse , (1971) . Total phosphorus was determined calorimetrically at a wavelength of 660 nm using Olsen and Sommers , 1982 . Total potassium and sodium were determined using flame-photometer according to Jackson (1972).

Soil analysis:

Mechanical analysis using pipette method (Piper, 1950) and calcium carbonate using calcimeter apparatus with 1:3 HCl were determined as described (Piper, 1950). Whereas, Saturation percentage (SP) and the soil field capacity (FC) were determined using the method described by Dewis and Freitas, (1970). The electrical conductivities were identified in 1: 2.5 soil extracts which were measured by EC meter according to Black, (1965) method. Soil reaction (pH) was determined in soil paste by using Beckman pH meter (Black, 1965). Available nitrogen was extracted by potassium chloride 1 normal (KCl) and was measured using the method of micro-Kjeldahl as described by Bremner and Mulvanym, (1982). Whereas, available phosphorus was extracted with 0.5 M sodium bicarbonate (Na HCO3), which has pH 8.5 and was determined at a wavelength of 660 µm by means of Spectrophotometer (Spectro,UV-2602) as described by Olsen and Sommers, (1982). Available potassium was extracted using natural solution of ammonium acetate 1 normal, at pH 7.0 and determined by Flam - photometer (JENWAY PFP7) according to Black(1965).

Statistical analysis:

Statistic analyses were done for all data using the analysis of variance (ANOVA). Gomez and Gomez, (1984) have described the method which was used in calculating the least significant difference (L.S.D) between the means of treatment values in this experiment using the methods described by version 6.303 of CoStat, CoHort program.

RESULTS AND DISCUSSION

Growth parameters

Data plotted in Table 1 show the water salinity levels and organic acids as foliar spray effect on wheat straw and grain dry weight. They were not significantly affected by all studied factors and/or levels except for saline water levels. It was found that total dry weight decreased significantly with increasing salinity levels.

Irrigation with different salinity levels caused significant reduction in most of growth parameters (straw, grains and total dry weight).

It was observed that irrigation at field capacity with water salinity levels of 0.4; 2.12; 4.82 and 9.11 dS.m-1 affected wheat growth parameters. It was found that the highest values of straw, g.pot-1, grain, g.pot-1 and total dry weight, g.pot-1 were decreased with increasing water salinity levels from 0.4 dS.m-1 (tap water) till 9.11 dS.m-1 by 0.46; 2.16 and 4.47% for straw dry weight compared to 0.4 water salinity(S0). Also, the dry weight of grain (g.pot-1) was decreased with increasing water salinity levels from 0.4 dS.m-1 (tap water) till 9.11 dS.m-1 by 0.2.12; 7.73 and 12.34% compared to control (tap water, 0.4 dS.m-1). Hence the resulting total dry weight of wheat (g.pot-1) gave also the same reduction with increasing water stress by increasing salinity levels (0.4, 2.12; 4.82 and 9.11 dS.m-1), the decreasing percentage was 1.1, 4.3 and 7.5, respectively compared with tap water (S0) Table (3). The decreasing percentage may be small due to the effect of crop tolerance for salinity because wheat is not salt sensitive crop or regarding the effect of the organic acids application which may minimize the growth reduction caused from studied treatments which reflect on insignificant reduction in wheat dry weight for straw or grain.

Data in Table 3 cleared that salt stress depressed the straw and grain dry weight of wheat plant but with foliar application of different types of organic acids, it was found that there was insignificant relation between the interaction effect of salinity levels and organic acids on the dry weight of wheat. It was noticed that spraying salicylic acid (Sa) at rate of 330 mg.L-1 improved dry weight of wheat in comparison with other organic acids. We could arrange the organic acids for increasing straw dry weight in the following order Sa> Aa> Ga> Ha. The increasing in total dry weight of wheat plants may be due to that salicylic acid acts as endogenous signal molecule responsible for inducing abiotic stress tolerance in plants. So, Sa treatment reduced the damage action of salinity, hence accelerated a restoration of growth processes, this may be related to its inhibiting effect on Cl- and Na+ and / or due to its effect on lipid peroxidation, and membrane permeability. Also, it is well documented that Sa treatment prevented decrease in IAA and cytokinin content completely, which reduced stress-induced inhibition of wheat growth. These results are in accordance with Singh and Ushu (2003), Afzal, *et al*(2005, 2006) and Gunes, *et al*(2006) who tested ascorbic acid and salicylic acid under both non-saline and saline conditions .

