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Physiological response of some wheat varieties to foliar application with yeast, potassium and ascorbic acid under salt affected soil conditions

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Growth, physiological response and productivity of four wheat varieties, namely Masr 1, Giza 171, Gemmeiza 12, and Sids 13, grown under salt-affected soil conditions irrigated with brackish water, and their feedback to reduce applied mineral nitrogen fertilizers from 215 kg N/ha to 145 kg N/ha coupled with the foliar application of 10g L^{-1} yeast extract or 10g L^{-1} K_2O or 0.3g L^{-1} ascorbic acid (AA) were the main objective of this study. Therefore, a field trial was conducted in salt-affected soils of South Port Said Governorate, Egypt, in two successive winter growing seasons 2014/2015 and 2015/2016. The experiments were performed in a split plot design with four replications. The main plots were devoted to the four wheat varieties, and the subplots for other treatments; i.e., 145 kg N with yeast extract, 145 kg N with 1% K_2O, 145 kg N with 300 ppm ascorbic acid and control with 215 kg N fertilization. Masr 1 significantly surpassed the rest of varieties for grain productivity and proved the most tolerant variety in the present experiment, followed by Giza 171; Sids 13 seemed to be the lowest tolerant variety under such conditions. Non-significant differences were observed between plants fertilized with 215 kg N/ha and those received 145 kg N/ha plus foliar application of yeast extract for plant height, leaf area index (LAI), crop growth rate (CGR), net assimilation rate (NAR), photosynthetic pigments, soluble sugars, catalase (CAT), polyphenol oxidase (PPO), peroxidase (POD), leaf potassium content, spike length, spike weight, 1000- grain weight, grain and straw yields. Plants treated with 145 kg N/ha plus foliar application of K_2O or ascorbic acid (AA) followed the aforementioned treatments in their effects for all studied traits. Relative reduction in soil salinity and sodium absorption ratio (SAR) values during the studied two seasons along with increasing soluble Ca^{2+} helped in the enhancement of wheat yield and its attributes.

Keywords: Wheat, salt stress, nitrogen fertilizer, yeast extract, potassium, ascorbic acid.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important crops in many countries, and it is the main winter cereal crop in Egypt. However, the total cultivated area of wheat reached about 1.425 million hectares and the total production exceeded *8.8* million tons with an average of 6.*6* t/ha (FAO STAT, 201*7*), which accounted for about 9 % of the total of agricultural production (Alwang et al., 2018). The balance between the production and consumption of wheat (about 40 % of the national demands) is achieved by importing from foreign markets. Due to the incapability of freshwater resources, Egypt has implemented large reclamation project El-Salam canal depending on reuse of agricultural drainage water after blending with Fresh Nile water in a ratio of about 1:1. About 64% of the reclamation area in West Suez Canal is located in north El-Hussainia, South Port Said and East Bahr El Bakar regions, where the salt-affected soils are developed (Hafez, 2005). On the other hand, the continuous use of low water quality irrigation and conventional agriculture practices continue to worsening the problem (Darwish et al., 2005). About 20 to 30 million hectares of irrigated land are currently damaged by salinity, and 0.25 to 0.50 million hectares are lost from production every year as a result of salt accumulation (Qadir et al., 2014). Therefore, good management practices coped with the contemporary environmental conditions are urged.

It has long been recognized that wheat productivity varies considerably as a result of genotype and environmental conditions as well as their interaction. Salt stress can result in ion toxicity, osmotic and oxidative stress, nutritional imbalances, reduction of cell divisions and alterations of metabolic processes as photosynthesis, respiration, and disorganization of plant membranes (Sen et al., 2002 and Hasanuzzaman et al., 2014), which reflected on reducing plant growth and its productivity. It is well known that (vertical expansion) maximizing the productivity of any crop could be achieved by using suitable agronomic practices. Also, the pronounced role of the agronomical processes such as using promising cultivars, foliar applications of stimulant substances, i.e. yeast extract, potassium as well as ascorbic acid that have very imperative effects on crop growth and chemical constituents, besides yield and its attributes (du Jardin, 2015).

Foliar spray of nutrients is perfect for correcting nutrient deficiencies. Foliar spray is a great supplement to boost flavors, sweetness, mineral density and yield of crops (Hsu, 1986). However, many studies indicated that yeast is one of the richest source of high-quality protein which contains the essential amino acids like lysine, tryptophan etc., also, contains the essential minerals and trace elements, i.e., calcium, cobalt, iron etc. and the best sources of the B-complex vitamins such as B1, B2, B6 and B12. Shehata et al. (2012) mentioned that yeast is an enriched source of phytohormones especially cytokinins, vitamins, enzymes, amino acids, and minerals as well as, it has a stimulatory effect on the cell division and enlargement, protein and nucleic acids synthesis, chlorophyll formation and protective role against different stresses. Moreover, improving growth of some plants by using foliar application with yeast extract was reported by Mohamed et al. (2018).

Potassium (K) is one of the vital elements required for plant growth and physiology. Potassium has a regulatory function in several biochemical processes related to protein synthesis, carbohydrate metabolism, and enzyme activation. Several physiological processes depend on K, such as stomatal regulation and photosynthesis. In recent decades, K was found to improve crop abiotic stress tolerance. Under salt stress, K helps to maintain ion homeostasis and to regulate the osmotic balance. Many reports support the notion that K enhances antioxidant defense in plants and therefore protects them from oxidative stress under various environmental adversities (Hasanuzzaman et al., 2018).

Ascorbic acid is an organic compound with antioxidant properties. The molecular formula of ascorbic acid is $C_6H_8O_6$ with the molecular weight of 176.13. It is a white solid, but impure samples can appear yellowish. It dissolves well in water to give mildly acidic solutions. Ascorbic acid can be slightly dissolved in ethanol, but not in diethyl ether, chloroform, benzene, petroleum ether or lipid (Zhang, 2012). Ascorbic acid plays role in plant growth and development, cell division, cell wall metabolism and cell expansion, shoot apical meristem formation, root development, photosynthesis, regulation of florescence and regulation of leaf senescence. Also, it is cofactors for enzyme activity, and affects on plant antioxidation capacity, heavy metal evacuation and detoxification and stress defense (Zhang, 2012 and Xu et al., 2015). Ascorbic acid foliar application increased the yield of wheat crop as found by Abd El-Hameed et al. (2004); Hafez and Gharib (2016); Osman and Nour Eldein (2017).

Nitrogen is one of the essential nutrients for growth, yield, and quality of most cultivated crops, especially wheat. Although the yield of wheat increase to some extent with increasing nitrogen dose during the growth period, nitrogen utilization is significantly reduced, this can result in increasing environmental pollution (Zhao et al., 2006). Nitrogen supply to the plant will influence the growth and photosynthetic pigments content. In spite of mineral fertilizers have a good effect on plant productivity; nevertheless, it also has a pollutant effect (with continuous use) on the environment especially dissolved ones like nitrogen fertilizer. Whereas, it is more rapidly leaching to ground water, which affects human and animal health (Wopereis *et al*., 2006).

