International Journal of Multiphysics
Volume 18, No. 3, 2024
ISSN: 1750-9548

Nutrient Uptake by Broad Bean as Affected by Mineral and Bio Nitrogen Fertilization Under Saline Conditions

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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 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 dos which is 60 kg^{-1} N Fed^{-1}. Bio fertilization was achieved through the addition of rhizobium which was thoroughly mixed with surface soil. Plant samples collection was done along three different growth stages i.e. 45, 75 and 140 days from sowing representing flowering, pod formation and maturity stages, respectively. Results show that, at flowering stage the highest values of plant dry matter content; N uptake; protein content; and uptake of Fe, Mn, and Zn were observed under the treatment of 60 mg N kg^{-1} soil+ Rhizobium. While at pod formation stage the highest values 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 N uptake; protein content; and uptake of Fe, Mn, and Zn; as well as seeds yield were obtained under the treatment of 45 mg N kg^{-1} soil + Rhizobium.

Key words: Salinity - nitrogen bio fertilization – nutrient uptake - broad bean

INTRODUCTION

Since agricultural production is greatly limited worldwide by shortage of water, the availability of high-quality irrigation water is anticipated to decline in the future, as the creation of new water resources will not match the rising water demands for agricultural purposes. Increased interest is being developed in using saline water for irrigation.

High salinity stress greatly hampers plant growth due to various factors, including osmotic stress, imbalances in nutrient absorption, and toxicity from specific ions, all of which lead to reduced nutrient uptake and result in physiological drought in plants **(Ahmad *et al.*,2016)**.

As a leguminous crop, faba beans are essential for sustainable farming, as they enhance soil fertility and lessen the reliance on synthetic fertilizers **(Crews and Peoples, 2005)**. The faba bean has a higher protein content than most pulses, including peas, chickpeas, lentils, and beans **(Raikos et al, 2014)**.

The intensive use of N-mineral 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 tolerant salt stress (**IFIA, 2000**).

Biofertilizer inoculation can lower the need for mineral fertilizers and considered as 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).**

The study aimed 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 dry matter content, nutrients uptake, yield quality and productivity of broad bean plants.

MATERIALS AND METHODS

A pot experiment was conducted under greenhouse conditions using broad been plant (*Vicia faba L.*) Soil sample was collected from Abu Hammed, Sharkia. Physical and chemical properties of soil used are shown in Table (1). The soil texture was sandy clay loam contented 3.28 g $100g^{-1}$ soil calcium carbonate, 0.595g 100g $soil^{-1}$ organic matter, pH 7.93, and Electrical conductivity of 1.23 dSm^{-1}. Irrigation water salinity was achieved by diluted sea water 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 fresh water used are shown in Table (2). 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 dos which is 60 kg^{-1} N fed^{-1}.

Bio fertilization was achieved through the addition of rhizobium which was thoroughly mixed with surface soil. Plant samples collection was done three different growth stages i.e. 45, 75 and 140 days from sowing corresponding to flowering stage, pod formation stages and maturity stages, respectively.

Table (1) Physical properties, chemical properties and nutrients concentration of the soil used

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

Chemical properties									
pH*	**EC***	**Soluble ions (mmol) ***							
		Cations				**Anions**			
		Na^+	**K^+**	**Ca^{2+}**	**Mg^{2+}**	**HCO_3^-**	**CO_3^{2-}**	**Cl^-**	**SO_4^{2-}**
12.5	1.23	6.75	1.15	2.65	2.10	8.05	Nil	2.85	1.75

Macro and micro nutrients concentration					
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 (2) Chemical analysis of sea water and irrigation water salinity at different levels

Type of water		**pH**	**EC ($dS\ m^{-1}$)**	**Cations (mmol)**				**Anions (mmol)**			
				Na^+	**K^+**	**Ca^{2+}**	**Mg^{2+}**	**HCO_3^-**	**CO_3^{2-}**	**CL^-**	**SO_4^{2-}**
Sea water		7.3	51.7	462.4	17.2	20.9	34.5	5.2	Nil	456.3	73.5
Irrigation water	**Wellwater**	7.85	0.625	2.95	0.35	0.80	2.46	1.98	Nil	2.50	2.08
	Salinity Level 1	8.06	2.43	13.11	0.58	2.81	9.41	4.27	Nil	13.94	7.70