Figs.1 reveals the interaction effect of water salinity levels and organic acids on total dry weight of wheat plant. Statistical analysis of obtained data outlined a non-significant interaction pattern was found regarding to total dry weight of wheat plant. It is obvious that the Sa treatments under all water salinity levels gave the highest values of total dry weight compared to the other organic acids.

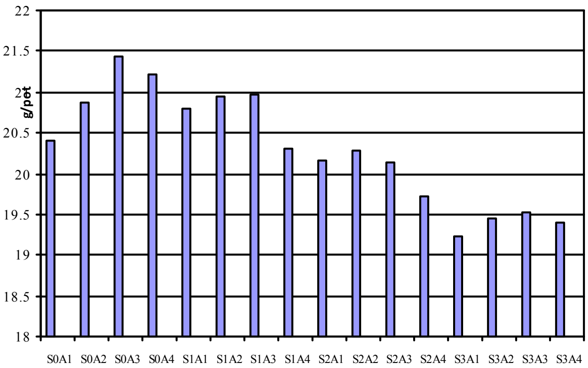

Fig. 1. Interaction effect of water salinity levels and organic acids on total dry weight of wheat plant

The highest total dry weight value was 21.44 g.pot-1 (S1H3) which was gained with salicylic acid with tap water (with salinity level=0.4 dS.m-1), whereas the lowest value of total dry weight was 19.23 g.pot-1 (S3H1), which was gained with humic acid with S3 (with salinity level=9.11 dS.m-1),

These results reveal that Sa could be used as a potential growth regulator to improve plant salinity stress tolerance. So, the resulted data in Table 3 indicated that foliar application of Sa (Salicylic acid) promoted growth and yield and counteracted the salt stress-induced inhibitory of salt tolerant as mentioned by Arfan, *et al*(2007) and Khatiby, *et al.* ,(2016).

All salinity levels (2.12, 4.82 and 9.11 dS.m-1) induced gradually decreases in plant height and 100 grain weight as illustrated in Table 3 as compared with control treatment (irrigation with tap water= 0.4 dS.m-1). For instance, the reduction in plant height and 100 grains weight reached to 12.86 and 13.27%, respectively in wheat plants irrigated with 9.11 dS.m-1 saline water.

Results in Table 3 show that, foliar treatment of Sa (330 mg.L-1) under normal conditions and all studied salinity levels caused an increase in 100 grains weight as compared to the other organic acids hence, it could arrange the organic acids for 100 grains weight in the following order Sa> Aa> Ga> Ha. Whereas, foliar treatment of Ga (330 mg.L-1) under normal conditions and all salinity levels caused an increase in plant height compared to the other organic acids hence, We could arrange the organic acids for plant height in the following order Ga> Sa> Ha> Aa. This may be related to its inhibiting effect on Cl- and Na+ and / or due to its effect on lipid peroxidation, and membrane permeability. These results are in accordance with Gunes, *et al*(2006)

Table 3 . Effect of water salinity treatments and organic acids on some growth and yield parameters of wheat plant in 2015/2016 winter season.