Therefore, the present study was undertaken to examine the growth, physiological response and productivity of four wheat cultivars under salt affected-soil conditions and the feasibility of compensating decreases in nitrogen dose by foliar application of stimulants yeast extract, potassium, and ascorbic acid and their effects on wheat growth and development.

MATERIALS AND METHODS

The present work was carried out at South Port Said Gov., Egypt (31˚ 08' 42˝ N 32˚ 17' 36˝ E) during two successive winter seasons 2014/15 and 2015/16 to study the productivity and physiological response of some wheat varieties grown under salt-stress conditions and their feedback to reduce applied mineral nitrogen fertilizers from 215 kg N/ha to 145 kg N/ha coupled with the foliar application of yeast extract or K_2O or ascorbic acid. Therefore, growth parameters, photosynthetic pigments, soluble sugars, antioxident enzymes, yield, yield components, proline contents, and Na^+/K^+ ratio of wheat plants, as well as soil conditions, are in concern.

The experiment was laid out in a split plot design with four replications, keeping wheat cultivars in the main plots and the nitrogen levels with spraying treatments in the subplots, and the experimental plot size was 10.5 m^2. The experiment was conducted precisely in the same place during the studied period. It was irrigated, using flood conditions, from El-Tina branch supported from El-Salam irrigation canal over a distance of about 15 km. The experimental area is located nearby the western site of Suez Canal about 1.5 km and too close to Port Said city and has an annual mean rainfall of about 97 mm/year according to Helmy et al. (2007).

Soil sampling and land preparation:

Initial soil properties and the irrigation water analysis during two winter seasons are shown in Tables 1 and 2. Physical and chemical properties of soil are obtained in the first year before land preparation. At wheat harvesting time, the surface layer of each plot was collected for chemical analysis to asses the impact of the concerned treatments on soil properties namely electrical conductivity of saturated soil paste extract (EC_e), sodium adsorption ratio (SAR) and soluble Ca^{2+}. Also, representative soil samples, before starting the second winter season, were obtained from each replicate to check the chemical state of the experimental site. Soil analyses were done according to the methods cited by Richards (1954).

Before the experimental setup, the soil was plowed at 20 cm depth followed by straight shank sub-soiling at distance of 2.5 m and 45-50 cm depth (ones at the beginning of the experiment). Gypsum requirements (GR) were estimated on SAR basis (Richards, 1954) and split into two equal doses and spread for each winter season. Again, the soil was plowed twice at 0.2 m depth to perfectly mixing and finally, the land level was conducted using light tractor at suitable moisture content to avoid soil compaction.

Fertilizer treatments (sub plots) were as follows:

1- 215 kg N/ha (control) (sprayed with water at 30 and 45 days after sowing; DAS).
2- 145 kg N/ha + Yeast extract (sprayed at 30 and 45 DAS).
3- 145 kg N/ ha + 1% K_2O in form of solo-potassium (50% K_2O) (sprayed at 30 and 45 DAS).
4- 145 kg N/ha+ 300 ppm ascorbic acid (AA) (sprayed at 30 and 45 DAS) according to Bakry et al. (2013).

Where: - Yeast extract was prepared according to Morsi et al. (2008) sprayed as 10 g/L.

Other, cultural practices were applied according to the recommendations of Egyptian Field Crops Research Institute at the site.

To calculate growth characters; five plants were randomly taken from each plot at 70, 85 and 100 days after sowing (DAS). Other plant samples were taken and dried at 70 °C in oven to a constant weight. According to Hunt (1990) formulas, the following characters were determined:

- Plant height (cm).
- Leaf area index (LAI)= leaf area of plant (cm^2) /land area occupied by plant (cm^2).
- Net assimilation rate, in $g/m^2/day$(NAR)= $(W_2-W_1)(\log_e A_2-\log_e A_1)/(A_2-A_1)(t_2-t_1)$.
- Crop growth rate, in $g/day/m^2$ (CGR) = $(W_2-W_1)/(t_2-t_1)$. Where:

A_2-A_1= differences in leaf area between two samples (cm^2).

W_2-W_1= differences in dry matter accumulation of whole plants between two samples in (g).

Table 1: Mean of some physiochemical analysis of the experimental soil (from surface at 20 cm depth) during the studied period.

A- Physical characteristics					
Clay (%)	**Silt (%)**	**Sand (%)**	**Texture class**	**SP**	**ρb (g. cm^{-3})**
52.38	28.17	19.45	Clay	91	1.39 ±0.04

B- chemical analysis										
pH (1:2.5)	EC dSm^{-1}	**Soluble cations ($mmol_c$ L^{-1})**				**Soluble anions ($mmol_c$ L^{-1})**				**SAR**
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	
1st season 2014 / 2015										
8.25 ±0.09	8.**77** ±0.89	11.55 ±2.5	20.33 ±3.1	65.66 ±7.6	3.92 ±0.9	-	1.78 ±0.4	70.7 ±6.1	29.5 ±7.6	16.5 ±0.7
2nd season 2015/ 2016										
8.18 ±0.1	**8.15** ±0.94	13.22 ±2.04	18.89 ±2.6	60.89 ±6.9	2.55 ±0.6	-	1.42 ±0.3	62.3 ±6.3	31.9 ±6.5	15.19 ±0.9
O.M:12 ± 1.61 (g kg^{-1}), $CaCO_3$: 73.6 ± 6.59 (g kg^{-1}), CEC : 40 ± 3.16 ($cmol_c$ kg^{-1}), Available N: 25 ±2.94 (mg kg^{-1})										

*Mean ± stander deviation. SP: saturation percentage, ρb: bulk density, OM: organic matter, $CaCO_3$: calcium carbonate, CEC: cation exchange capacity, SAR: sodium adsorption ratio.

Table 2: Means of some chemical analyses of irrigation water (1st and 2nd seasons, respectively)

pH	**EC dSm^{-1}**	**Soluble cations ($mmol_c$ L^{-1})**				**Soluble anions ($mmol_c$ L^{-1})**				**SAR**	**R.S.C**
		Ca^{2+}	**Mg^{2+}**	**Na^{+}**	**K^{+}**	**CO_3^{2-}**	**HCO_3^{-}**	**Cl^{-}**	**SO_4^{2-}**		
7.52±0.2	3.06±0.3	4.93±0.6	7.54±0.9	18.26±1.7	0.52±0.1	-	2.64±0.4	18.14±2.1	10.48±1.0	7.31±0.3	0.0
7.35±0.2	2.34±0.3	4.51±0.4	6.4±0.8	15.36±1.6	0.45±0.1	-	2.45±0.3	12.2±1.8	12.07±0.8	6.58±0.4	0.0
NH_4^{+}-N: 15 ±2.4 mg L^{-1}, NO_3^{-}-N: 18 ±1.8 mg L^{-1}											

*Mean ± stander deviation, SAR: sodium adsorption ratio**,** R.S.C: residual sodium carbonate.

Table 3: Name, pedigree and selection history of the studied cultivars.