	Salinity Level 2	8.09	4.33	18.95	0.79	8.43	16.10	9.14	Nil	21.91	13.22
	Salinity Level 3	8.12	6.10	26.18	1.07	11.96	23.06	12.18	Nil	29.16	20.93

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 extract using the stander methods described by **Jackson (1973).** Organic matter was determined by Walkley and black methods according to **Page (1982).** Available nitrogen was determined by steam - distillation procedure using MgO-Devardah 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_e) and PH, as well as Soluble cations and anions were determined according to **Chapman and Pratt (1978).**

Cultivation: Seven kg of air-dried soil were placed into closed-bottom plastic pots with internal measurements of 25 and 20 cm. Six seeds of broad been were sown; and at the stage of fully opening of the first leaf, the seedlings were thinned to be three homogenous plants per pot. Soil moisture content was adjusted to be around the soil field capacity.

Plant analysis: Plant samples were collected at different growth stages and wet digested to determine total nitrogen content using micro- Kjeldahl method as described by **Chapman and Pratt (1978).** Yield quality "protein content" was calculated by N content of seeds × 6.25 according to **Bishni and Hughes (1979).** Micro nutrients (Fe, Zn and Mn) were extracted by digestion with conc. H_2SO_4 + $HCLO_4$ and measured by ICP according to **Chapman and Pratt (1978).**

Dray matter content was conducted at the three different growth stages; and seed yield was detected at harvest stage.

Statistical analysis: Data was analyzed according to **Snedecor and Cochran (1988).** The significance level for the Differences (LSD) test was set at 0.05 as described by **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 GROTH AT DIFFERENT STAGES:

Dry matter content:

Regarding the effect of irrigation water salinity, the data in Tables (3 and 4) show that raising the irrigation water salinity leads to a decrease in dry matter content, this decreases probably due to the plant suffering from osmotic stress, specific ion toxicity, imbalance and oxidative stress. In this context, **Benlloch et al. (2005)** pointed out that salinity stress results in a decrease in water potential, creates ion imbalance or disrupts ion homeostasis, and leads to toxicity. This change in water status results in an initial reduction in growth and restricts plant productivity. **Yousif (2007)** indicated that salinity's impact on growth may arise from diminished water absorption, metabolic disruptions, reduced meristematic activity, and less cell expansion.

The lowest values of dry matter content presented data reveal that the lowest values 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^{-1} soil without Rhizobium, when plants irrigated with the highest irrigation water salinity

6.10 dSm^{-1}. These results are in accordance with those found by **Cordovilla *et al.* (1999)** who found that in faba bean plant grown under saline levels of 0, 50, 75 and 100 m mole NaCl, salinity significantly decreased shoot and root dry weight and mean nodule 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)** observed that the dry weight of faba bean significantly decreased under salinity stress, particularly at 6000 ppm.

Concerning the effect of nitrogen fertilization, data revealed that increasing addition level of mineral-N generally increased the dry matter content. 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, probably due to the ability of bio fertilizers to increase amino acid content. In this context, [**Zaki et al. (2019)** demonstrated that the rise in plant dry weight was linked to an increase in various growth factors, particularly the number of leaves, which they attributed to enhanced efficiency of photosynthetic pigments, including chlorophyll and carotenoids, as well as chlorophyll content itself.

Table (3) 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	1.379	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 **S*RN:** 0.2915				**S:** 0.3116 **RN:** 0.3116 **S*RN:** 0.6231			

Table (4) 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	5.116	7.034	6.069	5.580

(0.625 dSm^{-1})				
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	

The highest values of dry matter content presented data reveal 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 **Ishaq (2002)** reported that inoculation of pea seeds with bio fertilizer and application of 40 Kg N fed^{-1} gave the best results of dry matter content of leaves and stems**. Gabr *et al.* (2007)** revealed that inoculating pea seeds with the mixture of bio fertilizer combined with 90 Kg N fed^{-1} gave the best vegetative growth as expressed by plant dry weight. **Abdel Fatah (2017)** noted that the application recommended N dose of 15 Kg N fed^{-1} combined with seed inoculation caused significantly increased dry weight of faba bean. **Aung *et al.* (2019)** discovered that nitrogen supplementation significantly promoted the growth of both shoot and root systems in cowpea and soybean when biofertilizers were applied, compared to the control group.