Parameters Treatments	straw dry weight	grain dry weight	total dry weight	plant height (cm)	100 grain weight (g)
		g.pot-1			
salinity treatments					
S0 (tap water=0.4 dS.m-1)	12.96	8.02	20.98	55.68	6.354
S1 (2.12 dS.m-1)	12.90	7.85	20.75	52.91	6.305
S2 (4.82 dS.m-1)	12.68	7.40	20.08	51.86	5.776
S3 (9.11 dS.m-1)	12.38	7.03	19.40	48.52	5.511
LSD at 5%	----	----	1.07	----	----
F. Test	N. S.	N. S.	*	N. S.	N. S.
Organic acids treatments					
A1 (Humic acid (Ha))	12.59	7.55	20.15	52.34	5.691
A2 (Ascorbic acid (Aa))	12.76	7.62	20.38	50.71	6.066
A3 (Salicylic acid (Sa))	12.81	7.71	20.52	52.62	6.185
A4 (Glycine (Ga))	12.75	7.41	20.16	53.31	6.004
LSD at 5%	----	----	----	----	----
F. Test	N. S.	N. S.	N. S.	N. S.	N. S.
Interaction effect LSD at 5%	----	----	----	----	----
F. Test	N. S.	N. S.	N. S.	N. S.	N. S.

Fig.2 reveals the interaction effect of water salinity levels and organic acids on plant height of wheat plant. Statistical analysis of obtained data outlined insignificant interaction pattern which was found regarding to plant height of wheat plant. The highest plant height value was 57.44 cm with Ga+tap-water treatment (S0A4) which was gained with glycin acid with tap water (with salinity level=0.4 dS.m-1), but the lowest mean value of plant height was 46.33 cm (S3A3 and S3A4), which was gained with salicylic acid and glycin acid with S3 (with salinity level = 9.11 dS.m-1), These results reveal that Ga could counteract the adverse effects of drought on wheat by improving growth of root and shoot, as osmoprotectants, which improve plant salinity stress tolerance. Also, with lower salinity levels Sa and Ga could promote elongation of wheat plant, as mentioned by Heshmat, et al(2012) and Aldesuquy (2014) .

Nutrients content:

Data plotted in Table 4 show the water salinity levels and organic acids as foliar spray effect on wheat content of nutrients. The majority of data in Table 4 were not significantly affected by all studied factors, and/or salinity levels except for Na and N contents in straw and P content in grain. There was a decreasing effect in nutrients content due to increasing salinity levels except for sodium content in both straw and grain.

Different salinity levels caused a significant increase in Na content in both straw and grain of wheat plant, but mostly in straw compared with grain. It was observed that irrigation with water salinity levels at 0.4; 2.12; 4.82 and 9.11 dS.m-1 affected wheat content of sodium as the main chemical composition of irrigation water is NaCl. It was found that the highest values of Na% in straw and grain were 1.907 and 0.214% respectively with salinity level of (S3= 9.11 dS.m-1). The increasing percentage of Na% with salinity levels at 2.12; 4.82 and 9.11 dS.m-1 were 51.44, 94.86 and 139.27%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1).

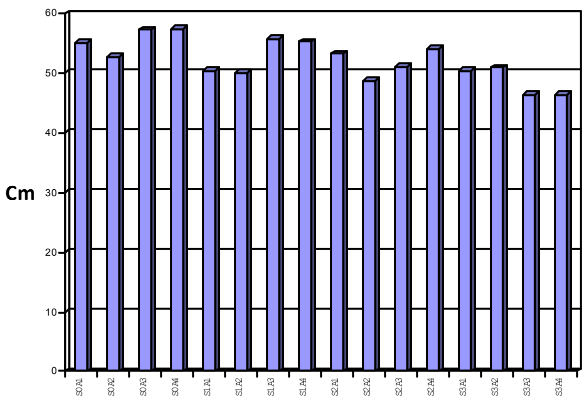

Fig. 2. Interaction effect of water salinity levels and organic acids on plant height of wheat

Regarding to organic acids types effect on Na content in straw and grain there was no significant difference between the mean values of Na%, the highest Na content in straw was gained with Ga (1.447%), whereas, it reaches 0.21% in grain using Aa (ascorbic acid with 330 mg/L)

The interaction effect of water salinity levels and organic acids on Na% in straw of wheat plant is shown in Fig 3. Statistical analysis of obtained data outlined insignificant interaction pattern was found in corresponding to Na% in straw of wheat plant. It is obvious that the highest Na% in straw value was 2.04% (S3A2) which was achieved with ascorbic acid under salinity level=9.11 dS.m-1, whereas the lowest value of Na% in straw was 0.67% (S0A2), which was gained with ascorbic acid with (S0) tap water (with salinity level=0.4 dS.m-1). It could interpret that Increasing NaCl concentration in irrigation water has induced increases in Na content in wheat straw .