Cultivar name	Pedigree and selection history
Masr 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR CMss00Y01881T-050M-030Y-030M-030WGY-33M-0Y-0S
Giza 171	"Sakha 93/Gemmeiza 9". "Gz 2003-101-1Gz-4Gz-1Gz-2Gz-0Gz".
Gemmeiza 12	OTUS/3/SARA/THB//VEE. (CMSS97YOO227 S-5Y-010M-010Y- 010M=2Y-1M-0Y-OGM).
Sids 13	ALMAZ-19= KAUZ"S"//TSI/SNB"S". ICW94-0375-4AP-2AP-030AP-0APS-3AP-0APS-050AP-0AP-0SD.

t_2-t_1= Number of days between two successive samples (day).
Log_e = Natural logarithm.
At 85 DAS, the following characters were determined:
Photosynthetic pigments (chl a, chl b and carotenoides) in mg/g fresh weight, according to Metzener et al. (1965).
Soluble sugars using modifications of the procedures by Yemm and Willis (1954).
Antioxidant enzymes catalase (CAT), polyphenol oxidase (PPO) and peroxidase (POD) activities according to Karo and Mishra (1976).
Leaf proline concentration, in µg/g fresh weight, according to Bates et al. (1973).
Potassium and sodium content in wheat plant as mmole/kg dry weight, according to Allen et al. (1974).
Just before harvest time, spike length (cm) and spike weight (g) were determined and after harvest 1000-grain weight (g), grain and straw yields (t/ha) were determined.
Data of the two seasons were subjected to statistical analysis of variance according to Steel and Torrie (1980). The treatments average was compared using LSD test at 0.05 level of significant.

RESULTS AND DISCUSSION

Growth and growth analysis:

Plant height and crop growth rate (CGR)

Data in Table 4 shows that wheat cultivars Masr 1, Giza 171, Gemmeiza 12 and sids 13 significantly differed in plant height at 70, 85 and 100 days after sowing as well as CGR at periods 70-85 and 85-100 DAS. However, Giza 171 exceeded other cultivars in plant height at 70, 85 and 100 DAS, while Masr 1 exceeded other cultivars in CGR at periods 70-85 and 85-100 DAS in the two seasons. It could be concluded that varietal differences between wheat cultivars may be due to the genetic differences between cultivars concerning partitioning of dry matter, where wheat cultivars differed in carbon equivalent, yield energy (Abd-El-Gawad *et al.,* 1987). The superiority (without significant difference) of Giza 171 or Masr 1 cultivar (compared to other two cultivars) may be due to the increase in the efficiency to photosynthate or uptake of more water and minerals from soil. This was reflected on increasing the production of more sizeable organs. The results of varietal differences in growth are in agreement with those obtained by El-Habbasha (2001), Hassanien (2001), Zaki et al. (2007) and Abdel-Ati and Zaki (2006).

The data also shows that plant height and CGR of wheat plants received 145 kg N/ha and yeast extract have values insignificantly differed than plants received 215 kg N/ha, while plants treated with 145 kg N/ha and 1% K_2O or 300 ppm AA shows significantly less values for plant height at 70, 85 & 100 DAS and CGR at periods 70-85 and 85-100 DAS in the two seasons. The stimulatory effect of yeast extract can be attributed to the increased contents of different nutrients as well as the concentration of protein, vitamin B and natural plant growth regulators such as cytokinins. The physiological roles of vitamins and amino acids in yeast extract can increase the metabolic processes and levels of endogenous hormones which in turn encourage the growth (Shehata et al., 2012 and El-Shafey et al., 2016).

Table 4: Plant height and crop growth rate (CGR) of some wheat varieties as affected by nitrogen dose, yeast extract, potassium and ascorbic acid for two winter seasons of 2014/2015 and 2015/2016.

Treatments		Plant height (cm)						CGR ($g/m^2/d$)			
		70 day		85 day		100 day		(70-85 day)		(85-100 day)	
		14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars											
Masr 1		54.13	54.63	77.63	78.69	85.25	86.69	11.78	12.07	14.76	14.91
Giza 171		54.19	55.13	78.81	79.68	86.13	88.25	11.50	11.81	14.50	14.66
Gemmeiza 12		52.44	52.94	76.41	77.59	84.94	86.06	11.08	11.37	13.92	14.24
Sids 13		52.31	52.81	76.06	76.94	84.38	85.38	10.66	11.00	13.58	13.88
LSD (0.05)		0.68	1.18	1.04	0.32	0.37	0.59	0.05	0.05	0.05	0.06
N and foliar spray											
215 kg N (control)		54.19	54.81	77.94	79.06	85.88	87.31	11.49	11.80	14.28	14.58
145 kg N + Yeast ext.		53.19	53.81	77.25	78.31	85.19	86.63	11.28	11.57	14.25	14.47
145 kg N + 1 % K_2O		52.75	53.31	76.91	77.84	84.88	86.31	11.14	11.45	14.14	14.33
145 kg N + 300 ppm AA		52.94	53.56	76.81	77.69	84.75	86.13	11.11	11.43	14.09	14.30
LSD (0.05)		0.79	0.59	0.66	0.74	0.73	0.75	0.10	0.11	0.10	0.11
Interaction											
Masr 1	**215 kg N**	55.0	55.5	78.5	79.5	86.0	87.5	11.95	12.28	14.88	15.08
	145 kg N + YE	54.0	54.5	77.5	78.8	85.3	86.8	11.79	12.08	14.86	15.01
	145 kg N + K	53.0	54.0	77.3	78.3	85.0	86.3	11.68	11.97	14.68	14.78
	145 kg N + AA	54.0	54.5	77.3	78.3	84.8	86.3	11.69	11.97	14.64	14.76
Giza 171	**215 kg N**	55.5	56.5	79.5	80.5	87.0	89.0	11.78	12.07	14.57	14.80
	145 kg N + YE	54.3	55.3	79.0	79.8	86.0	88.3	11.58	11.88	14.53	14.68
	145 kg N + K	53.5	54.3	78.5	79.3	85.8	88.0	11.37	11.68	14.48	14.58
	145 kg N + AA	53.5	54.5	78.3	79.3	85.8	87.8	11.29	11.63	14.43	14.57
Gemmeiza 12	215 kg N	53.3	53.8	77.0	78.5	85.5	86.8	11.28	11.58	14.00	14.38
	145 kg N + YE	52.3	52.8	76.5	77.8	85.0	86.0	11.08	11.37	13.98	14.28
	145 kg N + K	52.0	52.5	76.1	77.4	84.8	85.8	10.99	11.28	13.87	14.18
	145 kg N + AA	52.3	52.8	76.0	76.8	84.5	85.8	10.97	11.27	13.83	14.13
Sids 13	215 kg N	53.0	53.5	76.8	77.8	85.0	86.0	10.97	11.28	13.68	14.07
	145 kg N + YE	52.3	52.8	76.0	77.0	84.5	85.5	10.68	10.97	13.63	13.93
	145 kg N + K	52.0	52.5	75.8	76.5	84.0	85.3	10.52	10.88	13.53	13.79
	145 kg N + AA	52.0	52.5	75.8	76.5	84.0	84.8	10.48	10.87	13.48	13.73
LSD (0.05)		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Leaf area index (LAI) and net assimilation rate (NAR)

Data in Table 5 showed that wheat cultivars Masr 1, Giza 171, Gemmeiza 12 and sids 13 significantly differed in LAI at 70, 85 and 100 days after sowing as well as NAR at the two periods 70-85 and 85-100 DAS. However, Masr 1 exceeded other cultivars in LAI at 70, 85 & 100 DAS and in NAR at periods 70-85 and 85-100 DAS. Similar results were also reported by Zheng et al., (2010); and Kumar et al., (2016).

