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Effects of The Diluted Sea Water and Benzyl Adenine on Macro and Micronutrients Content of Barley Shoots

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A POT experiment was conducted in the greenhouse of the National Research Centre, Dokki, Cairo, Egypt during 2000/2001 winter season to see the effect of Benzyl adenine (BA) (0 ppm and 50 ppm) and salt stress [tap water (250 ppm), 2000, 4000, 6000 and 8000 ppm from the mixed diluted sea water] on macro and micro nutrients concentration and content at the barley shoots. The obtained result showed that all micro-nutrients and Na lowered with water salinity. Similarly, Mn and Zn minerals were showed approximately the same response. Fe content was increased by salt stress up to 2000 ppm and tended to decrease by increasing salt concentration up to the highest level used. Spraying BA in the rate of 50 ppm led to significant decreases in N and Ca content but P and K contents were reversely responded. In the shoots, Zn content was lowered, but Fe and Mn contents seemed to be without effect by BA treatment compare to the control. The interaction effects of BA and salt stress in the nutrient concentration and contents were discussed.

Keywords: Salinity, Diluted with sea water, BA, Macro and Micronutrients.

Barley is considered one of the important cereal crops for farmers especially for its lesser water requirements and more tolerant to the salt stress than wheat (*Triticum* spp.). There are two major problems that limit its production level and cultivation area. These factors are availability of fresh water and avoid from the salinity.

The relation between mineral status in plants and irrigation by saline water were investigated by Chen Deming *et al.* (1995), Datta *et al.* (1995) Halperain *et al.* (1997), Grieve and Poss (2000), Hussein *et al.* (2002) and Saleh *et al.* (2002). Many salt-tolerance non-halophytes tended to resist Na^+ uptake and take up more K^+ than do the less relative ones (Shah *et al.* 1987 and Colemer *et al.* 1995).

Numerous attempts were done for increasing tolerance to salinity of crop plants. One of them was use of bio-regulators in order to elevate the harmful effects of salt stress in plants (Li *et al.* 1998, Gadallah 1999, Senaranta *et al.* 2000, El-Shintinawi and El-Shourbagy , 2001), Sultana *et al.* 2001, Ashraf *et al.* 2002 and Hussein *et al.* 2003).

Growth regulators and its effect on nutrients concentration and content were studied by Nowak and Wierzbowska (1991) who reported that the auxines and cytokinins increased grain N^+ content and remobilization of N^+. Zang Shigong *et al.* (1992) reported that BA inhibited absorption and mobilization of Na^+ in shoots, increased the K^+ content and the rate of its translocation to shoots of wheat seedlings. However, Popova and Maselenova (1997) indicated that barley leaf N^+ and its contents in the plants were lower in jasmonic acid pre-treated plants.

Hathout *et al.* (1993), El-Bassiony and Shokry (2001), Saleh *et al.* (2002) detected the interaction effect of growth regulators and salinity on macro and micro-nutrients status in plants.

Aim of this study was: (a) to find out relation between application of Benzyl adenine, (b) to obtained the effect of salt stress on macro and micro-nutrients concentration and contents in shoots of barley plants.

Material and Methods

A pot experiment was conduced in the greenhouse of the National Research Centre at Dokki, Cairo, Egypt during the winter season of 2000/2001 to evaluate macro and micronutrients concentration and content at the barley shoots. The effect of salinity and 6-Benzyl adenine on two treatments were applied: (*i*) salt concentration in irrigation water (by diluting Mideterranean sea water with fresh water): tap water 250 ppm 2000 ppm, 4000 ppm, 6000 ppm and 8000 ppm, *(ii)* Benzyl adenine treatments (tap water) and 50 ppm foliar spray.

The experiment included 5 levels of salinity in combination with 2 levels of growth hormone in completely randomized design. Metallic tin pots 35 cm in diameter and 50 cm in depth were used. Every pot contained 30 kg of air dried clay loam soil. The inner surface of the pots was coated with three layers of bitumen to prevent direct contact between the soil and metal. In this system, 2 kg of gravel (particles about 2-3 cm in diameter) was used to cover the bottom of the pot. Irrigation water was poured to a vertical tube (2.5 cm in diameter), so the movement of water was from the base upward.

