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SUSTAINABLE AGRICULTURE OF BROAD BEAN USING DILUTED SEA WATER FOR IRRIGATION COMBINED WITH MINERAL AND BIO NITROGEN FERTILIZATION

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ABSTRACT: A pot experiment was conducted under greenhouse conditions using broad been plant (*Vicia faba* L.). Irrigation water salinity was achieved by diluted sea water collected from Suez Canal to reach salinity levels of 2.43, 4.33 and 6.10 dSm-1. Nitrogen was added as ammonium nitrate at the rates of 60, 45, 30 mg N kg-1 soil corresponding to 100, 75 and 50 % from recommended dose which is 60 kg N fed-1. Bio fertilization was achieved through the addition of rhizobium which was thoroughly mixed with surface soil. Plant samples were collected at three different growth stages i.e. 45, 75 and 140 days from sowing corresponding to flowering stage, pod formation stages and maturity stages, respectively. Results showed that, at flowering stage, the highest values of plant height, number of leaves, and dry matter content as well as P and K uptake were observed under the treatment of 60 mg N kg soil-1 + Rhizobium. At the pod formation stage, the highest values of plant height and number of leaves were observed under the treatment of 60 mg N kg-1 soil+ Rhizobium, while the highest values of dry matter content and as well as P and K uptake were obtained under the treatment of 45 mg N kg-1 soil + Rhizobium. At maturity stage, the highest value of dry matter content was observed under the treatment of 60 mg N kg-1 soil+ Rhizobium, while P and K uptake, and pods number per plant were obtained under the treatment of 45 mg N kg-1 soil + Rhizobium.

Key words: Irrigation water - salinity - bio fertilization - broad bean.

INTRODUCTION

Since agricultural production is greatly limited worldwide by shortage of water, supplies of good quality irrigation water are expected to decrease in the future because the development of new water supplies will not keep pace with the increasing water needs for agricultural activity. Increased interest is being developed in using saline water for irrigation.

Plant growth is suppressed severely by high salinity stress due to many factors such as osmotic stress, mineral nutrition absorption imbalance and specific ion toxicity, all combined to reduce nutrient uptake consequentially causing physiological drought to plants **(Ahmad *et al.*, 2016).**

Mineral-N fertilizers have many problems such as speedy losses and conversion into insoluble forms. The intensive use of mineral-N fertilizers, which may result in an environmental problem, has attracted the attention of many researchers to investigate the possibility of using bio fertilizers to promote plant tolerance to salt stress **(IFIA, 2000).**

Biofertilizer inoculation can lower the need for mineral fertilizers and is an advantageous method for soil development, lowering agricultural expenditures, ameliorate the adverse effects of salinity on growth, and increasing crop output since it gives crops access to readily available nutrients **(Metin *et al.*, 2010).**

Bean plants are an important source of food; they contain high protein and appreciable amounts of minerals and vitamins. It is considered as one of the main sources of plant proteins for human nutrition **(Crepon *et al.*, 2010)**.

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The purpose of this study was to investigate the possibility of using an integrated salinity stress management strategy including bio stimulants to ameliorate the adverse effects of irrigation water salinity on growth, P and K uptakes, and yield components of broad bean plant.

MATERIALS AND METHODS

A pot experiment was conducted under greenhouse conditions using broad been plant (*Vicia faba L.*). Soil samples were collected from Abu Hammed, Sharkia. Physical and chemical properties of soil used are shown in Tables (1, 2 and 3). Soil texture was sandy clay loam contented 3.28 g 100 g^{-1} soil calcium carbonate, 0.595g $100g^{-1}$ soil organic matter, pH 7.93 and Electrical conductivity of 1.23 dSm^{-1}. Irrigation water salinity was achieved by diluted sea water collected from Suez Canal to reach salinity levels of 2.43, 4.33 and 6.10 dSm^{-1}, compared with well water salinity of 0.625 dSm^{-1}. Chemical properties of sea water and well water used are shown in Tables (4 and 5). Nitrogen was added as ammonium nitrate at the rates of 60, 45, 30 mg N kg $soil^{-1}$, corresponding to 100, 75 and 50 % from recommended dose which is 60 kg^{-1} N fed^{-1}. Bio fertilization was achieved by added Rhizobium which thoroughly mixed with surface soil. Plant samples were collected at three different growth stages i.e. 45, 75 and 140 days from sowing corresponding to flowering stage, pod formation stages and maturity stages, respectively.

Soil Analysis

Particle size distribution was carried out using international pipette methods, according to **Gee and Bauder (1986).** Total calcium carbonate (Ca CO_3%) was determined volumetrically using the Collin's calciminer according to **Klute (1986).** Electrical conductivity (EC_e) and pH as well as soluble cations and anions were determined in soil paste extracts using the standard methods described by **Jackson (1973).** Organic matter content was determined by Walkley and black methods according to **Page (1982).** Available nitrogen was determined by steam-distillation procedure using MgO-Devarda alloy according to Bremner and Keency methods as described by **Black (1982).** Available phosphorus was extracted by 0.5 N $NaHCO_3$ of pH adjusted at 8.5 and determined calorimetrically using the ascorbic acid methods described by **Watanabe and Olsen (1965).** Available potassium was extracted by 1 N ammonium acetate of pH adjusted at 7.0 and determined using flame photometer according to **Jackson (1973).** Micro nutrients (Fe, Mn and Zn) were determined by atomic absorption described by **Lindsay and Norvell (1978)**

Irrigation water analysis

Electrical conductivity (EC) and pH as well as soluble cations and anions were determined according to **Chapman and Pratt (1978).**

Plant analysis

Plant height, number of leaves per plant and dry matter content were detected. Plant samples were collected at different growth stages and wet digested to determine total phosphorus calorimetrically using the ascorbic acid methods according to **John (1970)** as well as total potassium volumetrically using flame photometer according to **Brown and Lilliland (1964).**

Statistical analysis

Data was analyzed according to **Snedecor and Cochran (1988).** The significance level for the Differences (LSD) test was set at 0.05, **Waller and Duncan, 1969.** The analysis of variance technique of the computer software package **(MSTAT-C, 1991)** was used to do statistical analysis.