Data plotted in Table 4 show the water salinity levels and organic acids as foliar spray effect on Na content in grain of wheat plant. Different salinity levels caused an increase in Na content in grain of wheat plant, but it was insignificant between means of Na%.

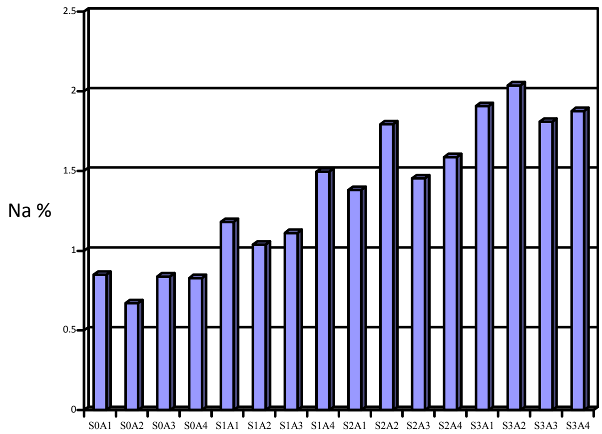

Fig. 3. interaction Effect of water salinity levels and organic acids on Na content of wheat straw

Considering the interaction effect of water salinity levels and organic acids on Na% in grain of wheat plant, it was found that the lowest mean value of Na% in grain was 0.182% (S0A4), whereas the highest mean value of Na% in grain was 0.24% (S3A3). So the highest accumulation of Na was gained with (S3A3) the treatment of salicylic acid + salinity level of 9.11 dS.m-1 . The increasing percentage of the Na% content was 31.57% in comparison with the lowest one . It is obvious that with different salinity levels with A4 (glycine acid treatments) gave the lowest content of sodium in grains. So, it could be concluded that there is a beneficial effect of glycine acid in decreasing Na content due to the protective effect of glycine on the integrity of plasma membrane and/or providing stabilization of biological membranes and proteins, transporters which resulted in Na discrimination, as mentioned by Cun and Shabala (2007) and Nawaz *et al* (2010).

Regarding nitrogen content in wheat plant, it illustrated in Table (4) that different salinity levels caused a significant reduction in N content in straw whereas, there was insignificant decrease in N content in grain of wheat plant. It was found that the highest values of N% in straw and grain were 2.355 and 3.827% respectively with salinity level of (S0= tap water 0.4 dS.m-1). The decreasing percentage of N% in straw with salinity levels at 2.12; 4.82 and 9.11 dS.m-1 were 3.31, 3.18 and 9.64%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1) which gave the highest mean value of nitrogen content. Whereas, The decreasing percentage of N% in grain with salinity levels at 2.12; 4.82 and 9.11 dS.m-1 were 2.51, 4.44 and 12.05%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1).

Regarding to foliar application of organic acids effect on N content in straw and grain, there was no significant difference between the mean values of N%, except for the nitrogen content in straw. The highest N content in straw was gained with Sa (2.38%), whereas, it reaches 3.778% in grain using Aa (ascorbic acid with 330 mg.L-1), but there was no significant differences between the mean values of nitrogen content in grain corresponding to foliar application of organic acids.

Table 4. Effect of water salinity treatments and organic acids on N,P,K and Na contents in grain and straw of wheat plant in 2015/2016 winter season.

