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RESPONSE OF SOME BREAD WHEAT CULTIVARS TO SALINITY STRESS BY RE-USE OF SEA WATER UNDER NORTH SINAI CONDITIONS

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ABSTRACT

Water salinity is a limiting factor stressed plants and associated with low wheat productivity in new reclaimed areas in Egypt such as North Sinai. Sea water is available water resources and renewable and non-exploited, it is necessary to maximize use of this water through scientific research for use in irrigation of wheat, to increase the cultivated area and thus, increase production towards self-sufficiency. So, two field experiments were carried out at Faculty of Environmental Agricultural Sciences, EI- Arish, Suez Canal University, during 2012/2013 and 2013/2014 seasons aiming to investigate the response of three wheat cultivar (*Triticum aestivum.* L.; $Masr_1$, $Masr_2$, $Sakha_{93}$) to four mixing ratios between well-water and sea water (control, 3:1, 2:1 and 1:1). Plants were subjected to salinity treatments at 60 days after sowing (DAS). Results showed that $Masr_2$ and $Masr_1$cvs were superior for yield and its attributes, the superiority was obtained from $Masr_2$ cv as well as seed content of proline and protein. Also, dry leaf content of Na^+ and Cl^{-2} were higher for $Masr_2$ as compared to the other studied cultivars under low mixing ratio (3:1 Well water: Sea water), while, the K^+ concentration was decreased with the same treatment of $Masr_2$. For soil analysis, EC, Na^+, Mg^{+2}, K^+, HCO_3^{-2} and Cl^- increased but Ca^{-2} decreased under the highest mixing ratio (1 Well water: 1 Sea water). So, it could be recommended to cultivate $Masr_2$ wheat cultivar under North Sinai conditions, using mixing ratio 3 Well water : 1 Sea water to maximize the benefit of sea water and gain economic productivity of bread wheat in this area and similar regions.

Key words: Wheat cultivars, Salinity stress, Re - Use of sea water, North Sinai conditions.

INTRODUCTION

Wheat is the most important cereal crop in the world both in terms of cultivated area or the amount of crop output, which depends upon most of the world's population as the main staple for them. In Egypt, it has a strategic important crop, where, the cultivated wheat area was about 3.1 million feddans in the 2014/2015 season, and produce 8.5 million tons, with high average per capita consumption valued 200 kg/year, as compared to the international rate which is by 100 kg/capita/year. It became self-sufficiency of the wheat, a vital requirement in light of the challenges and the lack of available water resources, so must the trend to modern agricultural technology and the development of new types bear the non-favorable environmental conditions and in new reclaimed lands.

In North Sinai, water is the most important determinants of agricultural development in general and wheat in particular, both in terms of the limited water resources quality and irrigation water quality. Wheat is moderately tolerant to salt with threshold without yield loss at 6 dS m^{-1} and with yield 50% loss at 13 dS m^{-1} **(Mass**

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and Hoffiman, 1977). On the other hand, **(Francois *et al.,* 1986**) found that wheat vegetative growth was decreased by soil salinity with a threshold of 4.5 dSm^{-1}.

The effect of salinity on tiller and spikelet number established had a greater influence on final seed yield than the effects exerted on yield components **(Kirby, 1988),** indicating the probability of improving salt tolerance of wheat genotypes during early growth stages. **(Zhang *et al.*, 2000; Sairam *et al.*, 2001)** reported that water stress increased catalase and peroxidase activities in wheat. Salinity can significantly affect yield, evapotranspiration, pre-dawn leaf water potential and stomatal conductance with higher concentrations lowering them **(Flowers, 2004 ; Katerji *et al.*, 2005)**.

Also, **Azizpour *et al.* (2010)** investigated the response of two durum wheat genotypes (Turkey 506, salt tolerant & Egypt 557, salt sensitive) to salinity using hydroponic conditions and exposing to different salt levels (0, 50, 100, 150 and 200 mmol NaCl). They found that salinity stress decreased relative water content (RWC), potassium content, potassium/sodium ratio, chlorophyll a (chla), chlorophyll b (chlb), and total chlorophyll contents, efficiency of photosystem but increased sodium, proline and soluble sugars concentrations in both genotypes. Increasing salinity levels in irrigation water of wheat plants exerted significant reduction in both yield and its components (number of grains/spike; weight of 1000 grains, straw, and grain yields g/pot and the biological yield g/pot) as compared with control treatment (**Eleiwa *et al.*, 2011)**. Therefore, this investigation aimed to study the response of some wheat cultivars to salinity stress by using sea water-mixing ratios with well-water.