RESULTS AND DISCUSSION

Effect of Irrigation Water Salinity and Nitrogen Fertilization on Growth at Different Growth Stages

Plant height

Concerning the effect of irrigation water salinity, data in Table (6) shows that increasing salinity of irrigation water leads to a decrease in plant height, the depressive effect of salinity on plant height is probably due to the decrease in water observation, metabolic processes, meristematic activity and cell enlargement. In this respect, **Cornillon and Palliox (1997)** noted that salts inhibit plant growth by increasing osmotic stress, nutritional imbalance, and specific ion toxicity. **Hasanuzzaman *et al*. (2013)** stated that the reduction in the growth could be attributed to osmotic stress and toxicity.

Table 1. Physical properties of the soil used in the current study

Mechanical analysis							
Clay	Silt	Coarse sand	Fine sand	Textural Class	$CaCO_3$	O.M	F.C
($g100g^{-1}$)					($g100g^{-1}$)		
26.49	11.79	18.60	43.12	Sandy clay loam	3.28	0.59	15.65

Table 2. Chemical properties of the soil used in the current study

pH*	EC*	Soluble ions (mmol) *							
		Cations				Anions			
		Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	CO_3^{2-}	SO_4^{2-}
7.93	1.23	6.75	1.15	2.65	2.10	2.85	8.05	nil	1.75

* In soil best extract

Table 3. Macro and micro nutrients concentration of the soil used in the current

Available macro nutrients ($mg\ kg^{-1}$ soil)			Available micro nutrients ($mg\ kg^{-1}$ soil)		
N	P	K	Fe	Mn	Zn
44.85	24.60	48.15	2.75	1.80	0.85

Table 4. Chemical analysis of sea water used in the current study

Sea water	pH	EC ($ds\ m^{-1}$)	Cations (mmol)				Anions (mmol)			
			Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	CL^-	SO^{-2}_4
	7.3	51.7	20.9	34.5	462.4	17.2	Nil	5.2	456.3	73.5

Table 5. Chemical analysis of irrigation water at different salinity levels used in the current study

Irrigation water	pH	EC($ds\ m^{-1}$)	Cations (mmol)				Anions (mmol)			
			Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	CL^-	SO^{-2}_4
Well water	7.85	0.625	0.80	2.46	2.95	0.35	nil	1.98	2.50	2.08
Salinity Level 1	8.06	2.43	2.81	9.41	13.11	0.58	nil	4.27	13.94	7.70
Salinity Level 2	8.09	4.33	8.43	16.10	18.95	0.79	nil	9.14	21.91	13.22
Salinity Level 3	8.12	6.10	11.96	23.06	26.18	1.07	nil	12.18	29.16	20.93

Table 6. Plant height (cm) at flowering and pod formation stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Flowering stage				Pod formation stage			
	100 % Menial-N without Bio	100 % Menial-N with Bio	75 % Menial-N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial-N with Bio
Control (0.625 dSm^{-1})	29.71	42.12	40.60	33.25	55.82	68.38	66.75	63.27
Level 1 (2.43 dSm^{-1})	25.40	35.87	34.75	28.28	47.02	62.51	57.35	54.02
Level 2 (4.33 dSm^{-1})	20.61	28.10	26.73	23.02	38.77	s47.91	46.85	44.5
Level 3 (6.10 dSm^{-1})	17.50	23.12	22.52	19.46	33.49	40.15	38.72	35.80
LSD	**S:** 1.4164 **RN:** 1.4164 **RN*S:** 2.8329				**S:** 1.7553 **RN:** 1.7553 **RN*S:** 3.5106			

The lowest values of plant height were 17.50 and 33.49 cm at flowering and pod formation stages, respectively. These values were observed under the addition of 60 mg N kg^{-1} soil without addition of Rhizobium, at salinity level of 6.10 dSm^{-1}. Similar results were previously observed by **Ibrahim (2002)** who studied the effect of water salinity levels (0, 1000, 2000 and 3000 mg L^{-1}) on common bean plants and found that salinity had a significant reduction in plant height. **Mohamed (2005)** noticed that irrigation of faba bean with saline water at the levels of 1000 and 2000 mg L^{-1} slightly affected all growth parameters. The decrease of these parameters was observed with the 3000 mg L^{-1} salt solution**.**

Concerning the impact of nitrogen fertilization, the data showed that the plant height increased as the addition amounts of mineral-N increased. Also, data showed that Rhizobium increased the effectiveness of N fertilizers and reduced the negative effects of salinity. This increase could result from the increase of the efficiency of photosynthesis pigments, chlorophylls and carotenoids contents. In this respect, **Benizri *et al.* (2001)** found that the rhizo-bacteria improved plant growth and enhanced root development either by producing phytohormones or indirectly by inhibiting pathogens through the synthesis of different compounds. **Dobbelaera *et al.* (2001)** stated that aspergillum is able to promote plant growth in many crops, due to the production of plant growth promoting substances, which leads to an improvement in root development and an increase in the rate of water and mineral uptake**. Lincoln and Edvardo (2006)** found that N supply must be available according to the needs of the plant, hence nitrogen deficiency generally results in stunted growth, chlorotic leaves because the lack of N limits the synthesis of proteins and chlorophyll.