Cultivar of barley (*Hordeum vulgare* L.), namely Giza 124 were sown in 15 November. Plants were thinned twice the 1^{st} and 20 days after sowing and two weeks later they were potted as to be three plants per pot. Calcium super phosphate (16 % P_2O_5) and potassium sulfate (48.5 % K_2O) in the rate of 2.29 and 1.14 g/pot were added before this procedure. As an equal amount, Ammonium sulfate (20.5 % N) in the rate of 6.86 g/pot was added, the 1^{st} after two weeks from sowing and the 2^{nd} two weeks latter.

Barley plants were sprayed with (BA) at 50 ppm at 75 days after sowing. Spraying was carried out using compressed air sprayers. "Nonidet 42" was used as a wetting agent at the rate of 0.10 %. Control plants were sprayed with tap water at the same rate of this agent.

Sampling

Samples were taken from every sub-plot cleaned and dried in an electric oven at 70 °C overnight and ground stainless steel digestion and determination of minerals were done according to the methods of Cottenie *et al.* (1982).

The data were statistically analyzed as described by Snedecor and Cochran (1980).

Results and Discussion

Salinity

Salt stress effects on macro-nutrient concentrations were recorded in Fig . 1. Nitrogen concentration decreased with the 1st level of salt (2000 ppm) and then increased to be near that of the control. P concentration increased by salt stress but at the 4000 and 6000 ppm salt level more than resulted by 8000 ppm level. K^+ concentration decreased with 2000, 4000 and 8000 ppm doses while irrigated with solution contained 6000 ppm seemed to be equal with that irrigated by fresh water. Salt stress levels did not exert any clear changes in Ca^{++} concentration. Nevertheless, Na^+ concentration increased by increased in salt concentration in the root media up to 6000 ppm, meanwhile, it tended to decrease when use the level of 8000 ppm to be equal the concentration of treatment irrigated by fresh water. Examination of data in Table 2 and Fig.2 showed that exposure barley plants to 2000 ppm salinity caused pronounced increases in Fe concentration and gradually decreased by other high concentrations of salts in the soil solution to be less than the untreated plants when plants irrigated by water contains 8000 ppm Mn or Zn concentration increased with the 1st dose and tended to decrease with 4000 and 6000 ppm salt and increased again with 8000 ppm.

Macro-nutrients content as affected by salt stress are presented in Table 2 and Fig. 2. It's clearly shown that all micronutrients content in shoots of barley plants was lowered by increasing in salt concentration at the root zone. These decrements in N, P, K, Ca and Na mg/plant were 64.2, 63.6, 68.8, 72.0 and 70.2 % when plants irrigated by solution contains 8000 ppm compare to that irrigated by fresh water. Chen-Deming *et al.* (1995) reported that increasing salinity uptake of Na^+ and deceased uptake of K^+ greatly and Ca slightly. K/Na and Ca/Na ratios in leaves were decreased by salinity. El-Fouly *et al.* (2000) noticed that dry weight and nutrient uptake of both plants (barley or wheat) were negatively affected by high NaCl content. On the other hand, Grieve and Poss (2000) revealed that shoot-calcium concentration increased with increasing salinity. The reverse was true for K and Mg in wheat. In Pakistan, Rajpot and Sail (2002) growing different wheat varieties, compare to other varieties, found that the poor performance Q19 was associated with higher Na^+ and lower K^+ Na^+ ratio. Better performance Kherchia was associated with less Na^+ and Cl^- accumulation in the flag leaf sap, however, this trend was not observed in

KTDH-19 and Cdenza cultivars grown up to flag leaf stage in NaCl solution at 120 ml/m^3. Halperian *et al.* (1997) revealed that salinity stress inhibits Ca translocation to the shoots and leading to Ca deficiency in barley. Furthermore, Salama *et al.* (2000) mentioned that root uptake of Na^+ and Mg was found to positively correlate with increasing in salt concentration in the root zone. The disturbance in mineral uptake may be due to the harmful affect of salt stress in the permeability of cell membranes and nutrients imbalance (Levitt 1980, Marshinar 1985 and Munns 1993).