MATERIALS AND METHODS

Experimental Site and Conditions

This study was carried out at the Experimental Farm, Faculty of Environmental Agricultural Sciences, EI-Arish, Suez Canal University Egypt, during two winter seasons (2012/2013 and 2013/2014). Mechanical and chemical analyses of the experimental soil during 2012/ 2013 and 2013/ 2014 seasons at El-Arish district is showing in Table 1.

Plant Material

Grains of bread wheat cultivars *(Triticum aestivum* L.) were acquired from Field Crops Research Institute, Agricultural Research Center, Egypt, based on the most salt-tolerant with high productive under environmental conditions of North Sinai.

Agricultural Practices

Sowing dates were on 10th December and 29th November in the 1st and 2nd seasons, respectively. Seeding rate was 75 Kg fed^{-1}. The plot area was 15 m² (12 rows with 5m long and 0.25 m width. the normal cultural practices for growing wheat in sandy soil were done as recommended. Surface irrigation system was used with well- water salinity of 2515 ppm. The average temperature was 18.90^{o}C and 15.30^{o}C and precipitation rate was 3.2 and 1.1 mm./ month in both respective seasons.

Treatments

Three wheat cultivars ($Masr_1$, $Masr_2$, $Sakha_{93}$) were irrigated by well-water till 60 DAS, then plants were subjected to salinity stress using sea- water mixing ratios of: well- water (Ww): sea water (Sw) 3:1, 2:1 and 1:1, where irrigated plants 1, 2, 3 and 4 irrigations through the growing period (Table 2).

Studied Criteria

At maturity stage (120 DAS) the following traits were determined: number of spikelets/ spike, number of grains per plant, 1000-grain weight (g), biological yield (ton /ha), grain Yield (ton /ha) and harvest index (%). Grain protein and proline percentages were determined according to **(Egan *et al.*, 1987**) and (**Bates *et al.*, 1973).** Then, 300 mg of ground dry leaves was taken to determine leaves Na^+, K^+, $Ca2^+$ and Cl^- ions contents. Soil ions content of the experimental site was measured according to **(Wright, 1939; Richards, 1954)**.

Table (1): Soil mechanical and chemical analyses of the experimental sites at 2012/2013 and 2013/2014 seasons.

Items	Seasons					
	2012/2013			2013/2014		
	Depth (cm.)			Depth (cm.)		
	0-15	15-30	30-45	0-15	15-30	30-45
Mechanical Analysis						
Coarse sand(%)	68.90	67.65	64.63	68.27	67.33	64.80
Fine sand(%)	20.13	20.99	24.91	20.75	21.39	24.80
Silt (%)	4.22	4.68	4.13	4.17	4.63	4.10
Clay (%)	6.75	6.68	6.33	6.81	6.65	6.30
Soil texture	Sandy loamy					
Bulk density(g.cm^{-3})	1.46	1.45	1.48	1.46	1.45	1.48
Particle density(g.cm^{-3})	2.43	2.42	2.45	2.43	2.42	2.45
Chemical Analysis (in 1:5 soil extract)						
Ca^{++} (meq./l.)	3.85	4.08	4.00	3.23	3.20	3.20
Mg^{++} (meq./l.)	0.80	1.25	1.00	0.85	1.55	1.10
Na^{+}(meq./L.)	4.60	3.52	3.28	4.35	3.20	3.15
K^{+}(meq./L.)	0.30	0.25	0.30	0.43	0.39	0.32
Co_3^{-}(meq./L.)	---	---	---	---	---	---
Hco_3^{-}(meq./L.)	1.00	1.35	1.75	1.10	1.40	1.65
Cl^{-} (meq./L.)	2.28	2.40	2.25	2.42	2.65	2.32
So_4^{-}(meq./L.)	4.39	4.45	4.48	4.75	4.50	4.02
$Caco_3$(%)	4.38	4.15	4.45	4.35	4.16	4.37
E.C (d.sm^{-1})	0.85	0.73	0.60	0.92	0.85	0.74
P_H in (1-2.5) soil extract	8.50	8.58	8.60	8.80	8.90	9.05
Organic matter (%)	0.25	0.20	0.15	0.22	0.20	0.12

Table (2): Salinity levels at the studied treatments.