Concerning the highest value of plant height, presented data revealed that the highest values at flowering and pod formation stages 42.12 and 68.38 cm, respectively, were observed under the treatment of 60 mg N kg^{-1} soil+ Rhizobium, when plants were irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. In this respect, **Abdel-Mouty (2000)** found that treating cowpea seed with bio-fertilizer and added mineral-N at rate of 50 g kg^{-1} seeds resulted in the highest values of plant length. **Sobkowicz and Parylak (2002)** investigated the effects of different N levels of 0, 25 and 50 kg ha^{-1} on the growth of faba beans and found that the increasing N application rate increased plant height. **Claudia *et al.* (2019)** found that it even increases abiotic stress, microbial inoculation increases plant height of beans, suggesting that dual inoculation had beneficial effects on bean growth by mitigating salinity stress.

Number of leaves per plant

Concerning the effect of irrigation water salinity, data in Table (7) show that increasing the salinity of irrigation water leads to a decrease in number of leaves, the inhibitory effect of salinity on leaves may be due to the reduced water potential which causes imbalance or disturbance in ion homeostasis and toxicity. In this respect, **Hassan and Mostafa (1994)** found that the deleterious influence of irrigation water salinity on growth could be due to increasing the osmotic pressure to the point which retarded or prevented the intake of water, resulting in water stress in the plant. **Ibrahim (2002)** found that the inhibitory effect of salinity on growth may be due to the decrease in water observation, metabolic processes, meristematic activity and cell enlargement.

Regarding the lowest value of leaves number, the presented data revealed that the lowest values were 5.24 and 8.88 leave plant^{-1} at flowering and pod formation stages, respectively. These values were observed under the addition of 60 mg N kg^{-1} soil without Rhizobium, at salinity level of 6.10 dSm^{-1}. Similar results were previously observed by **Delgado *et al.* (1994)** who found that faba bean and pea plants had a depressive effect of saline due to saline stress and acetylene reduction activity of nodules was directly related to the salt-induced decline in dry weight. **Al-Tahir and Abdulsalam (1997)** found that faba beans were more sensitive to salinity during the vegetative stage and less sensitive at later stage, hence the growth was reduced significantly when the EC of irrigation water was up to 6 dS.m^{-1} and above.

Regarding the impact of nitrogen fertilization, data showed that the number of leaves per plant was generally increased as mineral-N addition level increased. The present data showed that adding Rhizobium to the soil before cultivation enhanced the effectiveness of N fertilizers and lessened the adverse negative effects of salinity. In this regard, **Subba-Rao (1984)** attributed this effect to other factors such as the ability of biofertilizers to synthesize and secrete indole acetic acid, cytokinins, and gibberellin, as well as increasing amino acid content. **Dobbelaera *et al.* (2001)** stated that aspergillum is able to promote plant growth in many crops, due to the production of plant growth promoting substances, which leads to an improvement in root development and an increase in the rate of water and mineral uptake.

Concerning the highest value of number of leaves, the presented data revealed that the highest values at flowering and pod formation stages 8.77 and 15.55 leave plant^{-1}, respectively, were observed under the treatment of 60 mg N kg^{-1} soil+ Rhizobium, when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. In this respect, **Abdel-Mouty (2000)** found that adding nitrogen as chemical fertilizer at a rate of 100 kg fed^{-1} and treating cowpea seed with nitrogen bio-fertilizer at a rate of 50 g kg^{-1} seeds resulted in the highest leaves number per plant. **El-Dsouky (2005)** found that the application of high nitrogen levels of 120 kg N fed^{-1} significantly increased the number of leaves. **Stefan *et al.* (2010)** stated that inoculation of soybeans by *Bacillus pumilus* significantly increased leaf number and nodulation. **Ednângelo *et al.* (2019)** found that the interaction between the salinity levels and mixed biofertilizer doses indicated a significant increase of leaf number of cowpea beans among all the treatments applied.

Dry matter content:

Concerning the effect of irrigation water salinity, data in tables (8 and 9) shows that increasing the salinity of irrigation water leads to a decrease in dry matter content, these decreases are probably due to the plant suffering from osmotic stress, specific ion toxicity, imbalance and oxidative stress. In this respect**, Benlloch *et al.* (2005)** mentioned that salinity stress reduces water potential, causes ion imbalance or disturbance in ion homeostasis and toxicity, this altered water status leads to initial growth reduction and limitation of plant productivity. **Yousif (2007)** revealed that the effect of salinity on growth may be due to the decrease in water observation, metabolic processes, meristematic activity and cell enlargement.

The presented data revealed that the lowest values of dry matter were 0.679, 2.051 and 3.611 at flowering, pod formation and maturity stage, respectively. These values were observed under the addition of 60 mg N kg soil^{-1} without Rhizobium, when plants irrigated with the highest irrigation water salinity of 6.10 dSm^{-1}. These results are in accordance with those found by **Cordovilla *et al.* (1999)** who found that faba bean plants grown under saline levels of 0, 50, 75 and 100 m moles NaCl, significantly decreases shoot and root dry weight. **Ibrahim (2002)** studied the effect of water salinity levels of 0, 1000, 2000 and 3000 mg L^{-1} on common bean plant and found that salinity had a significant reduction in dry weight of plant. **Gaballah and Gomaa (2009)** noted that dry weight of faba bean was reduced under salinity stress conditions mostly at 6000 ppm.