Data recorded in Table 2 showed that micro-nutrients approximately the same trends of macro-nutrients except Fe which increased by level 2000 ppm and tended to decrease sharply as the salt concentration go up in water of irrigation. Irrigation of barley plants by solution contained 8000 ppm depressed Fe, Mn and Zn contents by 66.7, 54.2 and 71.2 %, relatively in comparable with that in shoots of plants irrigated by tap water (250 ppm). Hu and Schmidhalter (2001) reported that changes of Mn, Zn, Fe and B concentrations under saline condition depend upon the level of macro-nutrients and salinity and the organ of plants. Salama *et al.* (2000) obtained that iron uptake was sharply decreased but was not affected in shoots of wheat plants. However, Zn and Cu uptake showed a remarkable decreased at 75 mM NaCl level in the roots and shoots of wheat.

Benzyl adenine

BA 50 ppm spraying was led to decrease concentrations of N, Na, Ca, Fe and Zn, while the opposite was true for P but for K concentration it was seemed to be without any effects Table 1.

The effect of BA treatment on macro nutrients in the shoots were indicated in Table 2. This data showed that spraying 50 ppm BA led to significant decreases in N and Ca contents, but P and K contents were reversely responded. Na content in shoots and leaves did not affected with this compound. Angris *et al.* (2001) concluded that the combined treatment of GA and Kinetin was the most effective on the content of nutrients than the other treatments used. El-Bassiony and Shokry (2001) pointed out that K, Na and Ca minerals showed increasing at the leaves of cowpea in response to IAA. These increases parallel with IAA concentration. It was further observed that the plant growth regulator-induce salinity stress alleviation was due to concomitant increase in the tissue N content and nitrate reductase activity. Popova and Maselenova (1997) indicated that leaf Na^+ concentration and content in barley plants were lower in jasmonic acid pre-treated plants. Sharma and Gain (1997) found that N uptake was higher with spraying Viapol on Sorghum, Nowak and Wierzbowska (1991) reported that auxins and cytokines increased grain N content and remobilization of N^+ was increased. Zang shigong *et al.* (1992) demonstrated that 6-Benzyl adenine inhibited the absorption and translocation of N^+ in shoots, increased the K^+ content in wheat seedlings and the rate of its translocation to shoots.

TABLE . 1 Effect of Benzyl adenine on macro and micro nutrients concentration in shoots of barley plants under different salinity levels by diluted sea water.

Saline conc. ppm	BA* ppm	Macro nutrients %					Micro nutrients ppm		
		N	P	K	Na	Ca	Fe	Mn	Zn
TW**	0	2.25	0.115	1.70	1.45	2.05	240	100	209
	50	2.21	0.235	1.70	1.75	1.28	317	64	200
	M	2.23	0.175	1.70	1.60	1.67	279	82	205
2000	0	2.14	0.125	1.05	2.45	1.54	691	132	261
	50	1.14	0.210	2.05	2.30	1.62	297	58	225
	M	1.64	0.168	1.55	2.38	1.58	494	95	243
4000	0	2.45	0.185	1.15	2.00	1.78	344	68	199
	50	1.90	0.200	1.25	1.95	1.27	251	66	168
	M	2.18	0.193	1.20	1.98	1.53	297	67	184
6000	0	2.10	0.285	2.15	2.45	1.93	243	48	181
	50	1.89	0.220	1.35	2.20	1.17	273	54	185
	M	2.00	0.253	1.75	2.23	1.55	258	51	183
8000	0	2.86	1.85	1.60	2.15	1.32	225	56	237
	50	1.75	1.95	1.35	1.20	1.85	162	141	190
	M	2.31	1.90	1.38	1.68	1.59	194	99	214
MBA Value	0	2.36	0.179	1.53	2.10	1.72	349	81	217
	50	1.78	0.212	1.54	1.80	1.44	260	77	194

* BA: Benzyle adenine.
** TW: Tap water.