Treatments	g L^{-1}	%	dsm^{-1}	ppm
Well water (Ww)	1.96	0.252	3.93	2515
Sea water (Sw)	24.1	3.091	48.30	30912
T_1 (3:1 Ww:Sw)	9.39	1.200	13.05	8350
T_2 (2:1 Ww:Sw)	11.24	1.438	17.50	11142
T_3 (1:1 Ww:Sw)	16.39	2.086	20.11	16713

Statistical Analysis

A factorial experimental design with three cultivars and four salinity levels was arranged in randomized complete block design (RCBD) in four replications and analysis of variance was done using GLM procedure **(SAS Institute, 2000).** Means separation was statistically analyzed by Duncan's multiple rang test **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Yield and its Components

Number of Spikelets per Spike

Number of spikelets per spike is considered one of the most important spike characters in order to estimate approximately number of the fertilized grains per spike, principally under stressed conditions conformably with favorable conditions. Results presented in (Table 3) indicated evidently that the inheritance of number of spikelets per spike, already was affected by both of genotypic and environmental components altogether.

Marked variation in number of spikelets per spike trait could be observed among the used genotypes that showed some differences in their number of spikelets per spike performance under the same condition during the two successful planting seasons. Under wele water (Ww), the maximum values (15.00, 15.27 and 15.13) were obtained from $Masr_2$ cultivar, while the minimum ones (9.00, 10.60, 9.80) were recorded by Masr1in T_3 during two seasons and their combined analysis, respectively.

These results revealed that $Masr_2$ cultivar scored the highest value in number of spikelets per spike in all treatments compared to the other cultivars and it is important to note that increasing concentration of salinity stress led to a shortage in number of spikelets per spike in all cultivars in both seasons and their combined. These results are in accordance with those obtained by **Kirby (1988), Grieve *et al.* (1993), Mans and Rawson (2004), El-Hendawy *et al.* (2009), Amin *et al.* (2010) and Eleiwa *et al.* (2011).**

Number of Grains per Plant

Data in Table 3 show that the highest values (138.33, 133.50 and 135.92 grains/ plant) were significantly obtained by $Masr_2$ in control (Ww), during two seasons and their combined analysis, respectively. Meanwhile, Masr1 in T3 gave the lowest values (26.33, 25.33 and 25.93 grains/plant) in the 1^{st}, 2^{nd} seasons and their combined analysis, respectively.

From previous results, it is clear that $Masr_2$ cultivar was scored the highest value in number of grains per plant in the control treatment as Well as in the other treatments compared to other cultivars. These results are supported by the findings of; **Francois *et al.* (1986), Mass and Poss (1989), Mass and Grieve (1994) and El-Hendawy *et al.* (2007) and (2009).**

1000-Grain Weight (g)

Data in Table (3) cleared that 1000-grain weight was maximized by $Masr_2$ in T_3 and weighted 39.86, 40.67 and 40.17g.in the first, second seasons and their combined analysis. Compared to T_3 with the two other cultivars, respectively.

On the other hand, $Masr_1$ in control had the lowest 1000-grain weight (24.00, 24.50 and 24.25g.) during two seasons and their combined analysis. In compotation with the other cultivars under the same conditions, respectively. These results are supported by the findings of **Cramer *et al.* (1994), Mresheh *et al.* (2009)** but opposite trend was found by **Asana and Kale (1965) and Torres-Bernal and Bingham (1973)**.

Biological Yield (ton/ha)

Biological yield is a function of grain and straw yields **(El-Sisy, 2000).** Data in Table 3 demonstrated that the highest values were obtained by $Masr_2$ in control treatment which recorded values of 13.19, 14.08 and 13.63 ton/ha. during two seasons as well as their combined analysis, respectively.

Table (3): Number of spikelets/spike, number of grains per plant, 1000-grain weight (g) and biological yield (ton /ha) as influenced by cultivars and salinity treatments during two growing seasons (2012/2013&2013/2014) and their combined analysis.