Table 7. Number of leaves per plant at flowering and pod formation stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Flowering stage				Pod formation stage			
	100 % Menial-N without Bio	100 % Menial-N with Bio	75 % Menial-N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial-N with Bio
Control (0.625 dSm^{-1})	7.33	8.77	8.66	7.55	12.66	15.55	14.66	12.89
Level 1 (2.43 dSm^{-1})	7.11	8.44	8.33	7.22	11.99	13.89	13.55	12.66
Level 2 (4.33 dSm^{-1})	5.99	7.39	7.19	6.30	10.59	12.40	11.79	11.19
Level 3 (6.10 dSm^{-1})	5.24	6.48	6.31	5.42	8.88	10.48	10.21	9.06
LSD	**S:** 1.3109	**RN:** 1.3109 2.6217		**S*RN:**	**S:** 1.1850	**RN:** 1.1850 2.3966		**S*RN:**

Table (8) Dry matter content (g $plant^{-1}$) at flowering and pod formation stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Flowering stage				Pod formation stage			
	100 % Menial-N without Bio	100 % Menial-N with Bio	75 % Menial-N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial-N with Bio
Control (0.625 dSm^{-1})	0.875	1.429	1.284	0.989	3.492	3.927	4.286	3.867
Level 1 (2.43 dSm^{-1})	0.838	1.397	1.242	0.961	3.189	3.634	3.939	3.532
Level 2 (4.33 dSm^{-1})	0.786	1.134	1.092	0.915	2.662	3.298	3.537	3.053
Level 3 (6.10 dSm^{-1})	0.679	0.746	0.841	0.905	2.051	2.351	2.717	2.978
LSD	S: 0.1458	RN: 0.1458 0.2915		S*RN:	S: 0.3116	RN: 0.3116		S*RN: 0.623

Table (9) Dry matter content (g $plant^{-1}$) at maturity stage as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / water salinity	Mineral and Bio nitrogen fertilizers			
	Straw yield			
	100 % Menial-N without Bio-N	100 % Menial-N with Bio-N	75% Menial-N with Bio-N	50% Menial-N with Bio-N
Control (0.625 dSm^{-1})	5.116	7.034	6.069	5.580
Level 1 (2.43 dSm^{-1})	4.789	6.586	5.729	5.154
Level 2 (4.33 dSm^{-1})	4.386	5.846	5.316	4.712
Level 3 (6.10 dSm^{-1})	3.611	4.946	4.708	4.462
LSD	**S:** 0.2952	**RN:** 0.2952		**S*RN:** 0.5905

Data also revealed that adding Rhizobium to soil before cultivation increased the efficiency of N fertilizers and minimized the harmful effects of salinity. In this regard, **Zaki *et al.* (2019)** found that the increased plant dry weight was obtained as a result of increase in other growth parameters, especially leaves number; this may be attributed to the increase obtained from the efficiency of photosynthesis pigments, chlorophylls and carotenoids contents.

Regarding the highest values of dry matter content, the presented data revealed that the highest values at flowering and maturity stages (1.429 and 7.034 g plant^{-1}, respectively) were observed under the treatment of 60 mg N kg^{-1} soil+ Rhizobium, when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. While at pod formation stage, the highest value of 4.286 g plant^{-1} was obtained under the treatment of 45 mg N kg^{-1} soil + Rhizobium when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. A similar trend was observed by **Abdel-Mouty (2000)** who found that adding nitrogen as chemical fertilizer at a rate of 100 kg fed^{-1} and treating cowpea seed with nitrogen bio fertilizer at a rate of 50 g seeds resulted in the highest values of dry weight of whole plant. **Gabr *et al.* (2007)** revealed that inoculating pea seeds with the mixture of biofertilizer combined with 90 kg N fed^{-1} to the growing plants gave the best vegetative growth as expressed by plant dry weight. **Daur *et al.* (2008)** studied the effect of different levels of nitrogen on dry matter and observed a significant relation with the increasing N rates between 0 and 200 kg N ha^{-1}. **Abdel Fatah (2017)** noted that the application of recommended N of 15 Kg N fed^{-1} combined with seed inoculation caused significantly increased dry weight of faba bean. **Aung *et al.* (2019)** found that with N supplementation, the biofertilizer application significantly increased the shoot and root growth of cowpea and soybean compared with the control.

Effect of Irrigation Water Salinity and Nitrogen Fertilization on Macronutrients Uptake at Different Growth Stages

Phosphorus uptake

Concerning the effect of irrigation water salinity, data in Tables (10 and 11) shows that increasing the salinity of irrigation water leads to a decrease in phosphorus uptake, this decrease may be attributed to physiological interactivities of a given nutrient resulting in an increase in the plants internal requirement for that essential element. In this respect, **Shehata *et al.* (1994)** stated that the content of phosphorus slightly decreased by salinity conditions relative to the control, and this may be due to the elevation of soil pH which decreased the phosphorus availability for plants. **El-Arqan *et al.* (2002)** reported that phosphorus uptake was decreased by increasing salinity levels, and this indicates that excessive content of Na^+ and Cl^- ions in growth media has an inhibitory effect on the uptake and translocation processes of phosphorus.

Regarding the lowest value of phosphors uptake, the presented data revealed that the lowest values were 2.52 and 6.28 mg P plant^{-1} at flowering and pod formation stages respectively, but at maturity stage the lowest values were 18.32 and 8.37 mg P plant^{-1} at seeds and straw, respectively. These values were observed under the addition of 60 mg N kg^{-1} soil without Rhizobium, when plants irrigated with the highest irrigation water salinity 6.10 dSm^{-1}. These results agree with the findings of **Rabie and Almadini (2005)** who studied the effect of salinity levels up to 6 dSm^{-1} on *Vicia faba* plants and found that phosphorus concentrations in shoots of faba plants were significantly decreased by increasing salinity. **Sadak *et al.* (2010)** found that the seed P content of faba bean seeds was reduced steadily with an increasing salinity level. **Naeem *et al.* (2017)** found that increased Na Cl concentration has been reported to decrease P level in many legume plants. **Ragab (2018)** mentioned that the increase of P content in faba bean plant grown in 50 mM NaCl solution and co-inoculated was significantly different when compared with uninoculated plants.