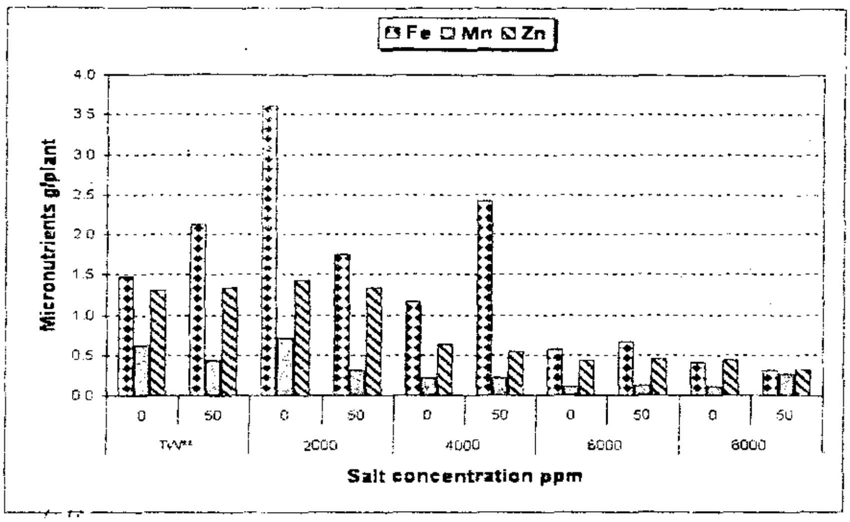

Fig. 1. Effect of Benzyl adenine on micronutrients content in shoots of barley plants under different salinity levels occurred by diluted sea water.

Micro-nutrients responses to BA are in Fig. 2. According to Fig. 2, the treatment of BA in 50 ppm rate was lowered of the Mn in ppm / plant while Fe and Zn seemed to be similar of the control plants. Saleh *et al.* (2002) revealed that spraying BA lowered the concentration of N but the reverse was true for Mn and Zn in barley seeds. The concentration of P, K, Ca and Fe were not affected, however, the grains' Mn and Zn content were significantly increased .

Salinity x Benzyl adenine

The interaction effect of different salinity levels and spraying BA on macro and micro nutrients in shoots are presented in Fig. (1.2)

Generally, salt stress exhibited a clear depression on macro and micro nutrients for their availability and functions. Especially this. vital effect increased as salt stress increased. Addition of BA lowered the content of N. This action decreased as the salt in water of irrigation increased up to 6000 ppm and tended to increase by higher level used. In the case of P or K, BA raised its content by the 1^{st} dose of salt i.e. 2000 ppm by about 183.3 and 108.6 % and then lowered by 6000 ppm level. In the contrary, 8000 ppm level, P content increased by 33.3 % compared to the control. Ca content seemed to be without effect. Spraying barley plants by 50 ppm BA increased the content of Na but followed by slight decreases by the next salt concentration and highly depression by 8000 ppm salt solution in water of irrigation . El-Bassiony and Shokry (2001) in cowpea and Hathout *et al.* (1993) in tomato, found that Indole Acetic Acid increased the uptake and translocation of the elements in the tissues and this led to conclude that this process conducted to counter the harmful effect of water stress.

It was further observed that the plant growth regulators induce salinity stress alleviation was due to concomitant increase in the tissue N content and nitrate reductase activity. Zang-Shigong *et al.* (1992) reported that BA improved absorption of Cl in roots and decreased its translocation and content in shoots. This increasing salt tolerance and the adaptability of wheat seedlings to salt stress.

TABLE 2. Effect of Benzyl adenine on macro and micro nutrient content of the shoots of barley plants under different salinity levels by diluted sea water.