Cultivar	Tr.	No. spikelets/spike			No. grains/plant			1000-grain weight (g.)			Biological yield (ton /ha)		
		1st	2nd	comb	1st	2nd	comb	1st	2nd	comb	1st	2nd	comb
Masr$_1$	**Con**	11.00^{c}	13.13^{b}	12.07^{bc}	51.77^{e}	55.73^{f}	53.75^{f}	24.00^{de}	24.50^{f}	24.25^{fg}	11.74^{c}	10.80^{c}	11.27^{c}
	T$_1$	11.00^{c}	11.53^{c}	11.27^{c}	45.00^{f}	47.36^{g}	46.17^{g}	26.00^{d}	26.50^{e}	26.25^{f}	9.75^{d}	9.18^{cd}	9.47^{d}
	T$_2$	10.87^{c}	11.27^{c}	11.07^{cd}	30.00^{g}	29.33^{hi}	29.67^{hi}	31.00^{bc}	31.83^{cd}	31.42^{d}	4.17^{ef}	5.16^{d}	4.67^{e}
	T$_3$	9.00d^{e}	10.60^{cd}	9.80^{d}	26.33^{h}	25.33^{i}	25.83^{j}	37.00^{ab}	38.50^{b}	37.75^{b}	2.35^{gh}	3.54^{f}	2.97^{f}
Masr$_2$	**Con**	15.00^{a}	15.27^{a}	15.13^{a}	138.33^{a}	133.50^{a}	135.92^{a}	30.33^{bc}	32.00^{cd}	31.17^{d}	13.19^{a}	14.08^{a}	13.63^{a}
	T$_1$	14.73^{ab}	15.27^{a}	15.00^{a}	115.33^{b}	119.67^{b}	117.50^{b}	30.50^{bc}	31.50^{cd}	31.00^{d}	11.47^{c}	12.54^{b}	12.00^{b}
	T$_2$	14.33^{ab}	15.00^{ab}	14.67^{ab}	86.00^{cd}	93.00^{c}	89.50^{cd}	37.00^{ab}	38.50^{b}	37.75^{b}	5.32^{e}	5.52^{d}	5.42^{e}
	T$_3$	12.47^{bc}	14.47^{ab}	13.47^{b}	58.67^{de}	64.67^{e}	61.67^{e}	39.67^{a}	40.67^{a}	40.17^{a}	2.46^{g}	3.38^{f}	2.92^{f}
Sakha$_{93}$	**Con**	13.67^{b}	15.27^{a}	14.47^{ab}	91.87^{c}	92.40^{c}	92.14^{c}	27.33^{c}	28.33^{b}	27.83^{e}	10.51^{b}	12.02^{bc}	11.27^{c}
	T$_1$	12.87^{bc}	15.00^{ab}	13.93^{b}	71.03^{d}	79.03^{d}	75.03^{d}	28.00^{c}	29.00^{b}	28.50^{e}	8.00^{de}	9.63^{cd}	8.81^{d}
	T$_2$	10.60^{cd}	13.13^{b}	11.87^{c}	51.77^{e}	55.73^{f}	53.75^{f}	33.00^{b}	33.17^{cd}	33.09^{cd}	3.59^{f}	4.24^{e}	3.91^{ef}
	T$_3$	9.67^{d}	9.80^{d}	9.73^{d}	31.57^{g}	33.67^{h}	32.62^{h}	34.50^{b}	35.00^{c}	34.75^{c}	2.63^{g}	3.16^{g}	2.90^{fg}

T_1= mixing ratio 3 Well water: 1 Sea water, T_2= mixing ratio 2 Well water: 1 Sea water and T_3= mixing ratio 1 Well water: 1sea water**.**

Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test.

During the two seasons as well as their combined analysis, $Masr_1$ in T_3 and $Sakha_{93}$ in T_3 classified into the low values cultivars. From previous results it is clear that $Masr_2$ cultivar scored the highest value in biological yield character under control treatment as well as in the other treatments compared to other cultivars.

These results are supported by the findings of **Afiah *et al.* (2002), Abou-Deif *et al.* (2005) and Eleiwa *et al.* (2011).**

Straw Yield (ton/ha)

Data noticed in Table 4 demonstrate that the highest values were significantly obtained by $Masr_2$ in control which recorded 9.40, 9.63 and 9.51 ton /ha during the two seasons as well as their combined analysis, respectively. On the other hand, $Sakha_{93}$ in T_3 classified into the low values cultivars, which recorded 2.05, 2.65 and 2.35 ton/ ha .during two successive seasons and combined analysis, respectively. From previous results, it is clear that $Masr_2$ cultivar scored the highest value in straw yield under control treatment as well as in the other treatments compared to other cultivars. It is necessary to note that increasing concentrations of salinity stress led to a decreasing in straw yield in all cultivars unevenly. These results are supported by the findings of **Afiah *et al.* (2002), Abou-Deif *et al.* (2005) and Eleiwa *et al.* (2011)**.