As for the impact of nitrogen fertilization, data showed that as mineral-N addition level increases, the phosphorus uptake generally increases as well. Also, data showed that adding Rhizobium to soil before cultivation reduced the negative effects of salinity and increased the effectiveness of N fertilizers. This increase may be attributed to biofertilizers improving soil fertility and enhancing nutrients uptake in deficient soil. In this respect, **Tairo and Ndakidemi (2014)** reported that inoculation with Brady rhizobium japonicum strains significantly improved P uptake in cowpea. The increases in phosphorus uptake might be attributed to indirect effects of inoculation that result in increased plant growth rhizosphere activities. **Naeem *et al.* (2017)** found that increased NaCl concentration has been reported to decrease P level in many legume plants.

Data about the impact of nitrogen fertilization showed that as mineral-N addition level increases, the phosphorus uptake generally increases as well. Data also showed that adding Rhizobium to soil before cultivation reduced the negative effects of salinity and increased the effectiveness of N fertilizers. This increase may be attributed to biofertilizers improving soil fertility and enhancing nutrients uptake in deficient soil. **Tairo and Ndakidemi (2014)** reported that inoculation with Brady rhizobium japonicum strains significantly improved phosphorus uptake in cowpea. Increased phosphorus uptake might be attributed to indirect effects of inoculation that result in increased plant growth rhizosphere activities.

Concerning the highest value of phosphors uptake, the presented data revealed that the highest value at flowering stage 10.23 mg P plant^{-1} was observed under the treatment of 60 mg N kg^{-1} soil+ Rhizobium; when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}, at pod formation stage the highest value was 19.47 mg P plant^{-1} obtained under the treatment of 45 mg N kg^{-1} soil $^{+}$ Rhizobium when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. While at maturity stage, the highest values 33.76 and 24.86 mg P plant^{-1} for seeds and straw, respectively, were obtained under the treatment of 45 mg N kg^{-1} soil + Rhizobium when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. Similar results were previously observed by **Mohamed (2005)** who found that the P uptake of faba bean plants significantly increased with an increasing nitrogen level up to 45 kg N fed^{-1}. **Mahmoud *et al.* (2010)** found that the effect of combination of mineral and bio fertilizers in nutritional quality, where the combination of biofertilizer (2 kg ha^{-1} + 280 kg N ha^{-1}) resulted in the highest content of phosphorus (0.38 %) in snap bean plant. **Bayou *et al*. (2020)** found that nitrogen fertilizer application 24.8 kg N ha^{-1} resulted in the highest shoot phosphorus uptake. **Vahid *et al.* (2022)** noted that the application of bio fertilizers enhanced the content of P by 22.7%, when compared with non-fertilized.

Potassium Uptake

Concerning the effect of irrigation water salinity, data in Tables (12 and 13) shows that increasing the salinity of irrigation water leading to a decrease in potassium uptake, this decrease may be due to decrease in the external osmotic potential of the soil solution and an ionic component linked to the accumulation of ions which become toxic at high concentrations. In this respect, **El-Arqan *et al.* (2002)** reported that K uptake was decreased by increasing salinity levels; this indicates that extensive content of Na^+ and Cl^- ions in growth media has an inhibitory effect on the uptake and translocation process of essential nutrients.

Regarding the lowest value of potassium uptake, the presented data revealed that the lowest values were 17.31 and 38.12 mg K plant^{-1} at flowering and pod formation stages, respectively, but at maturity stages were 96.2 and 44.8 mg K plant^{-1} at seeds and straw, respectively. These values were observed under the addition of 60 mg N kg^{-1} soil without Rhizobium, when plants irrigated with the highest irrigation water salinity 6.10 dSm^{-1}. Similar results were noted by **Abdel-Aal (1992)** who revealed that saline water at the levels of 0, 1000, 2000 and 3000 ppm NaCl on was significantly reduced K content of snap bean leaves. **Kaya *et al.* (2001)** found that plants grown in saline media generally exhibit tissue accumulation of Na and Cl and/or inhibition of uptake of mineral nutrients, especially K**. Rabie and Almadini (2005)** studied the effect of salinity levels up to 6 dSm^{-1} on (*Vicia faba)* plants and found that potassium content was decreased with raising salinity levels.

Concerning the effect of nitrogen fertilization, data revealed that increasing addition level of mineral-N generally increased the potassium uptake. Data also indicated that the addition of Rhizobium to soil before cultivation improved the efficiency of N fertilizers and decreased the hazardous effect of salinity. In this respect, **Sherif *et al*. (2007)** found that K uptake in the whole faba bean plants significantly increased due to the interaction between mineral and bio fertilizers. It could be concluded that bio fertilizers improve soil fertility and enhance nutrients uptake in deficient soil, thereby adding in better establishment of plants

Table 10. Phosphorus uptake (mg plant $^{-1}$) at flowering and Pod formation stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Flowering stage				Pod formation stage			
	100 % Menial-N without Bio	100 % Menial-N with Bio	75 % Menial-N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial-N with Bio
Control (0.625 dSm^{-1})	4.62	10.23	7.21	6.31	11.15	12.03	19.47	12.92
Level 1 (2.43 dSm^{-1})	3.93	7.71	7.15	6.03	10.16	11.58	14.82	12.02
Level 2 (4.33 dSm^{-1})	3.72	6.72	5.89	4.57	7.36	9.87	12.37	10.77
Level 3 (6.10 dSm^{-1})	2.52	5.32	5.58	3.55	6.28	8.60	9.72	9.53
LSD	**S:** 0.2163	**RN:** 0.2163		**S*RN**: 0.4326	**S:** 0.3379	**RN:** 0.3379		**S*RN**: 0.6758