EFFECT OF IRRIGATION WATER SALINITY AND NITROGEN FERTILIZATION ON NITROGEN UPTAKE AT DIFFERENT GROWTH STAGES:

Nitrogen uptake:

Concerning the effect of irrigation water salinity, data in Table (5) show that increasing the salinity of irrigation water leads to a decrease in nitrogen uptake. These decreases, probably due to the harmful effect of salinity on nitrogen uptake could be attributed to a disruption of the physiological processes of absorption of nitrogen. In this regard, **Lea-cox and Syvertsen (1993)** reveal that the reduction in N content of plants induced by salinity stress may be attributed to the antagonism between Cl^- and NO^{3-} for uptake or to the salinity effect on reduced water uptake.

Table (5) Nitrogen uptake (mg plant^{-1}) at different growth stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen Fertilization / Water salinity	Mineral-N and Bio fertilization							
	100 % Mineral-N without Bio	**100 % Mineral-N with Bio**	**75 % Mineral-N with Bio**	**50 % Mineral-N with Bio**	**100 % Mineral-N without Bio**	**100 % Mineral-N with Bio**	**75% Mineral-N with Bio**	**50% Mineral-N with Bio**
	Flowering stage				**Pod formation stage**			
Control	46.2	62.5	50.7	47.5	93.4	103.8	125.5	101.3

(0.625 dSm^{-1})								
Level 1 (2.43 dSm^{-1})	42.6	58.8	48.4	45.7	85.6	98.1	112.2	93.4
Level 2 (4.33 dSm^{-1})	37.8	53.7	46.2	40.9	76.6	85.6	100.4	81.7
Level 3 (6.10 dSm^{-1})	30.9	38.1	42.4	45.3	59.6	65.9	70.7	79.6
LSD	**S**: 0.4695 **RN**: 0.4695 **S*RN**: 0.9318				**S**: 0.6257 **RN**: 0.6257 **S*RN**: 1.2513			
	Maturity stage (Seeds)				**Maturity stage (Straw)**			
Control (0.625 dSm^{-1})	155.2	159.6	176.5	163.1	117.2	145.8	170.2	126.8
Level 1 (2.43 dSm^{-1})	143.5	149.7	159.1	154.6	86.7	133.5	151.8	106.9
Level 2 (4.33 dSm^{-1})	127.1	135.1	146.6	143.6	68.8	118.3	130.7	86.1
Level 3 (6.10 dSm^{-1})	119.5	122.4	130.8	137.7	51.7	99.8	103.7	62.1
LSD	**S:** 0.6001 **RN:** 0.6001 **S*RN:** 1.2003				**S:** 1.2080 **RN:** 1.2080 **S*RN:** 1.4159			

Gama *et al.* (2007) stated that plants subjected to saline conditions experience stress primarily due to a decrease in water potential in the root zone, resulting in water scarcity; toxicity from ions like Na^+ and Cl^-; and nutrient imbalances caused by reduced nutrient uptake. **Talaat *et al.* (2014)** found that nitrogen concentration was significantly decreased in shoots of common bean plants untreated with microorganisms and grown under different salinity levels**,** this reduction has been linked to an imbalance of ions, lack of nutrients, and toxicity from specific ions.

The lowest value of nitrogen uptake presented data revealed that the lowest values were 30.9 and 59.6 mg $plant^{-1}$ at flowering and pod formation stages, respectively, but at maturity stage the lowest values were 119.5 and 51.7 mg plant $^{-1}$ at seeds and straw, respectively, and 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 are in accordance with those found by **Abdel-Aal (1992)** who studied the effect of saline water levels of 0, 1000, 2000 and 3000 ppm NaCl on snap bean plant, and found that the contents of N contents in the leaves were significantly reduced as the level of salinity increased. **Rabie and Al madini (2005)** studied the effect of salinity levels up to 6 dSm^{-1} on faba bean plants and observed that nitrogen levels were significantly affected by rising salinity, resulting in a decrease of 64% at elevated salinity levels. **Mohamed (2005)** found that irrigation with saline water at the levels of 1000, 2000 and 3000 mg L^{-1} slightly decreased the average values percentage of N in faba bean.