Plants received 145 kg N/ha plus foliar application of yeast extract have values of LAI and NAR relatively comparable to those plants received 215 kg N/ha, with insignificant differences in each season followed by potassium treatment and ascorbic acid treatment, respectively. These results are in coincidence with those of Seadh et al. (2015) and Hafez and Gharib (2016), who found that foliar spraying of wheat plants during growth stage with stimulants had a pronounced role in improving plant growth and accumulation of more assimilates.

Photosynthetic pigments:

Data in Table (6) indicate that chlorophyll a, chlorophyll b and carotenoid contents were significantly differed among the wheat cultivars in the two seasons. Leaves of Masr 1 variety shows the highest content of photosynthetic pigments at 85 DAS followed by Giza 171 and the lowest one was Sids 13. This variation in photosynthetic pigment content of the four tested wheat cultivars could be mainly due to their genetic backgrounds. Such varietals' differences among wheat cultivars under salt-affected soil conditions have been pointed out by Kandil et al. (2016).

The results also show that photosynthetic pigment contents in wheat leaves to some extent are affected by nitrogen rate under the stress conditions during the studied seasons which indicate the role of N-level on relieving of the stress effect. Such results are in agreement with those reported by Hafez et al., (2014). However, the plants received 145 kg N/ha in addition to foliar application of stimulants had values of photosynthetic pigments adequate to those received 215 kg N/ha with insignificant differences with yeast extract during two seasons. These results may be attributed to the stimulating effect of the foliar treatments on the enzymes related to photosynthetic process and reducing electrolyte leakage that resulted in increasing uptake of magnesium and iron as well as other nutrients which are required for chlorophyll biosynthesis (Hammad and Ali, 2014; El-Guibali, 2016; Hafez and Gharib 2016).

Soluble sugars and antioxidant enzymes

Soluble sugars content and antioxidant enzymes in four wheat cultivars as affected by nitrogen and stimulants at 85 DAS grown in saline soil are presented in Table (7). Wheat cultivar Masr 1 shows significantly the highest values of soluble sugars content, and studied enzymes activities, *i.e.* catalase (CAT), polyphenol oxidase (PPO) and peroxidase (POD) in the two seasons followed by Giza 171, while the lowest values were obtained with Sids 13 cultivar, consequently, Sids 13 cultivar seemed to be the less affected variety under the experimental conditions. These findings are on line with those of El-Lethy et al. (2013) who reported that salt stress significantly inhibited wheat plant growth and photosynthetic pigments, particularly less tolerant varieties.

On the other hands, the soluble sugars content and antioxidant enzymes activities of wheat plants received 145 kg N/ha plus yeast extract foliar application exhibited relatively adequate values for the above mentioned enzymes as compared to those plants received 215 kg N/ha and to some extent in comparable to the other plant stimulates. These finding agreed with those of Van and Clijsters (1990), who found that accumulation of soluble sugars, which increased as a result of salt–stress, resulted in osmotic regulation of plant cells, which led to store an optimum level of their carbohydrate metabolism (Gibson, 2005). Moreover, Złotek (2017) concluded that foliar spray of 1% yeast extracts can be effectively elevate the content of some bioactive compounds in plants. In this regard, Abdel Latef (2011) suggested that plants develop self defense mechanisms by producing antioxidant enzymes like superoxide dismutase, ascorbate peroxidase and catalase. A continued increase in CAT, PPO and POD activity might indicate that these enzymes are major enzymes detoxifying hydrogen peroxide (oxidative stress) under stress conditions (Malik et al., 2015 and Babaei et al., 2017).

Table 5: Leaf area index (LAI) and net assimilation rate (NAR) of some wheat varieties as affected by nitrogen dose, yeast extract, potassium and ascorbic acid for two winter seasons of 2014/2015 and 2015/2016.

Treatments		Leaf area index						NAR ($g/m^2/d$)			
		70 day		85 day		100 day		(70-85 day)		(85-100 day)	
		14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars											
Masr 1		1.88	1.98	2.21	2.30	2.17	2.21	9.52	9.56	10.10	10.13
Giza 171		1.69	1.73	2.03	2.11	2.00	2.03	9.16	9.20	9.91	9.95
Gemmeiza 12		1.59	1.60	1.92	1.96	1.87	1.90	8.98	9.01	9.79	9.82
Sids 13		1.48	1.50	1.90	1.94	1.86	1.89	8.88	8.91	9.71	9.74
LSD (0.05)		0.03	0.07	0.13	0.05	0.13	0.13	0.07	0.05	0.05	0.05
N and foliar spray											
215 kg N (control)		1.74	1.79	2.09	2.16	2.05	2.08	9.22	9.26	9.95	9.98
145 kg N + Yeast ext.		1.69	1.74	2.03	2.10	1.99	2.03	9.16	9.19	9.90	9.93
145 kg N + 1 % K_2O		1.63	1.66	1.99	2.05	1.95	1.98	9.10	9.13	9.85	9.88
145 kg N + 300 ppm AA		1.57	1.62	1.94	1.99	1.90	1.93	9.06	9.10	9.82	9.85
LSD (0.05)		0.10	0.10	0.08	0.10	0.09	0.08	0.11	0.10	0.11	0.10
Interaction											
Masr 1	**215 kg N**	1.98	2.09	2.30	2.40	2.27	2.31	9.63	9.67	10.17	10.21
	145 kg N + YE	1.92	2.03	2.22	2.31	2.19	2.23	9.55	9.59	10.11	10.14
	145 kg N + K	1.84	1.92	2.20	2.29	2.15	2.19	9.47	9.5	10.06	10.09
	145 kg N + AA	1.78	1.89	2.12	2.20	2.09	2.13	9.45	9.49	10.05	10.08
Giza 171	**215 kg N**	1.78	1.83	2.13	2.22	2.10	2.14	9.23	9.28	9.99	10.03
	145 kg N + YE	1.73	1.78	2.04	2.13	2.01	2.05	9.19	9.23	9.94	9.98
	145 kg N + K	1.67	1.68	1.99	2.08	1.97	2.00	9.13	9.18	9.89	9.93
	145 kg N + AA	1.61	1.63	1.94	2.03	1.92	1.95	9.09	9.13	9.84	9.88
Gemmeiza 12	**215 kg N**	1.66	1.68	2.01	2.05	1.94	1.97	9.07	9.10	9.87	9.90
	145 kg N + YE	1.61	1.63	1.92	1.97	1.88	1.91	9.01	9.04	9.82	9.85
	145 kg N + K	1.56	1.58	1.89	1.93	1.85	1.88	8.95	8.98	9.75	9.78
	145 kg N + AA	1.51	1.53	1.86	1.88	1.80	1.83	8.91	8.94	9.73	9.76
Sids 13	**215 kg N**	1.56	1.58	1.94	1.99	1.90	1.93	8.96	9.00	9.77	9.80
	145 kg N + YE	1.50	1.52	1.93	1.98	1.89	1.93	8.90	8.93	9.74	9.77
	145 kg N + K	1.46	1.48	1.88	1.92	1.85	1.88	8.85	8.88	9.70	9.73
	145 kg N + AA	1.41	1.43	1.84	1.88	1.80	1.83	8.81	8.84	9.65	9.68
LSD (0.05)		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 6: Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) content of some wheat varieties as affected by nitrogen dose, yeast extract, potassium and ascorbic acid for two winter seasons of 2014/2015 and 2015/2016.