Characteristics	Na %		N %		P %		K %	
Treatments	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**
salinity treatments								
S0 (tap water=0.4 dS.m-1)	0.797	0.189	2.355	3.827	0.0647	0.6298	1.809	0.890
S1 (2.12 dS.m-1)	1.207	0.197	2.277	3.731	0.0647	0.5585	2.303	1.031
S2 (4.82 dS.m-1)	1.553	0.207	2.280	3.657	0.0643	0.5558	2.060	0.881
S3 (9.11 dS.m-1)	1.907	0.214	2.128	3.366	0.0643	0.5539	1.977	1.301
LSD at 5%	0.53	----	0.0917	----	----	0.0098	----	----
F. Test	*	N. S.	**	N. S.	N. S.	**	N. S.	N. S.
Organic acids treatments								
A1 (Humic acid(Ha))	1.330	0.204	2.237	3.605	0.0643	0.5523	2.130	1.098
A2 (Ascorbic acid (Aa))	1.385	0.210	2.183	3.778	0.0649	0.5534	2.106	1.074
A3 (Salicylic acid (Sa))	1.303	0.204	2.379	3.761	0.0644	0.5942	1.993	0.860
A4 (Glycine (Ga))	1.447	0.189	2.240	3.437	0.0643	0.5973	1.920	1.070
LSD at 5%	----	----	0.131	----	----	0.0148	----	----
F. Test	N. S.	N. S.	*	N. S.	N. S.	**	N. S.	N. S.
Interaction effect LSD at 5%	----	----	----	----	----	0.0148	----	----
F. Test	N. S.	N. S.	N. S.	N. S.	N. S.	**	N. S.	N. S.

The interaction effect of water salinity levels and organic acids on N% in grain of wheat plant is shown in Fig 4. Statistical analysis of obtained data outlined a non-significant interaction pattern was found regarding to N% in grain of wheat plant. It is obvious that the highest N% value in grain was 4.29% (S2A2) which was gained with ascorbic acid under salinity level=4.82 dS.m-1, whereas the lowest value of N% value in grain was 0.67% (S2A4), which was gained with Ga (glycine acid treatment) with S2 (with salinity level = 4.82 dS.m-1) . It could be concluded that Increasing NaCl concentration in irrigation water has induced decrease in N content in wheat grain, and glycine has a less effect in corresponding with other organic acids .

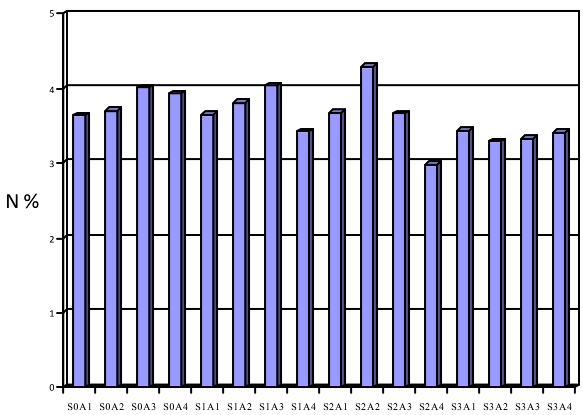

Fig. 4. Interaction Effect of water salinity levels and organic acids on N content in grain of wheat plant

Concerning the interaction effect of water salinity levels and organic acids on N% in straw of wheat plant, it was found that the lowest mean value of N% in straw was 2.04% (S3A3), whereas the highest mean value of N% in straw was 2.63% (S0A3). So the highest accumulation of N was gained with (S0A3) treatment of salicylic acid + tap water =salinity level of 0.4 dS.m-1 . The increasing percentage of N content was 29.3% in comparison with the lowest values . It has been found also, that high levels of NaCl significantly reduced the N accumulation in wheat plant. Whereas , SA (salicylic acid) treatments reduced the damaging action of salinity and accelerated a restoration of growth processes. Also, salicylic acid inhibited strongly salinity hazard and stimulate N concentration of stressed plants as mentioned by Gunes, *et al.* (2007) and Turan *et al.* (2007a, b).