Regarding the effect of nitrogen fertilization, data emphasized the positive effect of increasing the addition level of mineral-N on increasing the nitrogen uptake. Data also revealed that adding Rhizobium to soil before cultivation increased the efficiency of N fertilizers and minimized the harmful effects of salinity. The increases in N uptake resulted from increasing of irrigation water salinity may be attributed to ionic imbalance, nutrient deficiency and specific ion toxicity. In this regard, **Sherif *et al.* (2007)** noticed that N uptake of faba bean plants was significantly increased by the interaction between mineral and bio fertilizers, probably due to the improving effect of bio fertilizers on soil fertility and enhance nutrients uptake in deficient soil. **Nabil and Talaat (2007)** stated that inoculation with bio fertilizers increased nitrogen content of faba bean plants compared to the control treatment, increasing plant nutrients content due to inoculation with bio-fertilizer is Probably due to the relationship between the microorganisms and plants.

Concerning the highest value of nitrogen uptake, presented data reveal that the highest value at flowering stage 62.5 mg N 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 125.5 mg N 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 176.5 and 170.2 mg N 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}. A similar pattern was noted by **Gabr et al. (2007)**, who examined the combined effects of biofertilizer and nitrogen fertilizer rates on the chemical composition of pea plants, and found that the highest nitrogen content in leaves was recorded in plants that had been inoculated with a mixed biofertilizer and received either 60 or 90 Kg N fed^{-1}. **Abdel Fatah (2017)** found that faba bean plants treated with 15 kg N fed^{-1} combined with rhizobia strains gave higher N content. According to **Bayou et al. (2020)**, the inoculation with a rhizobium strain led to a substantial increase in nitrogen absorption compared to the plants that were not inoculated. **Vahid *et al.* (2022)** noted that the application of biofertilizers enhanced the content of N by 12%, when compared with the control plants.

EFFECT OF IRRIGATION WATER SALINITY AND NITROGEN FERTILIZATION ON SEEDS PROTEIN CONTENT:

Protein content:

Regarding the effect of irrigation water salinity, data in Table (6) show that increasing the salinity of irrigation water leads to a decrease in protein content. This result was similar to those found by **Abou Zeid and Hassan (2011)** who observed a decrease in protein content of faba bean plants grown under salinity stress. **Mahmoud (2017)** observed a significant reduction in the total protein content of the stem and leaves of faba bean as the salinity levels in the plants increased.

Table (6): Yield quality (g plant $^{-1}$) as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / water salinity	Protein content			
	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})	0.971	0.997	1.103	1.019
Level 1 (2.43 dSm^{-1})	0.896	0.935	0.994	0.966
Level 2 (4.33 dSm^{-1})	0.794	0.844	0.916	0.897
Level 3 (6.10 dSm^{-1})	0.746	0.765	0.817	0.860

The lowest value of protein content presented data reveals that the lowest value was 0.746 g 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}. These results are in accordance with those found by **Gloria (2010)** found that protein content significantly decreased under salinity stress in plants treated with 8 mM of sodium chloride. **Mahmoud (2017)** found that total protein content in faba bean plants markedly decreased in stem and leaves with increasing salinity level. **Zaki *et al.* (2019)** found that seed protein content was decreased from 31.2 to 23.8 % under salt stress compared to control**.**

Concerning the effect of nitrogen fertilization, data revealed that increasing addition level of mineral-N generally increased the protein content. 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.

The increases of protein content may be attributed to physio-biochemical attributes affected by salinity stress in different plants including protein synthesis and

phytohormone regulation. **Attia *et al.* (2014)** stated that protein content of grains in soybeans under saline conditions combined with bio fertilizer were higher than without bio fertilizer. This trend could be attributed to the disturbance in nitrogen metabolism or to inhibition of nitrate absorption resulting from salinity effect.

The highest value of protein content presented data reveal that the highest value 1.103 g 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 **Mahmoud *et al.* (2010)** who found that the combination of mineral and bio fertilizers resulted in the highest protein content of bean plants**. Nicolás et al, (2011)** found that bio fertilizer application increased protein content of bean plant by 21.6 % compared with the control. **Marius *et al.* (2013)** found that bean plants inoculated with plant growth promoting rhizobium showed higher seed protein content compared to control plants. **Fuskhah and Darmawati (2019)** found that inoculation with Rhizobium has been able to increase crude protein content of soybeans significantly and decreased the hazardous effect of salinity, and this increases may be attributed to physio-biochemical attributes affected by salinity stress in different plants including protein synthesis and phytohormone regulation.