Grain Yield (ton/ha)

Data in Table 4 pointed out that grain yield of $Masr_2$ in control gave the highest values which recorded 3.796, 4.452 and 4.123 ton/ha., during the two seasons as well as their combined analysis, respectively. On the other hand, $Masr_1$ in T3 had the lowest values concerning to grain yield recording 0.268, 0.483 and 0.375 ton/ha during two seasons as well as their combined analysis, respectively. From previous results, it is clear that Masr2 cultivar scored the highest values in grain yield character under control treatment as well as in the other treatments compared to other cultivars. It is important to note that increasing concentrations of salinity stress led to decreasing in grain yield in all cultivars unevenly. These results are supported by the findings of **Afiah *et al.* (2002), Abou-Deif *et al.* (2005) and Eleiwa *et al.* (2011).**

Harvest Index (%)

Data in Table 4 showed that during the first season and the combined analysis, the highest values obtained by Masr2 in control recorded values of 28.77 and 30.24%, respectively. In the second season, $Sakha_{93}$ in control gave the highest values of harvest index which recorded 36.81%. On the other hand, $Sakha_{93}$ in T3 had the lowest values recorded 13.28, 16.33 and 14.95% during the two seasons and their combined analysis, respectively. According to the previous results it is clear that $Masr_2$ cultivar scored the highest value in harvest index in the control as well as in most treatments compared to other cultivars and it is important to note that increasing concentrations of salinity stress led to decreasing in harvest index in all cultivars unevenly. These results are supported by the findings of; **Afiah *et al.* (2002); Abou-Deif *et al.* (2005) and Eleiwa *et al.* (2011).**

Grain and Leaves Chemical Contents

Grain Protein and Proline Contents

For protein contents (%), during the two seasons as well as their combined analysis, $Masr_1$ under control treatment scored the highest value which recorded 13.60, 12.89 and 13.25%, respectively. On the other hand, the lowest values were estimated in $Sakha_{93}$ under T_3 which recorded values of 7.23, 7.15 and 7.19% compared to other cultivars during the two seasons and their combined analysis, respectively. For proline contents (mg g^{-1} dw), during the two seasons and their combined analysis, Masr2 in T_3 scored the highest value which recorded 0.537, 0.552 and 0.545 mg g^{-1} dw, respectively. The lowest values were estimated in $Sakha_{93}$ under the control

Table (4): Straw yield, grain yield and harvest index as influenced by cultivars and salinity treatments during two growing seasons (2012/2013 & 2013/2014) and their combined analysis.

Cultivar	Trt.	Straw yield (ton/ ha)			Grain yield (ton/ ha)			Harvest index (%)		
		1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
$Masr_1$	Con	8.56^{b}	7.49^{b}	8.03^{b}	3.180^{ab}	3.312^{b}	3.246^{bc}	27.08^{ab}	30.64^{bc}	28.86^{ab}
	T_1	6.24^{cd}	6.38^{c}	6.31^{d}	2.408^{bc}	2.806^{c}	2.607^{c}	26.89^{b}	30.55^{bc}	28.74^{ab}
	T_2	3.45^{d}	4.17^{d}	3.82^{e}	0.729^{e}	1.003^{de}	0.866^{e}	17.46^{c}	19.41^{cd}	18.44^{d}
	T_3	2.08^{ef}	3.12^{e}	2.60^{f}	0.268^{h}	0.483^{h}	0.375^{h}	11.38^{f}	13.41^{g}	12.40^{g}
$Masr_2$	Con	9.40^{a}	9.63^{a}	9.51^{a}	3.796^{a}	4.452^{a}	4.123^{a}	28.77^{a}	31.61^{ab}	30.19^{a}
	T_1	8.33^{b}	8.59^{ab}	8.46^{b}	3.128^{ab}	3.946^{bc}	3.538^{b}	27.30^{ab}	31.46^{b}	29.38^{c}
	T_2	3.97^{d}	4.02^{d}	3.98^{e}	1.359^{d}	1.514^{d}	1.444^{d}	25.52^{bc}	27.38^{c}	26.45^{bc}
	T_3	2.13^{e}	2.83^{f}	2.48^{f}	0.327^{g}	0.553^{f}	0.440^{f}	13.28^{e}	16.33^{ef}	14.80^{fe}
$Sakha_{93}$	Con	7.03^{c}	7.60^{b}	7.32^{c}	2.861^{b}	4.426^{a}	3.644^{bc}	27.23^{ab}	36.81^{a}	32.02^{ab}
	T_1	5.95^{cd}	6.91^{c}	6.43^{d}	2.037^{c}	2.721^{c}	2.379^{c}	25.52^{bc}	28.24^{c}	26.88^{b}
	T_2	3.02^{de}	3.47^{e}	3.23^{ef}	0.570^{f}	0.774^{e}	0.672^{fe}	15.89^{cd}	18.25^{d}	17.07^{e}
	T_3	2.05^{f}	2.65^{f}	2.35^{fg}	0.312^{g}	0.514^{fg}	0.413^{fg}	13.28^{e}	16.33^{ef}	14.81^{f}