Treatments		Photosynthetic pigments (mg/g FW)					
		Chl a		Chl b		Carotenoids	
		14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars							
Masr 1		0.310	0.315	0.119	0.121	0.080	0.082
Giza 171		0.291	0.295	0.109	0.110	0.075	0.077
Gemmeiza 12		0.278	0.281	0.104	0.105	0.073	0.075
Sids 13		0.272	0.275	0.095	0.096	0.069	0.072
LSD (0.05)		0.003	0.003	0.004	0.004	0.004	0.004
N and foliar spray							
215 kg N (control)		0.295	0.299	0.113	0.115	0.077	0.079
145 kg N + Yeast ext.		0.290	0.293	0.108	0.110	0.075	0.077
145 kg N + 1 % K_2O		0.285	0.289	0.104	0.106	0.074	0.076
145 kg N + 300 ppm AA		0.280	0.284	0.101	0.102	0.073	0.075
LSD (0.05)		0.011	0.011	0.010	0.010	0.009	0.009
Interaction							
Masr 1	215 kg N	0.318	0.323	0.126	0.129	0.082	0.084
	145 kg N + YE	0.313	0.317	0.120	0.123	0.081	0.083
	145 kg N + K	0.308	0.313	0.117	0.120	0.080	0.082
	145 kg N + AA	0.303	0.307	0.112	0.115	0.078	0.080
Giza 171	215 kg N	0.298	0.302	0.115	0.117	0.078	0.080
	145 kg N + YE	0.293	0.297	0.111	0.113	0.076	0.078
	145 kg N + K	0.289	0.293	0.107	0.109	0.075	0.077
	145 kg N + AA	0.283	0.288	0.102	0.104	0.074	0.076
Gemmeiza 12	215 kg N	0.287	0.290	0.110	0.112	0.076	0.078
	145 kg N + YE	0.280	0.283	0.106	0.108	0.074	0.076
	145 kg N + K	0.275	0.278	0.101	0.103	0.073	0.075
	145 kg N + AA	0.270	0.273	0.098	0.100	0.072	0.074
Sids 13	215 kg N	0.278	0.281	0.101	0.103	0.072	0.075
	145 kg N + YE	0.274	0.277	0.096	0.098	0.070	0.073
	145 kg N + K	0.270	0.273	0.091	0.093	0.069	0.072
	145 kg N + AA	0.265	0.268	0.090	0.092	0.068	0.071
LSD (0.05)		ns	ns	ns	ns	ns	ns

Table 7: Soluble sugars content, catalase (CAT), polyphenol oxidase (PPO) and peroxidase (POD) activities of some wheat varieties as affected by nitrogen dose, yeast extract, potassium and ascorbic acid for two winter seasons of 2014/2015 and 2015/2016.

Treatments		Soluble sugars (mg glucose equivelant /g dry tissue)		Catalase activity (µmole H_2O_2 min^{-1})		Polyphenol oxidase activity (mg protein min^{-1})		Peroxidase activity (mg protein min^{-1})	
		14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars									
Masr 1		20.00	20.26	29.75	29.95	64.00	64.30	123.1	125.3
Giza 171		19.45	19.74	29.51	29.71	62.49	62.86	115.1	117.8
Gemmeiza 12		19.28	19.47	29.24	29.45	61.22	61.47	113.4	114.9
Sids 13		19.23	19.41	28.81	29.10	60.71	60.91	112.1	114.3
LSD (0.05)		0.02	0.04	0.05	0.06	0.01	0.02	0.34	0.14
N and foliar spray									
215 kg N (control)		19.61	19.86	29.40	29.63	62.69	62.97	117.4	120.0
145 kg N + Yeast ext.		19.53	19.75	29.35	29.57	62.25	62.54	116.3	118.8
145 kg N + 1 % K_2O		19.45	19.67	29.30	29.53	61.88	62.16	115.4	117.4
145 kg N + 300 ppm AA		19.38	19.60	29.25	29.48	61.60	61.86	114.6	116.1
LSD (0.05)		0.11	0.11	0.11	0.11	0.12	0.12	1.37	1.20
Interaction									
Masr 1	**215 kg N**	20.18	20.49	29.83	30.02	64.69	64.98	124.8	127.5
	145 kg N + YE	20.09	20.30	29.78	29.97	64.14	64.43	123.3	125.5
	145 kg N + K	19.93	20.17	29.72	29.93	63.64	63.95	122.8	124.5
	145 kg N + AA	19.82	20.09	29.68	29.88	63.55	63.84	121.5	123.5
Giza 171	**215 kg N**	19.59	19.88	29.59	29.80	63.03	63.42	117.3	120.5
	145 kg N + YE	19.50	19.79	29.54	29.73	62.63	63.02	115.8	118.5
	145 kg N + K	19.39	19.68	29.49	29.68	62.30	62.69	113.8	116.8
	145 kg N + AA	19.34	19.62	29.42	29.63	62.02	62.31	113.5	115.5
Gemmeiza 12	**215 kg N**	19.38	19.57	29.30	29.51	61.76	62.00	114.5	117.3
	145 kg N + YE	19.30	19.49	29.27	29.48	61.34	61.59	114.0	115.5
	145 kg N + K	19.28	19.47	29.22	29.43	61.03	61.29	113.0	114.5
	145 kg N + AA	19.19	19.38	29.17	29.38	60.75	60.99	112.3	112.5
Sids 13	**215 kg N**	19.31	19.50	28.89	29.18	61.29	61.50	113.0	114.8
	145 kg N + YE	19.24	19.43	28.84	29.13	60.91	61.12	112.3	114.5
	145 kg N + K	19.20	19.38	28.80	29.09	60.54	60.73	112.0	114.0
	145 kg N + AA	19.16	19.33	28.74	29.03	60.10	60.29	111.3	113.0
LSD (0.05)		ns	ns	ns	ns	ns	ns	ns	ns

Proline, sodium, potassium and Na^+/K^+ ratio

Data of Table (8) indicated that, the four tested wheat cultivars were significantly varied in their proline, K^+, Na^+ contents, as well as, Na^+/K^+ ratio during the two seasons. The maximum potassium content was obtained by Masr 1 wheat cultivar. The differences among wheat cultivars in their leaves potassium content were significant during two growing seasons were significant. Meanwhile, Sids 13 wheat cultivar revealed the highest significant values for proline and sodium content, opposite to K^+ contents as well as, those of Na^+/K^+ ratio during the studied growing seasons among the aforementioned varieties. These varietal variations among these tested wheat cultivars could mainly be due to their genetic background and their variation in their ion selectivity. Also, these differences could be due to the ability of cultivars to reduce NaCl accumulation in their cells that enables the cultivar to thrive well under salinity and drought conditions (El-Lethy et al., 2013).