EFFECT OF IRRIGATION WATER SALINITY AND NITROGEN FERTILIZATION ON MICRO NUTRIENT UPTAKE AT DIFFERENT GROWTH STAGES:

Iron uptake:

Concerning the effect of irrigation water salinity, data in Table (7) show that increasing the salinity of irrigation water leads to a decrease in iron uptake. These decreases are probably due to saline conditions, drastically changing the environment of root aeration, osmotic potential of soil solution and normal equilibrium of the dissolved ions. In this respect, Hassan and Mostafa (1994) discovered that the detrimental effects of water salinity could be due to increasing the osmotic pressure which retarded or prevented the intake of water, resulting in water stress in the plant. **Taie *et al.* (2013)** found that the increasing salinity level caused gradual decreases in Fe concentration in faba bean shoots, probably because the solubility of Fe is particularly low under such conditions. **El-Fouly and Abou El-Nour (2021)** concluded that under salinity conditions, the uptake of Fe showed great reduction in stem Fe uptake and the reduction was around 11% as compared with those plants growing under normal conditions.

The lowest value of iron uptake presented data reveals that the lowest values were 55.2 and 183.2 µg Fe plant^{-1} at flowering and pod formation stages, respectively, but at maturity stage the lowest values were 423.7 and 325.6 µg Fe 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 agreed with the findings of **Talaat and Abdallah (2008)** found that Fe concentration was significantly decreased in shoots and seeds of bean plants as affected by different salinity levels. **Abd Elhamid *et al.* (2013)** found that increasing salinity level caused gradual decreases in Fe^{2+} concentration in faba bean shoots.

Regarding the impact of nitrogen fertilization, the data showed that as mineral-N addition level increases, the iron 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. The increases of iron uptake resulted from increasing of irrigation water salinity may be attributed to **Goel *et al.* (1999)** reported that the increase in Fe concentration is mainly due to the action of biofertilizers that rendered most micronutrients in the available form**. Abdel Elah (2004)** discovered that the addition of chemical fertilizer for broad bean plant caused a significant increase in Fe of seeds tissue; this may be attributed to its availability and solubility, which in turn to present the N with enough quantity in the suitable time. **El-Rys (2012)** observed that applied N-fertilizers singly or combined with biofertilizers to legumes increased Fe uptake. **Ethan *et al.* (2023)** found that N-fertilizer application increased uptake of Fe concentration of forage legumes. The improved Fe uptake could primarily be explained by improved resource allocation under N-fertilization.

Table (7) Iron uptake (mg plant^{-1}) at different growth stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen Fertilization / Water salinity	Mineral-N and Bio fertilization							
	100 % Mineral -N without Bio	100 % Mineral -N with Bio	75 % Mineral -N with Bio	50 % Mineral -N with Bio	100 % Mineral -N without Bio	100 % Mineral -N with Bio	75% Mineral -N with Bio	50% Mineral -N with Bio
	Flowering stage				Pod formation stage			
Control (0.625 dSm^{-1})	76.2	122.6	95.5	85.5	298.4	328.7	358.8	308.3
Level 1 (2.43 dSm^{-1})	73.4	88.2	83.5	79.5	221.5	273.6	287.2	253.7
Level 2 (4.33 dSm^{-1})	68.1	83.3	80.6	72.6	193.8	259.7	260.8	231.6
Level 3 (6.10 dSm^{-1})	55.2	80.4	78.6	57.2	183.2	228.8	242.3	190.6
LSD	**S:** 0.8148 **RN:** 0.8148 **S*RN:** 1.6295				**S:** 1.8420 **RN:** 1.4820 **S*RN:** 3.6840			
	Maturity stage (Seeds)				Maturity stage (Straw)			
Control (0.625 dSm^{-1})	743.7	842.2	984.2	918.8	513.2	669.1	759.2	603.6
Level 1 (2.43 dSm^{-1})	589.2	620.7	939.3	785.2	491.8	601.7	634.4	588.7
Level 2 (4.33 dSm^{-1})	465.8	519.4	766.7	669.5	460.2	598.2	620.4	516.5
Level 3	423.7	458.3	571.1	652.7	325.6	567.7	601.1	408.3