Table 4 shows the effect of water salinity levels and organic acids as foliar spray effect on phosphorus content of wheat plant. There was a significant decrease of P% in grain of wheat plant, but there was in-significant effect in relation to P% in straw with increasing water salinity levels. It was observed that the differences between the mean values of p% in straw was less than that in grain due to most values of phosphorus accumulated in the grains. Also, irrigation with water salinity levels affected wheat content of phosphorus, it was found that the highest values of P% in straw and grain were 0.0647 and 0.6298% respectively with salinity level of (S0=tap water 0.4 dS.m-1). The reduction in percentage of P% in straw with salinity levels of 2.12; 4.82 and 9.11 dS.m-1 were 0.0, 0.62 and 0.62%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1). Whereas with grain the reduction percentages of P% in straw with salinity levels at 2.12; 4.82 and 9.11 dS.m-1 were 11.32, 11.75 and 12.05%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1)

Regarding to organic acids types effect on P content in straw and grain, the highest P content in straw was gained (0.0649%) with Aa (ascorbic acid with 330 mg.L-1), whereas, it reaches 0.5973% in grain using Ga (glycine acid treatment)

The interaction effect of water salinity levels and organic acids on Na% in straw of wheat plant is shown in Fig 5. Statistical analysis of obtained data outlined a non-significant interaction pattern was found regarding to P% in straw of wheat plant whereas, there was a significant differences between the mean values of p% in grains. Considering the interaction effect of water salinity levels and organic acids on P% in grain of wheat plant, it was found that the lowest mean value of P% in grain was 0.481% (S3A1), whereas the highest mean value of P% in grain was 0.639% (S0A2). So the highest accumulation of P was gained with the treatment of (Aa) ascorbic acid + (tap water) salinity level of 0.4 dS.m-1 , the increasing percentage of the P% content was 32.92% in comparison with the lowest values .

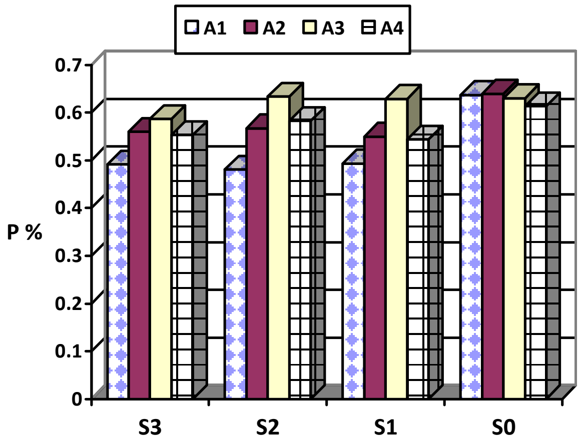

Fig. 5. Interaction Effect of water salinity levels and organic acids on P content of wheat grains

It is obvious that with tap water there was no differences between the mean values of P% in grain as influenced by spraying different types of organic acids but, with increasing salinity levels it was found that Sa (salicylic acid) had more pronounced effect on increasing P% in grain than other organic acids. These results suggest that Sa could be used as a potential growth regulator to reduce damaging action of salinity. So, the foliar application of Sa (Salicylic acid) promoted growth and stimulated the uptake of P in stressed wheat plants as mentioned by Sakhabutdinova, *et al*(2003); Arfan, *et al*(2007); Gunes, *et al*(2007) and Khatiby, et. al.,(2016).

In respect to phosphorus content in straw as affected by the interaction of water salinity levels and organic acids, Fig (6) showed this relation. Statistical analysis of obtained data outlined insignificant interaction pattern which found in corresponding to P% in straw of wheat plant. It was found that the lowest mean value of P% in straw was 0.063% (S3A1), whereas the highest mean value of P% in straw was 0.065% (S0A2). So the highest accumulation of P was gained with the treatment of (Aa) ascorbic acid + (tap water) salinity level of 0.4 dS.m-1 , the increasing percentage of P% was 2.09% in comparison with the lowest values . As shown in Fig. (6) it is clear that with different salinity levels, it was found that Aa (ascorbic acid) had more pronounced effect on straw than other organic acids in increasing P% in straw. These results could be due to that ascorbic acid proved to be more effective in alleviating harmful effect of salinity by reducing the harmful effect on reaction of oxygen species (ROS) caused by salinity resulting scavenging cytotox H2O2, and reacts non-enzymatically with other ROS singlet oxygen, superoxide radical and hydroxyl radical, as mentioned by Amin *et al*(2008)