Table 11. Phosphorus uptake (mg plant $^{-1}$) at maturity stage as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Seeds				Straw			
	100 % Menial N without Bio	100 % Menial N with Bio	75 % Menial N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial-N with Bio
Control (0.625 dSm^{-1})	23.27	24.95	33.76	28.84	18.97	21.02	24.86	22.52
Level 1 (2.43 dSm^{-1})	21.46	24.18	31.44	27.03	16.76	17.06	21.43	19.87
Level 2 (4.33 dSm^{-1})	20.37	23.72	26.76	24.46	12.96	14.38	18.66	15.25
Level 3 (6.10 dSm^{-1})	18.32	20.87	23.52	21.08	8.37	13.38	14.54	11.26
LSD	**S:**0.4456	**S*RN:** 0.8912	**RN:** 0.4456		**S:** 0.3444		**RN:** 0.3444	**S*RN:** 0.6888

Table 12. Potassium uptake (mg plant $^{-1}$) at maturity stage as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Flowering stage				Pod forming stage			
	100 % Menial-N without Bio	100 % Menial-N with Bio	75 % Menial-N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial N with Bio
Control (0.625 dSm^{-1})	25.31	36.55	31.39	28.11	68.41	77.08	88.51	75.75
Level 1 (2.43 dSm^{-1})	22.88	33.84	30.15	26.65	61.26	70.24	77.75	68.23
Level 2 (4.33 dSm^{-1})	20.88	27.14	26.29	24.45	50.49	61.73	69.32	57.94
Level 3 (6.10 dSm^{-1})	17.31	19.01	20.09	21.29	38.12	43.09	49.93	55.56
LSD	**S:** 0.3756	**S*RN:** 0.7512	**RN:** 0.3756		**S:** 0.4639	**RN:** 0.4639		**S*RN:** 0.9277

Table 13. Potassium uptake (mg plant $^{-1}$) at maturity stage as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / Water salinity	Mineral-N and Bio fertilization							
	Flowering stage				Pod forming stage			
	100 % Menial-N without Bio	100 % Menial-N with Bio	75 % Menial-N with Bio	50 % Menial-N with Bio	100 % Menial-N without Bio	100 % Menial-N with Bio	75% Menial-N with Bio	50% Menial-N with Bio
Control (0.625 dSm^{-1})	153.8	170.9	178.3	172.1	89.5	110.4	134.1	100.1
Level 1 (2.43 dSm^{-1})	135.2	149.5	165.6	155.5	71.8	95.4	110.7	77.4
Level 2 (4.33 dSm^{-1})	116.1	127.4	152.6	136.9	56.8	85.1	96.7	68.3
Level 3 (6.10 dSm^{-1})	96.2	99.9	114.8	128.8	44.8	72.6	80.5	57.7
LSD	**S:** 2.2912 **RN:** 2.2912 **S*RN**: 4.5825				**S:** 0.5349 **RN**: 0.5349 **S*RN:** 1.0697			

Concerning the highest value of potassium uptake, the presented data revealed that the highest value at flowering stage 36.55 mg K plant^{-1} was observed under the treatment of 60 mg N kg^{-1} soil+ Rhizobium; when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}, at pod formation stage the highest value was 88.51 mg K plant^{-1} obtained under the treatment of 45 mg N kg^{-1} soil + Rhizobium when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. While at maturity stage, the highest values 178.3 and 134.1 mg K plant^{-1} at seeds and straw, respectively, were obtained under the treatment of 45 mg N kg^{-1} soil + Rhizobium when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. Similar results were previously observed by **Abdel-Mouty (2000)** who found that the highest percentage of potassium in leaves and shoot tissues of cowpea plant was observed under the addition of nitrogen at a rate of 100 kg fed^{-1} with treating the seeds before sowing with bio-nitrogen fertilizer at a rate of 50 gm kg^{-1} seeds. **Gabr *et al.* (2007)** revealed that the highest mean values for potassium content of leaves were obtained where plants previously inoculated with bio fertilizer and given either 60 or 90 kg N fed^{-1}. **Attia *et al.* (2014)** found that K concentrate and uptake of soybean plants treated with bio fertilizer were higher as compared with untreated plants. **Ethan *et al.* (2023)** found that the uptake of K significantly increased with application of mineral N at the rate of 50 kg^{-1} ha for forage legumes.

Effect of Irrigation Water Salinity and Nitrogen Fertilization on Yield Components

Number of pods per plant

Concerning the effect of irrigation water salinity, data in Table (14) shows that increasing the salinity of irrigation water leads to a decrease in pods number per plant. In this regard, **Benlloch *et al.* (2005)** found that salt stress reduces water potential and causes ion imbalance or disturbance ion homeostasis and toxicity, and this altered water status leads to limitation of plant productivity.

The lowest value of pods number revealed that the lowest value was 2.167 pod plant^{-1}. This value was observed under the addition of 60 mg N kg^{-1} soil without Rhizobium, when plants irrigated with the highest irrigation water salinity

6.10 dSm^{-1}. Similar results were previously observed by **Pascal *et al.* (1999)** who studied the effect of salinity levels on yield components of *phaseolus vulgaris* plants and found that numbers of pods decreased with increasing salinity level from 0.125 to 1.00 NaCl. **Mohamed (2005)** noted that the number of pods per plant of faba bean plant decreased significantly by increasing irrigation water salinity from 1000 up to 3000 mg L^{-1} as compared to the control treatment. **Zaki *et al.* (2019)** mentioned that the number of pods decreased from 10.6 to 6.4 $plant^{-1}$ under salt stress compared to control.