T_1= mixing ratio 3 Well water: 1 Sea water, T_2= mixing ratio 2 Well water:1 Sea water and T_3= mixing ratio 1 Well water: 1 Sea water.

Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test.

which recorded values of 0.027, 0.048 and 0.038 mg g^{-1}dw during the two seasons and their combined analysis, respectively. These results are supported by the findings of **Greenway and Munns (1980), Handa *et al.* (1985), Singh *et al.* (1985), Hasewaga *et al.* (2000), Vendruscolo *et al.* (2007), Tatar and Gevrek (2008) and Johari *et al.* (2010).**

Leaves Ion Contents

Data in Table 6 show the effect of salinity treatments on dry leaves elements content; Na^+ , K^+ , Cl^- and K^+/Na^+ ratio in leaves of three bread wheat cultivars. ($Masr_1$, $Masr_2$ and $Sakha_{93}$). For Na^+ concentration, $Sakha_{93}$ in T3 scored the highest value which recorded 0.064 mg $g.^{-1}$. On the other hand, the lowest value was estimated in $Masr_2$ and Masr1 in control which recorded values of 0.032 and 0.034 mg $g.^{-1}$, respectively. This result means that the increase of salinity treatments concentration led to the increased of Na^+ concentration. It is clear also that $Masr_2$ cultivar scored lower concentration of Na^+ in control and also in all treatments when compared to other cultivars. It means that $Masr_2$ was more salt-tolerant cultivar compared to other cultivars ($Masr_1$ and $Sakha_{93}$). All cultivars in control treatment scored the highest value of K^+ concentration which recorded 0.086, 0.069 and 0.070 mg $g.^{-1}$, dw. without significant among them. On the other hand, the lowest value was estimated in $Masr_2$ in T_3 which recorded value of 0.032 mg $g.^{-1}$, dw, These results means that the increase of salinity concentration led to the decrease of K^+ concentration .Compared to other cultivars, the highest value of Cl^- concentration (0.358 mg $g.^{-1}$, dw). And was significantly obtained by $Sakha_{93}$ in T_3, while, the lowest value was significantly estimated by $Masr_2$ in control treatment which recorded values of 0.168 mg $g.^{-1}$ dw.

Table (5): protein and proline contents as influenced by cultivars and salinity treatments during two growing seasons (2012/2013 & 2013/2014) and their combined analysis.

Cultivars	Trt.	Protein contents (%)			Proline contents (mg g^{-1} dw.)		
		1st	2nd	comb	1st	2nd	comb
Masr1	Con	12.53b	12.18ab	12.36b	0.030f	0.082f	0.056e
	T1	10.93d	11.00bc	10.97cd	0.192d	0.198e	0.195d
	T2	9.66e	9.98d	9.82d	0.218c	0.210cd	0.214c
	T3	7.64g	7.99e	7.82f	0.326b	0.289c	0.308b
Masr2	Con	13.60a	12.89a	13.25a	0.122e	0.192e	0.157de
	T1	11.90c	11.52b	11.71c	0.218c	0.224c	0.221c
	T2	10.50d	10.85c	10.67cd	0.326b	0.350b	0.338b
	T3	8.92f	9.00de	8.96e	0.537a	0.552a	0.545a
Sakha93	Con	11.89c	12.05ab	11.97c	0.027ef	0.048ef	0.038ef
	T1	10.55d	10.23c	10.39c	0.198d	0.215cd	0.207cd
	T2	9.42e	9.08de	9.25de	0.211c	0.326b	0.269bc
	T3	7.23gh	7.15f	7.19fg	0.305b	0.340b	0.323b

T_1= mixing ratio 3 Well water: 1 Sea water, T_2= mixing ratio 2 Well water: 1 Sea water and T_3= mixing ratio 1 Well water: 1 Sea water.
Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test.

Table (6): Plant ion content of Na^+, K^+, Cl^- and K^+/Na^+ ratio of wheat dry leaves as influenced by cultivars and salinity treatments (combined analysis).