The effects of nitrogen and stimulants on proline content, Na^+, K^+ and Na^+/K^+ ratio in leaves of wheat plants at 85 DAS were also presented in Table 8. Except for K foliar application treatment (1% K_2O+ 145 kg N/ha) which recorded the highest value of K+ content and the lowest values of sodium content and Na^+/K^+ ratio; reducing N level from 215 kg N/ha (control treatment) to145 kg N/ha lead to increase values of proline and sodium content as well as Na^+/K^+ ratio and decrease leaf K^+ content of plants received the foliar application of yeast extract or ascorbic acid during two studied seasons. This behavior may be due to the rapid effects of K^+ adsorption within the foliar treatment of 1% K_2O which seemed to compensate K^+ reduction uptake resulted from competition with Na^+ ions under experimental saline conditions (Carden et al., 2003).

The interaction between wheat cultivars and stimulants on Na^+/K^+ ratio in leaves at 85 DAS in the two seasons was shown in Table 8. Data revealed that except for values of Na+/K^+ ratio which were significantly affected by the interaction between wheat cultivars and stimulants; values of proline, Na^+ and K^+ contents were not significant, but Masr 1 cultivar shows the lowest value in Na^+/K^+ ratio as compared with other cultivars followed by Giza 171. While the highest value was achieved by Sids 13 cultivar which referring that cultivar is more suffering under the studied conditions. These findings agreed with those of Zayed et al. (2007) who reported that the ratio of Na^+/K^+ could be a good indicator of the rate of salt tolerance. It may worth to mention that, foliar application treatments of yeast extract or potassium or ascorbic acid to the concerned wheat varieties ameliorate their capability to overcome the adverse effects of stress conditions, soil and water salinity as well as reduction of nitrogen dose, during the two studied seasons. These results are in harmony with those obtained by El-Lethy et al. (2013); Hammad and Ali (2014); Desoky and Merwad (2015) and El-Hawary and El-Shafey (2016).

Yield and yield components

Data in Table (9) reveal that Masr 1 cultivar gave a significant increase in spike length, spike weight, 1000-grain weight, grain yield, straw yield and harvest index as compared with other wheat cultivars under stress conditions during the two seasons. These findings came in line with those of Atia and Ragab (2013) and Seleem and Abd El-Dayem (2013), who observed that wheat cultivars significantly differed in their straw and grain yield. Also, Mansour et al. (2017) reported that these variations are associated with cultivars genetic back-ground.

With respect to the effect of the addition of 145 kg N/ha coupled with the foliar application of yeast extract or potassium or ascorbic acid on spike length, spike weight, 1000-grain weight, grain yield, straw yield, and harvest index produced relatively comparable effects with insignificant differences, particularly, yeast, to those plants received 215 kg N/ha. Masr 1 variety shows the highest value of 1000-grain weight as compared with other wheat cultivars. However, decreasing the nitrogen dose decreased the 1000-grain weight. This behavior may be attributed to the promoting effects of the stimulators materials (Hammad and Ali, 2014; El-Hawary and El-Shafey, 2016 and Mohamed et al., 2018) on plants to overcome salt stress conditions and encouraged plants to utilize soil macro and micronutrients along with the considerable nitrogen content of continues irrigation with blended water (El-Sawy et al., 2015). Furthermore, 145 kg N/ha coupled with the K_2O-foliar application resulted in convenient results compared to those received full nitrogen dose or those received less nitrogen with yeast. These may be due to the essential role of K^+ in crop physiological and nutritional processes, beside its improvement role on plants osmotic adjustment to overcome abiotic stress (Aown et al., 2012 and Demidchik et al., 2014).

Table 8: Proline, sodium, potassium content and Na^+/K^+ ratio in leaves of some wheat varieties as affected by nitrogen dose, yeast extract, potassium and ascorbic acid for two winter seasons of 2014/2015 and 2015/2016.

Treatments		Proline (µg/g FW)		Na^+ Leaf content (mmole/kg)		K^+ Leaf content (mmole/kg)		Na^+ /K^+ ratio	
		14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars									
Masr 1		115.4	111.9	386.3	380.4	574.1	579.7	0.67	0.66
Giza 171		119.3	115.9	395.7	390.3	566.0	571.1	0.70	0.68
Gemmeiza 12		121.5	118.1	419.2	413.4	552.6	558.6	0.76	0.74
Sids 13		124.5	121.1	425.5	419.9	550.9	555.3	0.77	0.76
LSD (0.05)		0.3	0.27	0.99	1.27	1.07	1.22	0.003	0.002
N and foliar spray									
215 kg N (control)		118.9	115.4	402.4	396.6	536.8	542.6	0.75	0.73
145 kg N + Yeast ext.		119.9	116.5	407.8	401.8	533.4	539.4	0.77	0.74
145 kg N + 1 % K_2O		120.6	117.3	400.7	395.8	643.3	645.8	0.62	0.61
145 kg N + 300 ppm AA		121.3	117.8	415.8	410.0	530.3	536.8	0.78	0.76
LSD (0.05)		1.14	1.01	7.27	7.40	8.25	8.52	0.006	0.007
Interaction									
Masr 1	215 kg N	113.8	110.3	380.0	374.1	551.5	557.6	0.69	0.67
	145 kg N + YE	114.8	111.3	387.0	381.0	548.5	554.8	0.71	0.69
	145 kg N + K	116.0	112.5	383.0	377.5	652.0	655.0	0.59	0.58
	145 kg N + AA	117.0	113.5	395.0	388.9	544.8	551.3	0.73	0.71
Giza 171	215 kg N	118.0	114.5	391.5	385.8	542.5	548.3	0.72	0.70
	145 kg N + YE	119.3	115.8	396.5	390.5	539.5	545.3	0.73	0.72
	145 kg N + K	119.8	116.5	391.5	387.5	644.3	647.3	0.61	0.60
	145 kg N + AA	120.3	116.9	403.3	397.4	537.8	543.6	0.75	0.73
Gemmeiza 12	215 kg N	120.5	117.0	415.3	409.3	528.0	533.8	0.79	0.77
	145 kg N + YE	121.5	118.0	419.5	413.5	524.3	530.3	0.80	0.78
	145 kg N + K	121.8	118.5	413.5	408.5	638.5	642.1	0.65	0.64
	145 kg N + AA	122.3	119.0	428.5	422.4	519.8	528.1	0.82	0.80
Sids 13	215 kg N	123.5	120.0	423.0	417.3	525.0	530.1	0.81	0.79
	145 kg N + YE	124.3	121.0	428.0	422.0	521.5	526.3	0.82	0.80
	145 kg N + K	124.8	121.5	414.8	409.6	638.5	641.1	0.65	0.64
	145 kg N + AA	125.5	121.8	436.3	430.9	518.8	523.6	0.84	0.82
LSD (0.05)		ns	ns	ns	ns	ns	ns	0.013	0.01

Table 9: Yield and yield components of some wheat varieties as affected by nitrogen dose, yeast extract, potassium and ascorbic acid for two winter seasons of 2014/2015 and 2015/2016.

