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EFFECT OF IRRIGATION WITH SALINE WATER ON SEED GERMINATION, GROWTH AND CHEMICAL COMPOSITION OF BROAD BEAN

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ABSTRACT

A pot experiment was conducted during the two winter seasons of 2003/2004 and 2004/2005 to study the effect of irrigation with saline drainage water on seed germination, growth and chemical composition of broad bean plants cv. Giza blanka . The used saline water concentration were 1000, 2000 and 3000 ppm and tap water at 260 ppm was considered as a control. The results showed that the germination percentage was not significantly affected by saline water up to 1000 ppm then a general significant decrease was took place with every increase in the salinity concentrations. However, plant height, number of branches, number of leaves, number of pods/plant and pods fresh weight per plant, significantly started to decrease at 3000 ppm . The content of T.S.S. was significantly increased with every increase in saline levels while the dry weight was significantly decreased with every increase in saline water up to 2000 ppm. Then umber of seeds /pod, 100- seed weight, seed contents of total nitrogen, phosphorus, potassium and total protein were not significantly differ from the application of various saline water concentrations.

INTRODUCTION

The quantity of drainage water which is of reasonable quality reached approximately about 13.5 billion m^3/year flow unused to the Mediterranean sea and the coastal lakes which are in direct connection with the sea. Part of this water could and should be reused for irrigation purposes to overcome water shortage in agricultural area. The use of saline water for irrigation is feasible, however, when water is alternated or combined with good quality water supplies (Abo Sedera, 1986 on pea, Shafshak, 1989 on broad bean and Abd El-Sayed *et al.*, 1993 on sugar beet). This mixed water with different salinity levels will be soon applied in both El-Salam and Nobaria canals to provides Sinai and North coast with mixed irrigation water for the plantation of various crops. Broad bean surely will be one of them due to its importance in the Egyptian diet.

In Egypt, broad bean is considered the principal winter leguminous crop used as a source of food protein. The previous work revealed that irrigation of broad bean water at 1500 ppm decreased seed germination, plant height, number

of leaves, fresh weight and nitrogen content in plant foliage, but increased T S.S with every increase in the concentration of this water In addition, these crops were completely dead when irrigated with salty water at 3000 ppm level of salts after two months from sowing (Salem, 1974).

Hussain *et al.*, (2002) working on wheat demonstrated that seed germinating, plant height and grain yield progressively decreased with increased level of salinity.

The present work has involved studies to have good knowledge and full understand on the physical and chemical changes occurred in broad bean plants from seeding to full maturity as result of using saline water in irrigation

MATERIALS AND METHODS

A pot experiment was conducted in the experimental farm of Faculty of Agriculture, Al-Azhar University at Assiut to study the effect of irrigation with saline drainage water on the growth, yield and chemical composition of broad bean (*Vicia faba, L.*) cv. Giza planka. Pots were arranged in three replicates and every replicate consisted of 6 pots where each pot contained three plants. The design of the experiment was complete randomized blocks. The used soil type was sandy- loam. The saline water was brought from Karoun lake at El-fayoum governorate at the concentration of 25000 ppm. This water was diluted to 1000, 2000 and 3000 ppm with tap water to have the required concentrations The control pots were irrigated with tap water at the concentration of 260 ppm The chemical analysis of the diluted saline water was done (Table 1) The soil used wee clay loam. It's chemical and physical characteristics are presented in Table (2). Twenty seeds were sown per pot (30 cm diameter) on October 25th in the two winter seasons of 2003/2004 and 2004/2005 Seedlings were thinned to three plants per pot after 20 days from sowing Pots were irrigated every 12 days and other agricultural practices took place whenever it was necessary Data were recorded on 5 plants on the following items

1. Germination percentage was calculated by using the following equation

$$\text{Germination \%} = \frac{\text{Number of germinated seeds}}{\text{Total number of planted seeds}} \times 100$$

Table (1): Chemical analysis of the diluted saline drainage water used in irrigation (meq/L.)

Treatments (ppm)	EC (ds/m)	HCO_3	Cl	SO_4	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	SAR*
260	0.41	3.1	1.5	0.1	1.9	1.5	1.1	0.2	0.8
1000	1.56	3.1	10.5	0.2	2.5	3.3	7.7	0.3	4.5
2000	3.12	3.1	24.1	0.5	2.9	6.6	17.5	0.4	8.1
3000	4.69	3.1	35.5	0.8	3.5	10.0	25.0	0.7	9.7

* (SAR) = Sodium adsorption ratio

Table (2): Chemical and physical characteristics of the soil:

Property		
O.M.%		0.8
$CaCO_3$%		1.65
Sand %		25.0
SilT		40.0
Caly%		35.0
Texture class		Clay loam
pH		7.9
EC_e (dS/m)		2.15
Soluble ions (meq./L)	CO_3	0.0
	HCO_3	2.34
	Cl	8.13
	SO_4	10.23
	Ca	10.38
	Mg	5.12
	Na	4.89
	K	0.31
Available (ppm)	NH_4	49.0
	NO_3	84.0
	P	9.4
	K	441.0
	Zn	2.3
	Fe	9.5
	Mn	4.1