Regarding the impact of nitrogen fertilization, results showed that the pods number generally elevated as mineral-N addition levels increased. The data also showed that adding Rhizobium to soil before cultivation reduced the negative effects of salinity and increased the effectiveness of N fertilizers. These increases might be explained on the basis that the promoting effects of biofertilizer and nitrogen together on growth of pea plants were reflected in the increase of yield components. In this respect, **Ali and Raouf (2011)** found that interactions between mineral-N fertilizer and Rhizobium inoculations significantly increased the total number of pods per plant. **Aung *et al.* (2019)** found that the biofertilizer significantly increased the number of pods per pot in soybean compared with the control.

Concerning the highest value of pods number, the presented data reveal that the highest value 6.332 pod $plant^{-1}$ was observed under the treatment of 45 mg N kg-1 soil+ Rhizobium, when plants irrigated with the lowest irrigation water salinity 0.625 dSm^{-1}. A similar trend was observed by **Edje *et al.* (1975)** who studied the responses of dry beans to six levels of nitrogen viz 0, 40, 80, 120, 160 and 200 kg ha^{-1}, and found that the number of pods per plant as an expression for the yield components increased. **Zhang *et al.* (2002)** reported that *B. japonicum* bacteria increased the number of pods per plant in two soybean cultivars. **Gabr *et al*. (2007)** indicated that the number of pods $plant^{-1}$ significantly increased through the inoculation of seeds with different bio fertilizers and different N levels compared to the control treatment.

Table 14. Pods number per plant as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / water salinity	Mineral and Bio nitrogen fertilizers			
	Pods number			
	100 % Menial-N without Bio-N	100 % Menial-N with Bio-N	75% Menial-N with Bio-N	50% Menial-N with Bio-N
Control (0.625 dSm^{-1})	5.368	6.032	6.332	5.767
Level 1 (2.43 dSm^{-1})	4.226	4.534	4.666	4.440
Level 2 (4.33 dSm^{-1})	3.000	3.439	3.769	3.169
Level 3 (6.10 dSm^{-1})	2.167	2.313	2.367	2.210

Number of seeds per plant

Concerning the effect of irrigation water salinity, data in Table (15) shows that increasing the salinity of irrigation water leads to a decrease in seeds number. In this regard, **Salter *et al.* (2007)** noticed that increasing sea water salinity level reduced the absorption of water leading to a drop in water content of tested plants. The inhibitory effect of sea water on growth parameters could be attributed to the osmotic effect of sea water salinity. **Sakr and El-Metwally (2009)** indicated that salinity stress effects on soybean yield components. The depression effects of salinity on grains may be due to decreasing the leaf area and number per plant, resulting in reduction supply of carbon assimilate due to decreasing the net photosynthetic rate and biomass accumulation.

Regarding the lowest value of seeds number, the presented data revealed that the lowest value was 6.65 seeds plant^{-1}. This value was observed under the addition of 60 mg N kg^{-1} soil without Rhizobium, when plants irrigated with irrigation water salinity of 4.33 dSm^{-1}. In agreement with the results obtained, **Gabr *et al.* (2007)** indicated that the number of seeds pod^{-1} was significantly increased through the inoculation of seeds with different biofertilizers and different N levels compared to the control treatment.

Concerning the impact of nitrogen fertilization, results showed that the seeds number generally elevated as mineral-N addition levels increased. The data also showed that adding Rhizobium to soil before cultivation reduced the negative effects of salinity and increased the effectiveness of N fertilizers. **Al-Zubaidi (2024)** found that treatment with biofertilizer increased seeds number of broad bean plant, it may be due to expanding the root system and increasing the absorption of water and nutrients from the soil, enhancing plant growth and increasing its ability to produce seeds

Regarding the highest value of seeds number, the presented data revealed that the highest value of 10.61 seeds plant^{-1} was observed under the treatment of 45 mg N kg^{-1} soil+ Rhizobium, when plants irrigated with the lowest irrigation water salinity 6.10 dSm^{-1}. In this respect, **Simon (1979)** found that using nitrogen fertilizer to pea plants from 0 up to 200 kg N ha^{-1} increased the number of seeds per pod. **Zeidan *et al.* (2001)** reported that the application of biofertilizer with chemical fertilizer resulted in the highest increase of seeds per faba bean plant. **Kazemi *et al.* (2005)** stated that soybean seed inoculation by rhizobia bacteria significantly increased the number of seeds per plant. **Mahmoud (2009)** found that the seed number for plants inoculated with rhizobium and uninoculated soybean were 82.73 and 74.80 seeds plant^{-1}, respectively.

Weight of 100 seeds:

Concerning the effect of irrigation water salinity, data in Table (16) shows that increasing the salinity of irrigation water leads to a decrease in weight of 100 seeds, this increase may be due to salinity stress affecting all stages of soybean growth as well as yield components. In this respect, **Wang *et al.* (2014)** found that salinity decreased photosynthesis performance of salt stressed seedling possibly offered an explanation that diminished exploits of energy toward sustaining photochemical reactions.