Treatments		Spike length (cm)		Spike weight (g)		1000-grain weight (g)		Grain yield (t/ha)		Straw yield (t/ha)		Harvest index	
		14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars													
Masr 1		12.2	12.3	4.27	4.30	50.4	50.7	5.40	5.62	7.67	7.88	41.3	41.6
Giza 171		11.7	11.8	4.15	4.18	48.6	48.9	4.98	5.24	7.69	7.81	39.3	40.2
Gemmeiza 12		11.6	11.7	4.06	4.09	47.2	47.5	4.67	4.90	7.36	7.60	38.7	39.3
Sids 13		10.7	11.0	3.91	3.94	45.6	45.9	4.43	4.64	7.00	7.19	38.7	39.2
LSD (0.05)		0.30	0.50	0.02	0.02	0.03	0.01	0.19	0.17	0.12	0.05	0.76	0.61
N and foliar spray													
215 kg N (control)		11.8	12.1	4.16	4.19	48.5	48.8	4.98	5.21	7.52	7.69	37.9	40.4
145 kg N + Yeast ext.		11.6	11.8	4.11	4.14	47.8	48.1	4.90	5.14	7.43	7.64	37.6	40.2
145 kg N + 1 % K_2O		11.5	11.6	4.10	4.13	48.2	48.5	4.81	5.05	7.40	7.60	37.6	40.1
145 kg N + 300 ppm AA		11.3	11.4	4.03	4.06	47.5	47.7	4.76	5.00	7.38	7.55	36.9	39.7
LSD (0.05)		0.26	0.25	0.11	0.11	0.10	0.11	0.14	0.19	0.26	0.13	0.51	0.98
Interaction													
Masr 1	215 kg N	12.5	12.8	4.34	4.37	51.2	51.5	5.52	5.73	7.71	7.96	41.7	41.8
	145 kg N + YE	12.1	12.4	4.30	4.33	50.3	50.6	5.45	5.64	7.68	7.88	41.5	41.7
	145 kg N + K	12.1	12.3	4.27	4.30	50.5	50.7	5.35	5.56	7.67	7.78	41.1	41.7
	145 kg N + AA	11.9	12.0	4.20	4.23	49.7	50.0	5.26	5.52	7.63	7.89	40.8	41.2
Giza 171	215 Kg N	12.0	12.3	4.22	4.25	49.2	49.5	5.11	5.39	7.78	7.86	39.6	40.7
	145 kg N + YE	11.8	11.9	4.15	4.18	48.5	48.8	5.01	5.25	7.67	7.80	39.5	40.2
	145 kg N + K	11.6	11.8	4.16	4.19	48.7	48.9	4.95	5.21	7.68	7.77	39.2	40.1
	145 kg N + AA	11.4	11.5	4.10	4.13	48.2	48.4	4.86	5.13	7.66	7.76	38.8	39.8
Gemmeiza 12	215 Kg N	11.8	12.0	4.12	4.15	47.7	48.0	4.76	5.00	7.48	7.65	38.9	39.5
	145 kg N + YE	11.6	11.8	4.07	4.10	47.1	47.4	4.68	4.95	7.36	7.61	38.9	39.4
	145 kg N + K	11.5	11.6	4.06	4.09	47.3	47.5	4.61	4.85	7.32	7.51	38.6	39.2
	145 kg N + AA	11.4	11.5	4.00	4.03	46.9	47.1	4.57	4.82	7.28	7.56	38.6	38.9
Sids 13	215 Kg N	11.0	11.3	3.97	4.00	46.2	46.5	4.52	4.75	7.08	7.28	39.0	39.5
	145 kg N + YE	10.8	11.1	3.92	3.95	45.6	45.9	4.48	4.70	7.04	7.26	38.8	39.3
	145 kg N + K	10.6	10.9	3.92	3.95	45.8	46.0	4.35	4.60	6.94	7.14	38.5	39.2
	145 kg N + AA	10.5	10.8	3.85	3.88	45.2	45.4	4.32	4.56	6.92	7.13	38.4	39.0
LSD (0.05)		ns	ns	ns	ns	0.21	ns	ns	ns	ns	ns	ns	ns

Some soil chemical analysis indicators

Soil electrical conductivity of saturation soil past (EC_e, in units of dSm^{-1}) and sodium adsorption ratio (SAR) are considered the best and fast indicators that express the soil chemical behavior and are used to identify the soil salinity and sodicity status. Data in Table 10 represents EC_e and soluble Ca^{2+} as well as SAR values of the experimental soil of different treatments and their interactions after wheat harvest of the two studied winter seasons. Obtained data obviously revealed that soil EC_e and SAR values were gradually decreased, opposite to soluble Ca^{2+} values which increased with the progress of the experiment period as compared to the initial soil values (Table 1). The average values of soil EC_e, SAR and soluble Ca^{2+} were 7.99 (dSm^{-1}), 14.77 and 14.42 ($mmol_c\ L^{-1}$), respectively, for the first season. While those values obtained for the second season were 7.42 (dSm^{-1}), 12.83 and 16.08 ($mmol_c\ L^{-1}$) that reflected a relative decrease of 15.4% for soil salinity and 22.5% for SAR values when compared to the initial soil analysis values. While soluble Ca^{2+} values reflected a relative increase of 39.2 %. These results indicated the progress in improving soil chemical properties which could be attributed to the management practices followed before experiment setup, particularly, gypsum addition along with considerable rainfall amount.

Table 10: Some soil parameters after wheat yield harvesting of the studied tow winter seasons of 2014/2015 and 2015/2016.