2. Morphological characteristics of plant foliage. Plant height, number of branches / plant, number of leaves/ plant, were determined on 5 plants taken at 95 days after sowing.
3. Green pods yield and its components number of pods/ plant, number of seeds/ pod, pods fresh weight/plant, and 100 – seed weight were weight in g .
4. Chemical constituents of greens eeds .
   a. Total soluble solids were determined by abbe refractometer (A.O.A.C., 1985).
   b. Dry matter percentage for produced seeds was determined by weight one hundred g. of fresh seed then dried at 70°C till constant weight was reached. The results were calculated as g/100 g. fresh weight.
   c. Total nitrogen, phosphours and potassium concentrations were determined in dry matter of seeds as follows:
      1. Total nitrogen was determined according to the micro- kjeldahl method (A.O.A.C., 1985).
      2. Phosphorus was determined colorimetrically using the ascorbic acid method (Mattk, 1970).
      3. Potassium was determined photometrically by using the flam photometer method (Richard, 1954).
      4. Total protein was determined after the method described by Ranganna (1979).

The obtained data were statistically analyzed according to Snedecor and Cochran (1982).

RESULTS

Germination percentage

The results of germination percentage in the two seasons of the experiment (Table 3) indicate that this percentage was not significantly affected by irrigation with the low concentration (1000 ppm) of saline water meanwhile a general significant depression occurred with every increase in the following high salinity concentrations.

Growth characteristics:

The effect of irrigation with saline water on the morphological characteristics of plant in both seasons is shown in Table (3) . The results indicated that plan length, number of branches per plant, number of leaves/plant were not significantly affected by the irrigation with saline water up to 2000 ppm. However, increasing the level of salinity up to 3000 ppm in irrigation water significantly reduced these plant growth traits.

Pod Physical characteristics :

The number of pod/ plant and pod fresh weight was not significantly affected by the saline levels up to 2000 ppm (Table 3). When the level of salinity was increased to 3000 ppm, a reduction was happened .

Table (3): Effect of irrigation with saline water on germination%, vegetative growth trails as well as green pods yield and its compounents during the two seasons of growth 2003/2004 and 2004/2005.

Salinity ppm	Germination %	plant height (cm)	number of branches /plant	Number of leaves/ plant	number of pods/ plant	Number of seed/ pod	pod fresh weight/ plant (g)	100-seed weight (%)
(2003/2004 season)								
Control	97.55	174.49	5.59	81.62	32.78	6.38	667.81	87.53
1000	84.15	170.81	4.98	78.83	30.13	5.83	629.09	83.74
2000	68.97	161.12	3.62	73.58	25.35	5.85	562.37	83.71
3000	57.85	122.24	2.06	51.20	18.07	5.84	344.88	83.14
L.S.D. at 5%	15.27	17.40	2.01	16.26	10.33	N.S.	121.22	N.S.
(2004 /2005 season)								
Control	95.75	164.80	6.54	82.09	38.17	5.93	593.14	91.23
1000	82.95	160.13	5.99	75.27	33.27	5.95	573.82	88.98
2000	69.70	154.29	3.76	70.24	26.93	5.84	529.67	88.66
3000	58.73	108.36	1.93	51.02	18.15	5.88	327.28	88.44
L.S.D. at 5%	14.68	14.96	2.88	15.91	14.06	N.S	81.19	N.S.

As concerning the effect of irrigation with saline water on the number of seeds/pod and 100-seed weight, these characters were not significantly affected by increasing the salt levels up to the rate of 1000, 2000 and 3000 ppm.

Seed Chemical constituents:

The data on pod T.S.S. in both seasons indicated that this characteristic was increased gradually with every increase in the concentration of saline water (Table 4).

The obtained data on seed dry weight in the two seasons (Table 4) demonstrated that his content was decreased with the increase of salinity levels.

The results of total N, P, K and Total protein content in the two seasons showed that there were no significant differences existed due to the application of the various levels of saline water (Table 4).

Table (4): Effect of irrigation with saline water on seed chemical constituents in two growth seasons of 2003/2004 and 2004/ 2005.

Salinity ppm	T.S.S.%	Dry weight %	N% (g/100 g dry weight)	P% (g/100 dry weight)	K% (g/100 dry weight)	Total protein
(2003/2004 season)						
Control	3.93	13.86	4.29	0.69	4.15	26.81
1000	5.08	13.23	4.26	0.66	4.12	26.63
2000	6.25	11.40	4.31	0.70	4.13	26.94
3000	6.962	10.16	4.26	0.67	4.13	26.63
L.S.D. at 5%	1.03	2.81	N.S.	N.S.	N.S.	N.S.
(2004 /2005 season)						
Control	5.25	13.88	4.16	0.65	4.22	26.00
1000	5.75	12.53	4.16	0.65	4.20	26.00
2000	6.50	11.49	4.12	0.65	3.52	25.75
3000	7.48	10.33	4.15	0.64	4.19	25.94
L.S.D. at 5%	0.37	2.50	N.S.	N.S.	N.S.	N.S.