Cultivar	Treatments	Na^+ mg g^{-1} dw.	K^+ mg g^{-1} dw.	Cl^- mg g^{-1} dw.	K^+/ Na^+ ratio (%)
Masr1	Con	0.034d	0.086a	0.175h	2.53a
	T1	0.044c	0.054c	0.235ef	1.23e
	T2	0.056b	0.043d	0.310c	0.77fg
	T3	0.060ab	0.038e	0.330b	0.63gh
Masr2	Con	0.032d	0.069ab	0.168i	2.16b
	T1	0.042cd	0.052c	0.225f	1.24e
	T2	0.052bc	0.040de	0.280d	0.77fg
	T3	0.059ab	0.032f	0.315c	0.54h
Sakha93	Con	0.040cd	0.070ab	0.210g	1.75c
	T1	0.046c	0.065b	0.245e	1.41d
	T2	0.059ab	0.052c	0.325bc	0.88f
	T3	0.064a	0.045d	0.358a	0.70g

T_1= mixing ratio 3 Well water: 1 Sea water, T_2= mixing ratio 2 Well water: 1 Sea water and T_3= mixing ratio 1 Well water: 1 Sea water.
Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test.

These results mean that the increase of salinity concentration led to the increase of Cl^- concentration. As for K^+/Na^+ ratio, Masr1 in control treatment scored the highest ratio which recorded 2.53%. On the other hand, the lowest ratio was estimated by $Masr_2$ in T_3 which recorded values of 0.54 and 0.63 %, respectively, compared to other cultivars. All of the previous results cleared that increasing salt stress led to an increase in concentration of sodium and chloride ions and decrease in potassium ion concentration in varying proportions between cultivars. These results are supported by the findings of **Kingsbury and Epstein (1984), Schachtman and Munns (1992), Dvorak *et al.* (1994), Chhipa and Lal (1995), Asch *et al.* (2000), Zhu (2003) and Parida *et al.* (2004)**.

Soil Ion Contents

Data in Table 7 showed the effect of salinity stress on chemical analysis of the empiric soil after yield. For Ca^{++} concentration, the highest value (3.20 meq./L) significantly recorded under control treatment. On the other hand, the lowest value (0.80 meq./L) significantly obtained by soil T_3. For Mg++ concentration, the highest value (2.40 meq./L) was significantly recorded in soil T_3, On the other hand, the lowest value (1.00meq./L) was significantly obtained by soil T_1.

This result means that the increase of salinity treatments concentration led to the increase of magnesium ions concentration. The highest value of Na^+ concentration (14.00 meq./L)was significantly obtained bysoil T_3. on the another hand, the lowest value (3.15meq./L) was significantly obtained by soil control . This result means that the increase of salinity concentration led to a significant increase of sodium ions. The maximum value of K^+ concentration (1.40 meq./L) was significantly recorded in soil T_3, On the other hand, the lowest value (0.32 meq./L) was significantly obtained by control treatment. This result means that the increase of salinity treatments concentration led to the increase of potassium ions concentration.

For Co_3^- concentration, the highest value (0.40 meq./L) was significantly recorded in T_3, On the other hand, the lowest values (0.00 meq./L) were significantly obtained by soil control and T_1. These results mean that the increase of salinity concentration up to 13.05 dsm.^{1} did not greatly affect the soil content of carbonate anions. For Hco_3^- concentration, the highest value (4.80 meq./L) significantly recorded in T_3, on the other hand, the lowest value (1.65 meq./L) was significantly obtained by control. For Cl^- concentration, the highest value (5.80 meq./L) was significantly recorded in soil T_3, On the other hand, the lowest value (2.32 meq./L) was significantly obtained by soil control. These results mean that the increase of salinity treatments concentration led to the increased concentration of chloride anions. For P^H concentration, the highest value (9.20 meq./L) was significantly recorded in soil T_3, On the other hand, the lowest value (9.05 meq./L) were significantly obtained by soil control and T_1. These results mean that the increase of salinity treatments concentration up to 13.05 dsm.^{1}, did not greatly affect the P^H of soil. For soil EC, the highest value was 1.08 EC which recorded in soil T_3, On the other hand, the lowest value (0.74 E.C) was obtained by soil control. These results means that the increase of salinity treatments concentration led to the increase concentration of soil EC. These results are supported by the findings of: **Tedeschi *et al.* (1997), Abou-Hadid (1998) and Dang *et al.* (2006)**.