Potassium content in straw and grain of wheat plant is presented in Table (4). There was in-significant decrease of K% in straw and grain of wheat plant as effected by water salinity levels. It was found that the highest values of K% in straw was 2.30 % with salinity level of (S1= 2.12 dS.m-1). The increasing percentage of K% in straw with salinity levels of 2.12; 4.82 and 9.11 dS.m-1 were 27.31, 13.88 and 9.29%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1). Whereas with grain the increasing percentage of K% with salinity levels of 2.12; 4.82 and 9.11 dS.m-1 were 15.84, -1.01 and 46.18%, respectively compared to the control (irrigation with tap water= 0.4 dS.m-1)

Regarding to organic acids types effect on K content in straw and grain, the highest K content were 2.13% and 1.10 % respectively. They were achieved by using foliar application of Ha (humic acid with 200 mg/L). Whereas, the lowest mean value of K% in grain was 0.86% (H3= Salicylic acid), and in straw was 1.92% (H4= Glycine acid), The interaction effect of water salinity levels and organic acids on K% in straw and grain of wheat plant outlined a non-significant interaction pattern. It was found that the lowest mean value of K% in grain was 0.595% (S1H4), whereas the highest mean value of K% in grain was 1.636% (S3H4). So the highest accumulation of K was gained with the treatment of Ga (glycine acid treatment)+ salinity level of 9.11 dS.m-1. Also, It was found that the lowest mean value of K% in straw was 1.56% (S3H4), whereas the highest mean value of K% in straw was 2.46% (S3H1). So the highest accumulation of K in straw was gained with the treatment of Ha (humic acid treatment)+ salinity level of 9.11 dS.m-1.

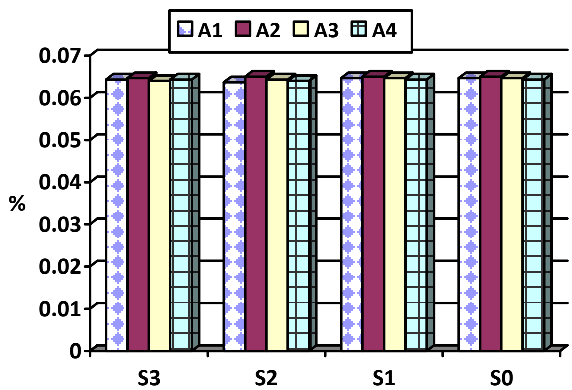

Fig. 6. Interaction Effect of water salinity levels and organic acids on P content of wheat straw

So, it could be reported that there is a beneficial effect of glycine acid in decreasing Na content, which may led to an increase in K content and uptake especially under the saline condition. As, excessive sodium ions at the root surface disrupt plant potassium nutrition. Because of the similar chemical nature of sodium and potassium ions, it can differentially cause nutrient deficiencies or imbalances, due to the competition (antagonism) between them. So, it is necessary for plants to operate the more selective high-affinity potassium uptake system in order to maintain adequate potassium nutrition. These results are in agreement with those obtained by Rahman, *et al*(2002); Cun and Shabala, (2007) and Nawaz, *et al*(2010)

CONCLUSION AND RECOMMENDATION

Our experiment indicates that phytohormones play critical roles in plant responses to salinity and it can be concluded that hormonal priming with 330 mg.L-1 of salicylic acid or glycine acid may increase the ability of wheat to grow successfully under saline conditions. It is worthy to conclude that under Egyptian conditions it is recommended to use these hormonal priming treatments for improving plant growth and yield in saline areas.