(6.10 dSm^{-1})								
LSD	**S**: 0.7219 **RN**: 0.7219 **S*RN**: 1.4438				**S**: 0.7644 **RN**: 0.7644 **S*RN**: 1.5288			

Given the data, the greatest value of iron uptake at flowering stage 122.6 µg Fe $plant^{-1}$ 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}. While at pod formation stage the highest value was 358.8 µg Fe $plant^{-1}$ and at maturity stage 984.2 and 759.2 µg Fe $plant^{-1}$ 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 **Daniel and Patrick (2014)** found that inoculation of B. japonicum significantly increased Fe uptake in the roots of cowpea grown in the screen house experiments by 32.2%. **Ibrahim et al. (2019)** found that Fe uptake increased significantly in common bean plants were inoculated with different biofertilizers.

Manganese uptake:

Concerning the effect of irrigation water salinity, data in Table (8) show that increasing the salinity of irrigation water leading to a decrease in manganese uptake. In this respect, **Grattan and Grieve (1994)** reported that the adverse effect of salinity may result from the effect on nutrient availability, competitive uptake, transport or partitioning within the plant. **Page *et al.* (1990)** found that in saline conditions, the solubility of Mn is particularly low and plants growing on such conditions often experience deficiencies in this element. **Salter *et al.* (2007)** noticed that the inhibitory effect of sea water could be attributed to the osmotic effect of sea water salinity.

The lowest value of manganese uptake, presented data revealed that the lowest values were 34.8 and 117.1 µg Mn $plant^{-1}$ at flowering and pod formation stages, respectively, but at maturity stage the lowest values were 262.7 and59.4 µg Mn $plant^{-1}$ 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 are in accordance with those found by **Sadak *et al.* (2010)** reported that seed Mn content of faba bean seeds were reduced steadily with increasing salinity levels. According to **Talaat et al. (2014)**, the concentration of Mn in the seeds and shoots of untreated common bean plants was significantly lower at varying salinity levels, but the concentration was higher in the seeds of treated plants. Regarding the impact of nitrogen fertilization, results showed that the manganese uptake 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. In this respect, **Thomson *et al.* (2008)** found that shoot Mn concentrations were higher for bean plants supplied with NH^{4+}-N. The only possible explanation for the increased Mn uptake by plants is rhizosphere acidification. **Sohrabi *et al.* (2012)** discovered that using nitrogen fertilizer enhanced the Mn concentration in soybean seeds, suggesting that nitrogen fertilizer may aid in the absorption of Mn by the roots and its movement from roots to shoots, resulting in higher Mn levels in the soybeans.

Regarding the peak manganese uptake, the data presented indicate that the highest value at flowering stage 72.4 µg Mn $plant^{-1}$ 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}. While at pod formation stage the highest value was 241.8 µg Mn $plant^{-1}$ and at maturity stage 493.4 and 223.3 µg Mn $plant^{-1}$ 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 **Nasef *et al.* (2006)** found that inoculation of seeds with N-fixing rhizobia increased Mn uptake in straw and seeds. **Jamal and Abdolmajid (2012)** reported that nitrogen application significantly raised Mn concentration by 37.61% and 87.06% at the application levels of 75 and 150 mg N, respectively, when compared to the control treatment**. Bogdan *et al.* (2020)** noted that nitrogen application considerably increased the Mn content in the seeds in comparison to the control treatment, with the effect being more evident at application rates of 30- 60 kg N ha^{-1}.