Table (7): Effect of salinity treatments on soil chemical composition of the experimental sites (0-20 depth) after yield in combined analysis.

Trt.	Ca^{++} (meq./L.)	Mg^{++} (meq./L.)	Na^{+} (meq./L.)	K^{+}(meq./L).	Co_3^{-} (meq./L.)	Hco_3^{-} (meq./L.)	Cl^{-} (meq./L.)	P^{H} in (1-2.5) extract	E.C ($d.sm^{1}$)
Con	3.20^{a}	1.10^{c}	3.15^{d}	0.32^{d}	0.00^{c}	1.65^{cd}	2.32^{d}	9.05^{c}	0.74^{c}
T_1	2.00^{b}	1.00^{cd}	9.40^{c}	0.90^{c}	0.00^{c}	1.80^{c}	3.00^{c}	9.05^{c}	0.88^{bc}
T_2	1.05^{c}	1.20^{b}	11.00^{b}	1.20^{b}	0.20^{b}	3.60^{b}	4.00^{b}	9.12^{ab}	0.95^{b}
T_3	0.80^{d}	2.40^{a}	14.00^{a}	1.40^{a}	0.40^{a}	4.80^{a}	5.80^{a}	9.20^{a}	1.08^{a}

T_1= mixing ratio 3 Well water: 1 Sea water, T_2= mixing ratio 2 Well water: 1 Sea water and T_3= mixing ratio 1 Well water: 1 sea water.

Means followed by the same letter within each column are not significantly different at 0.05 level of probability according to Duncan's multiple range test.

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الملخص العربي

استجابة بعض أصناف قمح الخبز للإجهاد الملحي بإعادة استخدام مياه البحر تحت ظروف شمال سيناء

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تعتبر ملوحة المياه من العوامل المحددة لنمو النباتات، والتي تؤدى إلى انخفاض إنتاجية القمح في المناطق الجديدة المستصلحة في مصر مثل شمال سيناء. وتعتبر مياه البحر من الموارد المائية المتاحة والمتجددة وغير المستغلة، لذا كان من الضروري تعظيم استخدام هذه المياه من خلال البحث العلمي لاستخدامها في ري القمح، وبالتالي زيادة المساحة المزروعة لزيادة الإنتاج نحو الوصول إلى مرحلة الاكتفاء الذاتي. لذلك أجريت تجربتين بالمزرعة البحثية، بكلية العلوم الزراعية البيئية بالعريش، جامعة قناة السويس، خلال موسمي الزراعة ٢٠١٣/٢٠١٢ – ٢٠١٤/٢٠١٣ م. حيث هدفت الدراسة إلى تحديد أفضل أصناف قمح الخبز (مصر١، مصر٢ ، سخا٩٣) تحت أربعة معاملات لملوحة المياه (كنترول بالري بمياه الآبار فقط + ٣ معاملات خلط) حيث كانت نسب الخلط مياة آبار: مياة البحر (١:٣، ١:٢، ١:١)، حيث تم تعريض النباتات للمعاملات الملحية بعد ٦٠ يوم من الزراعة، أظهرت النتائج تفوق الصنف مصر٢ في محصول الحبوب وجميع مساهماته. كما أتضح من النتائج تفوق الصنف مصر٢ في محتوى حبوبه من البرولين والبروتين، بينما أعطى أقل معدل لتركيز أيونات الصوديوم والكلور والبوتاسيوم. ولقد أثرت نسب الخلط على التركيب الكيميائي للتربة، فقد أشارت النتائج إلى زيادة القدرة على التوصيل الكهربائي وتركيز أيونات كلاً من الصوديوم والماغنسيوم والبوتاسيوم، وأنيونات البيكربونات والكلوريدات، ونقص أيون الكالسيوم وثبات رقم الحموضة للتربة في العينات التي تم ري النباتات بها بأعلى نسبة خلط مع مياة البحر (١:١ مياة آبار : مياة بحر).

لذا، توصى الدراسة بزراعة الصنف مصر٢ تحت ظروف شمال سيناء وباستخدام الري التكميلي بنسبة خلط ٣ مياه آبار: ١ مياه بحر، مما يعظم الاستفادة من مياه البحر ويعطى إنتاجية اقتصادية لقمح الخبز في هذه المنطقة والمناطق المشابهة.

الكلمات الإسترشادية: أصناف القمح، الإجهاد الملحى، مياه البحر، ظروف شمال سيناء.

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