Saline conc. ppm	BA* ppm	Macro nutrients Mg/plant					Micro nutrients Mg/plant		
		N	P	K	Na	Ca	Fe	Mn	Zn
TW**	0	140	7	108	90	128	1.47	0.62	1.30
	50	119	15	111	118	86	2.12	0.43	1.33
	M	121	11	109	104	107	1.80	0.53	1.32
2000	0	118	6	58	134	84	3.62	0.72	1.43
	50	86	17	121	135	92	1.75	0.31	1.33
	M	104	12	86	135	88	2.69	0.52	1.38
4000	0	75	6	40	63	56	1.17	0.22	0.63
	50	62	7	41	58	41	2.42	0.22	0.55
	M	69	7	41	61	49	1.80	0.22	0.59
6000	0	47	7	51	58	44	0.58	0.11	0.43
	50	46	5	33	56	28	0.66	0.13	0.45
	M	47	6	42	57	36	0.62	0.12	0.44
8000	0	53	3	29	39	24	0.41	0.11	0.44
	50	33	4	28	23	35	0.31	0.27	0.33
	M	43	4	34	31	30	0.36	0.19	0.38
MBA	0	82	5.8	5.7	7.7	6.7	1.45	0.36	0.85
Value	50	69	9.6	6.7	7.8	5.6	1.45	0.27	0.80
LSD	S	4.6	3.7	5.8	4.2	5.4	0.076	0.0033	0.0283
at 5 %	BA	2.7	6.6	8.6	N.S	5.1	N.S	0.0069	0.0227
level	SxBA	4.3	13.6	19.3	6.3	12.8	0.663	0.0152	0.0509

* BA: Benzyle adenine.
** Tw: Tap water.

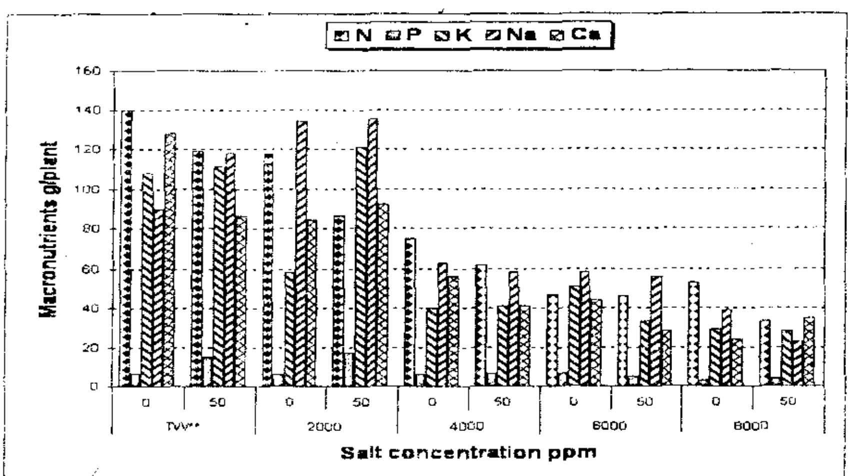

Fig. 2. Effect of Benzyl adenine on macronutrients content in shoot of barley plants under different salinity levels occurred by diluted sea water.

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تأثير الرش بالبنزايل أدنين و الري بماء البحر المخفف على الحالة الغذائية للمجموع الخضري لنباتات الشعير

محمد مرسى محمد حسين* ، عبد القادر عبد العزيز عبد القادر **و محمود سيد أحمد أبو الخير* وأسامة مصطفى إبراهيم كساب*
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أجريت تجربة قصارى في صوبة المركز القومي للبحوث بالدقى– جمهورية مصر العربية في الموسم الشتوي ٢٠٠٠ / ٢٠٠١ م لدراسة تأثير الرش بالبنزايل أدنين (صفر –٥٠ جزء/مليون) مع الري بماء البحر المخفف ماء الصنبور (٢٥٠ جزء/مليون) و ٢٠٠٠ و٤٠٠٠ و٦٠٠٠ و٨٠٠٠ جزء/مليون على محتوى السيقان والأوراق لنبات الشعير من المعادن. انخفض محتوى كل العناصر الكبرى المقدرة في هذه الدراسة . قيم المنجنيز والزنك أظهرت نفس الاستجابة تقريبا. زاد محتوى الحديد بالري بالماء المالح حتى تركيز ٢٠٠٠ جزء/ مليون ثم انخفض بزيادة تركيز الأملاح بماء الري. الرش بالبنزايل أدنين أدى إلى خفض محتوى كل من النتروجين والكالسيوم بينما الفوسفور والبوتاسيوم كانت استجابتهما عكسية. انخفض محتوى الزنك ولكن محتوى كل من الحديد والمنجنيز تقريبا متساوي. كما تضمن البحث تأثير فعل التداخل بين الرش بالبنزايل أدنين و الري بالماء المالح.