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استجابة نبات القمح للرش بالأحماض العضوية تحت الظروف الملحية

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تم تنفيذ تجربة أصص فى فصل الشتاء لعام ٢٠١٦/٢٠١٥ فى صوبة التجارب الزراعية لقسم الأراضى –كلية الزراعة – جامعة المنصورة محافظة الدقهلية – مصر لدراسة تأثير التفاعل بين أنواع مختلفة من الأحماض العضوية (حمض الهيوميك بتركيز ٢٠٠ ملجم/لتر بينما احماض الاسكوربيك والسلسيليك والجليسين بتركيزات ٣٣٠ ملجرام /لتر) تحت ظروف الرى بمياه ذات تركيزات ملوحة مختلفة (ماء الصنبور =٠.٤ - ٢.١٢ – ٤.٨٢ و٩.١١ ديسمنز/متر) باستخدام صنف قمح سدس ١٢ مزروع فى ارض طينية. وتم تقييم هذة التجربة فى تصميم قطع منشقة مرة واحدة فى ثلاث مكررات.ويمكن تلخيص أهم النتائج المتحصل فيما يلى: الوزن الجاف لحبوب القمح انخفض مع زيادة تركبز الأملاح فى مياه الرى من ٠.٤ الى ٩.١١ ديسمنز/متر بنسبة ٢.١٢ و ٧.٧٣ و ١٢.٣٤ % مقارنة بمحصول الحبوب فى الكنترول (الرى بمياه الصنبور = ٠.٤ ديسمنز/متر). كما يمكن ترتيب الأحماض العضوية فى قدرتها على زيادة محصول القش الجاف فى الترتيب التالى : السلسيليك > الاسكوربيك > الجليسين > الهيوميك كذلك يمكن ترتيب الأحماض العضوية فى قدرتها على زيادة وزن الـ ١٠٠حبة الترتيب التالى : السلسيليك > الاسكوربيك > الجليسين > الهيوميك. كما وجد ان معاملة الرش بحمض الجليسين تحت كل تركيزات الأملاح فى الدراسة تسبب فى زيادة طول نبات القمح مقارنة بباقى الأحماض تحت ظروف التجربة.كانت غالبية النتائج الخاصة بمحتوى وتركيزات العناصر المغذية بنبات القمح لم تتأثر بصورة معنوية تحت ظروف التجربة ما عدا نتائج تركيزات الصوديوم والنيتروجين فى قش القمح ومحتوى الفسفور فى حبوب القمح . ووجد نقص فى تركيز المغذيات نتيجة زيادة تركيز الأملاح ماعدا تركيز عنصر الصوديوم فى كلا من القش والحبوب . كانت أعلى نسبة محتوى لعنصر الصوديوم فى قش القمح =٢.٠٤% مع معاملة (S3A2) وهى اعلى تركيز املاح +حمض الاسكوربيك ، بينما كانت أعلى نسبة محتوى لعنصر الصوديوم فى حبوب القمح =٠.٢٤% مع معاملة (S3A3) وهى اعلى تركيز املاح +حمض السلسيلك . كذلك كانت أعلى نسبة محتوى لعنصر النيتروجين فى قش القمح =٢.٣٨% مع حمض السلسيلك بينما كانت أعلى نسبة محتوى لعنصر الصوديوم فى حبوب القمح =٣.٧٧٨% مع مع حمض الاسكوربيك . كانت أعلى نسبة محتوى لعنصر الفسفور حبوب القمح =٠.٦٣٩% مع معاملة (S0H2) وهى الرى بماء الصنبور (اقل تركيز املاح=٠.٤ ديسمنز/متر)+حمض الاسكوربيك . بينما كانت أعلى نسبة محتوى لعنصر الفسفور فى قش القمح =٠.٠٦٥% مع معاملة (S0H2) وهى الرى بماء الصنبور (اقل تركيز املاح=٠.٤ ديسمنز/متر)+حمض الاسكوربيك. كما كانت أعلى نسبة محتوى لعنصر البوتاسيوم فى حبوب القمح =٠١.٦٣٦% مع معاملة الرى باعلى تركيز املاح (٩.١١ ديسمنز/متر) +الرش بحمض الجليسينلذا يمكن التوصية يالرش بحمضى الجليسين أو السلسيلك بتركيز ٣٣٠ ملجم/لتر والذى يمكن أن يتيح الفرصة لمحصول القمح بالنمو بصورة جيدة تحت الظروف الملحية .