Regarding the lowest value of weight of 100 seeds, the presented data reveal that the lowest was 36.57 g., this value was observed under the addition of 60 mg N kg^{-1} soil without Rhizobium, when plants irrigated with the highest irrigation water salinity of 6.10 dSm^{-1}. These results are in accordance with those found by **Banuelos (2001**) who investigated the response of faba beans to irrigation with saline waters and the results showed that the yield of faba beans decreased with increasing salinity levels due to the sensitivity of faba beans to salinity. **Zaki *et al.* (2019)** mentioned that 100 seed weight was reduced from 10.7 to 5.9 under salt stress treatment compared to control. **Abd El-Ghany and Magdy (2020)** study the inoculation of broad bean seeds with bacteria under saline conditions and found that the lowest averages of 100 seed weight under saline condition was 62.3 g, while the plants grown under non-saline conditions displayed value of 74.42 g.

Table 15. Seeds number per plant as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / water salinity	Mineral and Bio nitrogen fertilizers			
	Seeds number			
	100 % Menial-N without Bio-N	**100 % Menial-N with Bio-N**	**75% Menial-N with Bio-N**	**50% Menial-N with Bio-N**
Control (0.625 dSm^{-1})	7.33	8.49	8.52	8.49
Level 1 (2.43 dSm^{-1})	6.98	8.47	8.66	8.23
Level 2 (4.33 dSm^{-1})	6.65	9.01	9.45	7.58
Level 3 (6.10 dSm^{-1})	7.71	10.48	10.61	7.62

Table 16. Weight of the 100 seeds (g) as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / water salinity	Mineral and Bio nitrogen fertilizers			
	100 % Menial-N without Bio-N	**100 % Menial-N with Bio-N**	**75% Menial-N with Bio-N**	**50% Menial-N with Bio-N**
Control (0.625 dSm^{-1})	56.91	60.64	72.42	67.90
Level 1 (2.43 dSm^{-1})	52.94	54.90	67.55	63.33
Level 2 (4.33 dSm^{-1})	48.09	51.15	58.18	54.55
Level 3 (6.10 dSm^{-1})	36.57	40.16	45.24	42.49

Regarding the impact of nitrogen fertilization, the results showed that the weight of 100 seeds generally elevated as mineral-N addition levels increased. The data also showed that adding Rhizobium to soil before cultivation reduced the negative effects of salinity and increased the effectiveness of N fertilizers.

Saharan and Nehra (2011) found that plant growth promoting rhizobium has been direct facilitating the proliferation of their plant hosts. These synthesize enzymes that can modulate plant growth and development.

Concerning the highest value of weight of 100 seeds, the presented data revealed that the highest value 72.42 g was observed under the treatment of 45 mg N kg^{-1} soil+ Rhizobium, when plants irrigated with the lowest irrigation water salinity of 0.625 dSm^{-1}. A similar trend was observed by **Metwally (1997)** who revealed that 100 seed weight of faba beans were markedly increased with raising nitrogen rate up to 45kg N fed^{-1}. **Azarpour *et al*. (2011)** reported that the effect of nitrogen fertilization treatments on faba bean 100 seeds weight had significant differences at 1% probability level. **Abdel Fatah (2017)** found that there is significantly difference were found of 100 seed weights between faba bean varieties

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الزراعة المستدامة للفول البلدى باستخدام مياه البحر المخففة فى الرى مع التسميد النيتروجينى المعدنى والحيوى

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أجريت تجربة أصص لدراسة إمكانية إستخدام مياه البحر المخففة فى رى نباتات الفول البلدى (*Vicia faba L.*) ، وذلك تحت تأثير مستويات مختلفة من التسميد النيتروجينى المعدنى والحيوى بهدف تقليل التأثير الضار لملوحة مياه الرى ورفع كفاءة التسميد النيتروجينى المعدنى . التركيزات المختلفة لملوحة مياه الرى تحت الدراسة " 2.43 - 4.33 - 6.10 ديسى م$^{-1}$ " تحصل عليها بتخفيف مياه البحر، بالإضافة إلى مياه عذبة تركيز الأملاح بها " 0.625 ديسى م$^{-1}$". أضيف النيتروجين المعدنى على صوره نترات أمونيوم بمعدلات 60 ، 45 ، 30 مللجم نيتروجين كجم تربة$^{-1}$. التسميد الحيوى تحصل عليه بإضافة " العقدين " الذى أضيف قبل الزراعة و تم خلطه جيداً بالطبقة السطحية للتربة . أخذت العينات النباتية خلال مراحل النمو المختلفة : مرحلة التزهير " بعد 45 يوم من الزراعة " ، مرحلة تكوين القرون " بعد 75 يوم من الزراعة " ، ومرحلة النضج " بعد 140 يوم من الزراعة ".

أوضحت النتائج أنه :

خلال مرحلة التزهير تحصل على أعلى قيمة لطول النبات ، عدد الأوراق لكل نبات ، محتوى النبات من للمادة الجافة، وكذلك محتوى النبات من الفوسفور ، والبوتاسيوم نتيجة المعاملة "60 mg N kg^{-1} soil + Rhizobium" .

خلال مرحلة تكوين القرون تحصل على أعلى قيمة لطول النبات، وعدد الاوراق لكل نبات نتيجة المعاملة " 60 mg N kg^{-1} soil + Rhizobium" ، بينما أعلى قيمة تحصل عليها لمحتوى النبات من المادة الجافة ، وكذلك محتوى النبات من الفوسفور والبوتاسيوم تحصل عليها نتيجة المعاملة (45 mg N kg^{-1} soil + Rhizobium) .

خلال مرحلة النضج تحصل على أعلى قيمة لمحتوى النبات من المادة الجافة نتيجة المعاملة " 60 mg N kg^{-1} soil+ Rhizobium " ، بينما أعلى قيمة لمحتوى النبات من الفوسفور ، والبوتاسيوم ، وكذلك عدد القرون لكل نبات تحصل عليها عند المعاملة (45 mg N kg^{-1} soil + Rhizobium) .

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