Table (8) Manganese uptake (mg plant^{-1}) at different growth stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen Fertilization / Water salinity	Mineral-N and Bio fertilization							
	100 % Mineral -N without Bio	100 % Mineral -N with Bio	75 % Mineral -N with Bio	50 % Mineral -N with Bio	100 % Mineral -N without Bio	100 % Mineral -N with Bio	75% Mineral -N with Bio	50% Mineral -N with Bio
	Flowering stage				**Pod formation stage**			
Control (0.625 dSm^{-1})	52.2	72.4	58.1	56.1	177.5	229.6	241.8	182.6
Level 1 (2.43 dSm^{-1})	45.6	66.7	50.3	48.2	153.7	169.4	187.2	164.7
Level 2 (4.33 dSm^{-1})	38.4	51.7	48.2	40.8	146.3	160.7	185.2	150.2
Level 3 (6.10 dSm^{-1})	34.8	43.3	40.1	39.4	117.1	141.2	152.1	131.7
LSD	**S**: 0.3684 **RN**: 0.3684 **S*RN**: 0.7367				**S**: 1.2603 **RN**: 1.2603 **S*RN**: 2.5206			
	Maturity stage (Seeds)				**Maturity stage (Straw)**			
Control (0.625 dSm^{-1})	305.6	438.4	493.4	459.2	142.4	199.2	223.3	169.1
Level 1 (2.43 dSm^{-1})	304.2	407.7	418.5	410.2	104.3	169.2	178.5	124.6
Level 2 (4.33 dSm^{-1})	292.4	309.6	369.7	316.8	71.5	136.7	147.8	94.6
Level 3 (6.10 dSm^{-1})	262.7	266.2	285.7	308.5	59.4	125.2	113.3	63.7
LSD	**S**: 0.6147 **RN**: 0.6147 **S*RN**: 1.2293				**S**: 0.5896 **RN**: 0.5896 **S*RN**: 1.1792			

Zinc uptake:

Regarding the impact of salinity in irrigation water, the data presented in Table (9) indicate that higher salinity levels lead to a reduction in zinc absorption. **Hassan and Mostafa (1994)** reveal that the uptake of Zn was reduced with increasing salinity irrigation water, and this decrease was more pronounced at a high level of salinity. **El-Bassiouny and Bekheta (2001)** attributed the decrease in Zn content to salinity which increase toxic ions accumulation leading to decrease the absorption of elements. **Gama et al. (2007)** pointed out that plants experiencing saline conditions undergo stress primarily due to a decrease in water potential within the root zone, resulting in a nutrient imbalance and lower nutrient levels.

The lowest value of zinc uptake presented data reveals that the lowest values were 8.91 and 33.96 µg Zn plant^{-1} at flowering and pod formation stages, respectively, but at maturity stage the lowest values were 103.1 and 51.3 µg Zn 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}. This finding aligns with **Magdi et al. (2013)**, who stated that salinity stress negatively affects the zinc content in both the shoots and seeds of faba bean.

Table (9) Zinc uptake (mg plant^{-1}) at different growth stages as affected by irrigation water salinity and nitrogen fertilization

Nitrogen Fertilization / Water salinity	Mineral-N and Bio fertilization							
	100 % Mineral-N without Bio	100 % Mineral-N with Bio	75 % Mineral-N with Bio	50 % Mineral-N with Bio	100 % Mineral-N without Bio	100 % Mineral-N with Bio	75% Mineral-N with Bio	50% Mineral-N with Bio
	Flowering stage				**Pod formation stage**			
Control (0.625 dSm^{-1})	19.41	38.06	34.57	22.94	58.51	64.79	96.36	87.87
Level 1 (2.43 dSm^{-1})	17.28	30.61	28.08	18.88	49.73	60.17	92.05	85.68
Level 2 (4.33 dSm^{-1})	13.91	27.98	26.43	17.12	40.22	49.02	77.78	76.71
Level 3 (6.10 dSm^{-1})	8.91	26.62	23.58	14.42	33.96	46.61	70.55	69.13
LSD	**S**: 0.4701 **RN**: 0.4701 **S*RN**: 0.9402				**S**: 3.8922 **RN**: 3.8922 **S*RN**: 8.7845			
	Maturity stage (Seeds)				**Maturity stage (Straw)**			
Control (0.625 dSm^{-1})	175.3	214.3	242.7	221.7	130.4	187.2	227.2	196.8
Level 1 (2.43 dSm^{-1})	125.5	182.7	193.2	192.1	122.5	142.7	178.1	148.2
Level 2 (4.33 dSm^{-1})	117.3	143.7	152.6	148.5	85.2	113.8	139.1	118.6
Level 3 (6.10 dSm^{-1})	103.1	112.6	143.3	117.7	51.3	98.2	113.4	71.7
LSD	**S**: 0.6069 **RN**: 0.6069 **S*RN**: 1.2138				**S**: 0.6076 **RN**: 0.6076 **S*RN**: 1.2153			

Regarding the impact of nitrogen fertilization, the data showed that the zinc uptake generally rose as mineral-N addition level increased. Additionally, data showed that adding Rhizobium to the soil before cultivation enhanced the effectiveness of N fertilizers and lessened the adverse negative effects of effectiveness of N fertilizers and lessened the adverse negative effects of salinity. **Goel *et al.* (1999)** noted that the rise in zinc concentration is predominantly attributed to the influence of bio fertilizers that render most micronutrients in the available form. **Talaat *et al.* (2014)** found that under different salinity levels, Zn concentration was significantly decreased in shoots and seeds of untreated common bean plants; while the concentration was elevated in seeds of plants treated with microorganisms. **Rogério et al. (2017)** observed that the application of nitrogen enhanced leaf concentrations of zinc in common beans.