DISCUSSION

Some data on broad bean placed this crop among the moderately sensitive ones (Salem, 1974).

The effect of irrigation with the various concentrations of saline water on either percent or rate of seed germination showed a significant reduction specially at the higher levels over 1000 ppm. This drop may be due to the adverse action of salts during the initial stages of germination on lowering synthesis and enhancement of protein hydrolysis or to the decrease of water absorption as a

result of the increase in soil solution osmotic pressure (El-Sharkawi and Sprenguel, 1979; Bresler *et al.*, 1982).

The growth parameters which were plant height number of branches and leaves/plant and yield components i.e., number of pods/plant and fresh pods yield /plant were not significantly affected up to 2000 ppm. However, significant drop happened when the rates of salts were increased to 3000 ppm. This reduction may occur from one or more reasons. Thus, these causes may include the plant inability to adjust osmotic pressur, counteract ion toxicities, excessive energy demand placed upon the metabolic machinery required for homeostatic systems (Flowers *et al.*, 1977; Greenway and Munns, 1980), the injurious effect of specific ions such as NaCl, $CaCl_2$ and $NaSO_4$ which inhibited the production of chlorophyll and carotene in leaves, (Abo Sedera, 1985 and Shafshak, 1989) the high sodium concentration that induce calcium and magnesium nutritional deficiencies and influenced the respiratory pathways in roots (Abel and Mackenzie, 1964), beside the fact that long term exposure of roots to high salt concentrations make the plant suffer from drought (Bernstein, 1975). Later, in more recent investigation another important reason may be added which point out the minimization of photosynthesis that led to reduction in stomatal function that led to stomatal limitations of CO_2 uptake (Pascal and Barbieri, 1995).

The chemical contents in the seed showed by the increase of salinity levels significant increase in T.S.S., no materially change in N,P, K and total protein and significant decrease in dry weight. The increase in T.S.S. may be attributed to the effect of saline water on increasing the movement of soluble solids to the plant and the conversion of insoluble compounds to simpler soluble forms (Singh and Abrol, 1985).

The continuous decrease in seed dry weight with the increase in salinity levels may be related to reduction in the amount of metabolites translocated from the leaves to the pod as a result of the decrease in photosynthetic capacity of plants (Bernstein and Ayers, 1953; Osawa, 1961).

From this study, it is reasonable to recommend that broad bean must be grown with the limit of 2000 ppm saline water.

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تأثير الرى بمياه ملحية على الانبات والنمو والمحتوى الكيماوى للفول الرومى

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اجريت هذه التجربة فى أصص خلال الموسم الشتوى لموسمى ٢٠٠٣/٢٠٠٤ و ٢٠٠٤ / ٢٠٠٥ م لدراسة تاثير الرى بمياه مالحة وذلك على انبات ونمو الفول الرومى. والمياه المالحة المستخدمة فى هذه التجربة بتركيزات ١٠٠٠، ٢٠٠٠، ٣٠٠٠ جزء فى المليون. كما تم رى نباتات الكنترول بمياه صنبور بتركيز ٢٦٥ جزء فى المليون. وقد اوضحت النتائج ان النسبة المئوية للانبات لم يتأثرا معنوياً بالرى بالمياه المالحة حتى تركيز ١٠٠٠ جزء فى المليون ولكن بزيادة التركيز حدث نقص معنوى فى هاتين الصفتين وكان هذا النقص متدرجاً مع الزيادة فى تركيز الملوحة. اما من ناحية طول النبات وعدد الافرع وعدد الاوراق وعدد قرون النبات ووزن قرون النبات. فقد حدث نقص معنوى فى هذه الصفات عند الرى بمياه مالحة بتركيز ٣٠٠٠ جزء فى المليون . اما بالنسبة للمحتوى الكيماوى للقرن فقد حدثت زيادة معنوية فى محتوى البذور من المواد الصلبة الذائبة الكلية وذلك بزيادة معدلات الملوحة وذلك مقارنة بالكنترول.

هذا فى حين انه حدث نقص معنوى فى الوزن الجاف للبذور بزيادة معدلات الملوحة اعلا من ١٠٠٠ جزء فى المليون.

هذا ولم تتاثر محتوى البذور من النيتروجينى والفوسفور واليوباسيوم والبروتين الكلى بالتركيزات الملحية المختلفة.

من هذا يتضح ان الفول الرومى حساس لملوحة مياه الرى حيث يتحمل حتى ٢٠٠٠ جزء فى المليون فقط وبزيادة التركيزات الملحية عن ذلك تتاثر قياسات النمو والانبات سلبا بشكل كبير.