Treatments		EC_e dSm^{-1}		Soluble Ca^{2+} ($mmol_c\ L^{-1}$)		SAR	
		14/15	15/16	14/15	15/16	14/15	15/16
Wheat cultivars							
Masr 1		7.86	7.23	14.56	16.34	15.04	13.08
Giza 171		8.05	7.49	14.46	16.20	14.86	12.86
Gemmeiza 12		8.09	7.49	14.44	15.94	14.80	12.80
Sids 13		7.97	7.48	14.23	15.86	14.37	12.58
LSD (0.05)		0.24	0.32	1.43	1.55	0.44	058
N and foliar spray							
215 kg N (control)		8.11	7.45	15.21	16.90	14.99	13.09
145 kg N + Yeast ext.		7.95	7.42	14.36	16.06	14.71	12.80
145 kg N + 1 % K_2O		7.95	7.44	14.23	15.92	14.70	12.75
145 kg N + 300 ppm AA		7.96	7.39	13.89	15.46	14.69	12.68
LSD (0.05)		0.33	0.22	0.91	0.99	0.40	0.43
Interaction							
Masr 1	215 kg N	8.08	7.27	15.33	17.16	13.95	12.23
	145 kg N + YE	7.86	7.15	13.96	15.63	14.66	12.85
	145 kg N + K	7.74	7.28	13.62	15.26	14.91	13.03
	145 kg N + AA	7.75	7.21	14.04	15.72	13.98	12.20
Giza 171	215 kg N	8.24	7.56	15.86	17.65	14.66	12.83
	145 kg N + YE	8.06	7.58	15.07	16.88	14.71	12.74
	145 kg N + K	8.06	7.52	13.43	15.04	15.35	13.23
	145 kg N + AA	7.84	7.29	13.89	15.79	14.72	12.65
Gemmeiza 12	215 kg N	8.21	7.72	14.07	15.75	14.96	13.02
	145 kg N + YE	7.90	7.35	14.21	16.00	14.52	12.55
	145 kg N + K	8.13	7.49	14.97	16.80	14.57	12.76
	145 kg N + AA	8.14	7.40	14.49	16.25	15.15	12.90
Sids 13	215 kg N	7.90	7.23	15.58	17.05	15.24	12.65
	145 kg N + YE	7.98	7.58	14.23	15.74	14.95	13.07
	145 kg N + K	7.90	7.48	13.55	14.75	15.12	13.35
	145 kg N + AA	8.09	7.65	14.50	15.91	14.89	13.27
LSD (0.05)		0.47	0.44	1.82	2.00	0.80	0.85

On the other hand, the slow rate of improving soil salinity as well as SAR may be related to the continued irrigation with brackish-water and water seepage from Suez Canal (Mohamed, 2013) besides, the slow rate of gypsum dissolution (Richards, 1954). However, the reduction of EC_e and SAR values along with increasing soluble Ca^{2+} during the experimental period were corresponding to the reduction of proline concentration and Na^+ leaf content along with increasing K^+ leaf content that modified Na^+/K^+ ratio (Table 8) which resulted in enhancement effects on wheat cultivars yield and its associated parameters (Table 9). These results are in agreement with the findings of Sima et al. (2009), who found that salt toxicity severely affected root and shoot growth which resulted in drastic reduction in dry matter and supplement of Ca^{2+} sources reduce such impact by reducing Na^+ transport from root to shoot and elevating Ca^{2+} and K^+ concentration in both organs. They also, added that Ca^{2+} play a vital role in the production of proline and glycinebetain beside its role in osmatic adjustment. Saeed et al. (2014) also, found that gypsum application greatly improved relative water content and decreased electrolyte leakage in leaves of okra plant grown under salinity. Recently, Kölling et al. (2019) added that calcium ions played an essential role in cellular signaling which acts as second messengers that transduce, integrate, and multiply incoming signals during numerous of plant growth processes. These finding indicated that crop productivity is governed by soil and water characteristics (Dinar et al., 1991).

Figure 1 illustrates reduction of soil salinity during the studied two seasons under wheat cultivars. No significant differences were observed on soil EC_e mean values among wheat cultivars. These findings may be as resultant of salt fluctuation, particularly, at the end of growing season. In spite of decreasing EC_e values of the second season, data also revealed that soil EC_e mean values of Masr1 cultivar plots reduced much more than other cultivars which indicated that cultivars affected to some extent on soil properties. These finding came in line with those of Czarnes et al. (2000), who reported that the production or plant root exudates and microbes in rhizosphere may enhanced strength between soil particles that led to stimulate changes in soil structure. Moreover, Haclmuftuoglu and Oztas (2017) found that changing in soil structure is significantly affected by plant patterns and root system.

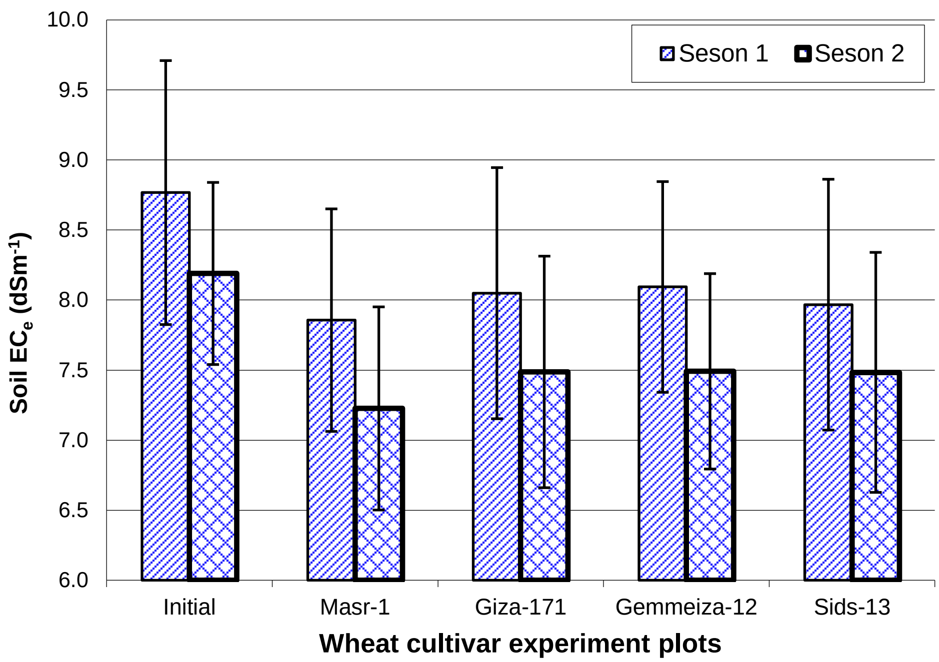

Figure. 1. Effect of continues wheat cropping seasons on soil EC_e (dSm^{-1}) of wheat cultivars

CONCLUSION

It could be concluded that wheat cultivar Masr 1 proved the most salt-tolerant variety among the other cultivars under the experimental conditions followed by Giza 171, while Sids 13 cultivar was less tolerant. Nitrogen fertilization of 145 kg N/ha coupled with the foliar application of 10g L^{-1} yeast extract or 10g L^{-1} K_2O or 0.3g L^{-1} ascorbic acid (AA) could be satisfactory for wheat productivity under using brackish water containing considerable amount of nitrogen. Also, these stimulators have preferential effect on wheat cultivars to overcome salt stress. Moreover, soil and water characteristics proved to be the most factors govern crop productivity.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

M.M. El-Hawary; K.I Gad and A.O.A. Ismail designed this work and conducted this experiment with all its analysis. They revised this work and wrote this manuscript, also they reviewed and approved the final version.

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