EFFECT OF IRRIGATION WATER SALINITY AND NITROGEN FERTILIZATION ON SEEDS YIELD:

Seeds yield:

Concerning the effect of irrigation water salinity, data in table (10) show that increasing the salinity of irrigation water leads to a decrease in seeds yield. In this regard, **Banuelos (2001)** studied the response of faba bean irrigated with saline drainage waters and found that the yield of faba beans decreased with increasing salinity levels due to the sensitivity of faba bean to salinity. **Sakr *et al.* (2004)** indicated that salinity impacts the yield of soybean plants, with the diminished seed yield primarily attributed to a reduction in seed set. **Sharifi *et al.* (2007)** suggested that the negative impact of salinity on grain yield could be attributed to a decrease in both leaf area and the number of leaves per plant, leading to a diminished supply of carbon assimilate.

The lowest value of seeds yield presented data reveal that the lowest value was 2.823 g 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}. In agreement with the results obtained, **Ullah *et al.* (1993)** studied the effect of irrigation with artificial sea water on faba beans and found that the grains yield faba bean irrigated with saline waters and found that the yield decreased with increasing salinity levels due to the sensitivity of faba bean to salinity. **Abd El-Ghany and Magdy (2020)** found that the lowest averages for seeds yield of 3.35 ton ha-1 was observed under saline conditions, while the plants grown under non-saline conditions displayed value of 4.58 ton ha-1.

Concerning the impact of nitrogen fertilization, the data showed that the seeds yield generally 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. Gabr et al. (2007) noted that the yield of green pods per kg fed-1 was significantly enhanced by inoculating seeds with various biofertilizers in conjunction with different levels of nitrogen, in comparison to the control treatment. These findings may be explained by the fact that the synergistic effects of biofertilizer and nitrogen on the growth of pea plants resulted in an increase in green pod yield. Al-Zubaidi (2024) discovered that biofertilization treatments significantly influenced seed yield, likely due to The highest value of seeds yield presented data reveal that the highest value 6.174 g 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}. In this context, **Da silva *et al.* (1993)** observed that seed yield was mainly influenced by seed inoculation, with the highest nitrogen addition rate of 10 kg N ha^{-1} producing results comparable to other higher nitrogen treatments. **Bai *et al.* (2002)** reported that plant growth-promoting rhizobacteria enhanced plant yield when co-inoculated with rhizobia, as opposed to using rhizobium alone for inoculation. **Shoukry *et al.*, (2014)** elucidated that the application of rhizobia inoculation, whether utilized independently or in conjunction with various forms of plant growth-promoting rhizobacteria, along with the soil amendment of 20 kg N per hectare, significantly enhanced seed yield in comparison to the application of the standard dosage of mineral fertilizers.

Table (10) Seed yield (g plant $^{-1}$) as affected by irrigation water salinity and nitrogen fertilization

Nitrogen fertilization / water salinity	Mineral and Bio nitrogen fertilizers			
	Seeds 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})	4.173	5.149	6.174	5.771
Level 1 (2.43 dSm^{-1})	3.698	4.522	5.850	5.336
Level 2 (4.33 dSm^{-1})	3.198	3.879	5.501	4.920
Level 3 (6.10 dSm^{-1})	2.823	3.063	4.453	4.802
LSD	**S:** 0.1803	**RN:** 0.1803	**S*RN:** 0.3606	

CONCLUSION

The results reveal that, under conditions comparable to those of the present study, the most effective treatment to ameliorate the adverse effects of irrigation water salinity was the application of 75% mineral nitrogen supplemented with Rhizobium, equivalent to 45 mg N kg^{-1} soil with Rhizobium inoculation. This treatment resulted in the highest uptake of macro and micronutrients, enhanced seeds protein content and the highest seed yield.

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