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THE INFLUENCE OF NITROGEN SOURCES ON GROWTH, YIELD AND PROTEIN CONTENT OF FABA BEAN IN SALT AFFECTED SOILS

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ABSTRACT: Two field experiments were designed at Agriculture Research Station of Tag El-Ezz, Dakahlia Governorate, during 1997-1998 and 2001-2002 seasons to study the influence of four nitrogen sources, two salinity levels and inoculation with Rhizobia for faba bean on growth measurements, yield components and protein content in salt affected soils. The experiment involved 20 treatments; each treatment replicated three times.

The obtained data revealed that, the differences among either the treatments or the most parameters were highly significant as compared with the control.

The inoculation increased the percentage of growth stage, nodulation stage, harvested measurements, yield and protein content with addition of NH_4NO_3 fertilizer, where the best was in the 4.7 dsm^{-1} salinity level comparing with control, while, the addition of $(NH_4)_2SO_4$ fertilizer was the best in the 4.4 dsm^{-1} level.

There is a significant difference between the salinity levels and treatments, that gave a higher value at 4.2 dsm^{-1} salinity leven than at 4.7 dsm^{-1} salinity level in presence or absence of inoculation under the studied parameters.

Thus, the inoculation of faba bean with nitrogen sources increased the percentage (about 40%), while the 4.2 dsm^{-1} salinity level gave a higher value than 4.7 dsm^{-1}. The best N-sources [i.e., NH_4NO_3 with 4.7 dsm^{-1} salinity level and $(NH_4)_2SO_4$ with 4.4dsm^{-1}].

INTRODUCTION

Soil salinity is one of the most important problems in the arid and semi arid zones causing significant decrease in solid productivity (El-Sherbeny et al., 1986). The harmful effect of soil salinity on growth development may be attributed to osmotic inhibition of water availability, toxic effect of salt ions, the depression in element uptake (Ashour et al., 1999).

Thus, it may be possible to identify some crops or varieties in the presence of high levels of fertilizer-N. Such crops could produce high crop and protein yield with a minimum loss of soil and fertilizer-N (Hamissa et al., 1994).

The form in which N is applied to salt stress plant may be influence salinity-nutrient relationship. The form of N (NO_3^- or NH_4^+) can affect the availability of N to the plant as a result of difference in mobility of each form in the soil solution. The mechanisms for uptake by plant roots differ for nitrate and ammonium because of differences in the charge.

The uptake of NO_3^- and NH_4^+ influences the uptake of other ions through the cation-anion balance phenomenon (Irshad et al., 2002).

Inoculation of wheat plants with Rhizobium strains alter root morphology, increase numerous plant shoots growth parameters and eventually increases the yield of many cereal crops. These changes have been attributed to inoculation induced enhancement of mineral uptake in plants (Amara and Dahdoh, 1997).

This work aimed to study the effect formes of N(NO_3^- or NH_4^+) and inoculation on growth, yield and protein content of faba bean in salt affected soils.

MATERIALS AND METHODS

Two field experiments were established during 1997-1998 and 2001-2002 seasons to fulfil the objectives of the present work as follows:

Location: Agriculture Research station of Tag El-Ezz, Dakahlia governorate, A.R.C.

Surface soil samples were taken and air-dried, ground a 2 mm sieve. Particle size distribution was determined according to the international method (Piper, 1950).

The chemical analysis of the experimental soil in Table 1.

Table 1: Chemical analysis of soil samples (0-30 cm).

Ec/dsm^{-1}	PH	Anion meq/100g soil				Cations meq/100g soil				Available nutrients (ppm)							ESP	Texture
		CO_3^-	HCO_3^-	Cl^-	SO_4^-	Ca++	Mg++	K^+	Na^+	N	P	K	Mn	Zn	Cu	Fe		
S_1 4.7	7.9	-	0.4	3.6	0.8	0.7	0.4	0.1	3.6	26	19	301	1.7	1.5	1.9	6.4	10.1	Clayey
S_2 4.2	8.1	-	0.3	2.4	1.8	1.3	0.8	0.1	2.3	31	15.2	194	1.8	1.6	1.3	8.4	8.6	

All chemical analyses were carried out according to Black (1965) and Page (1983). Three nodule observations were recorded during different stages of growth. The Rhizosphere soil of the faba bean was also collected during the nodule observations by analyzed for NO_3^- and NH_4^+ according to Bremner and Mulvany (1982).

Studied crop: Faba bean (Vicia faba, Var, Sakha 461).

Experimental plot: 3 x 4m

Date of sowing: The seeds were sown on 11th November 1997 and 2001.

Experimental treatments:

The experiments were carried out in split-split plot design involving 20 treatments. Each treatment was replicated three times.

The detailed experimental treatments were as following:

a- Main plot; two salinity levels ($S_1 = 4.7$ dsm^{-1} and $S_2 = 4.2$ dsm^{-1}).

b- Sub-plot; N-sources i.e. control treatment without any addition, (nitrate-N + Ammonium-N) as NH_4NO_3, (Ammonium-N) as $(NH_4)_2SO_4$, (Urea-N) as $CO(NH_2)_2$ and (nitrate-N) as $Ca(NO_3)_2$. N-source was added (16 kg N/fed).

c- Sub-sub plot; Rhizobium inoculated and free inoculated.

A basal dose of phosphorus and potassium were applied at the rate of (15 kg P_2O_5/fed.) as $Ca(H_2PO_4)_2.H_2O$ and K_2SO_4 at the rate of (48 kg/fed.) as stimulating dose.

The sesds were inoculated with Rhizobium Leguminosarum before cultivation (300gr/40kg seeds/fed).

Plant samples:

Shoots samples were collected from each plots at 40 and 110 days after seedlings. Seeds oven dried (65°C) for 48 hours, weighed and milled into powder. The milled samples were digested using sulfuric and perchloric acid solutions, for determination of N concentration, then calculated the protein content.

Statistical analysis:

A combined analysis of collected data for both seasons was done using the analysis of variance technique according to Gomez and Gomez (1984).

RESULTS AND DISCUSISON

The effect of inoculation and N-sources on growth measurements:

The data in Table 2 show that there were a significant differences among fertilizer treatments at all studied parameters compared with control at 40 and 110 days. The growth parameters [plant height (cm), fresh and dry weight (g/m^2)] were affected by inoculation with Rhizobium at different growth stages as well as increased with inoculated treatments as compared with the control (i.e., free both inoculated and fertilizer for each salinity levels S_1 and S_2).

The increasing percentages over the control were 62.5, 62.5 and 70.6 at S1 at 40 days, while, the increasing percentages were 48.1, 73.9 and 71.4 at 110 days, respectively for the previous parameters with NH_4NO_3 fertilize, while the increasing percentages at S_2 were 65.0, 70.4 and 73.9 at 40 days. However, they were 60.5, 76.2 and 68.1 at 110 days, respectively for the previous parameters with $(NH_4)_2SO_4$ fertilizer. Amara and Dahdoh (1997) found that the wheat shoots, roots and seed yield responded positively and significantly to inoculation due to some bacteria produce organic acids which solubilize inorganic and organic forms of phosphorus and other minor elements that are unavailable to plants.

The effect of salinity and N-sources on growth measurements:

Data obtained show that there were significant differences between salinity levels at all studied growth parameters with control at 40 and 110 days.

The increasing percentages for S_2 than S_1, were 0.6, 1.4 and 2.4 at 40 days, with NH_4NO_3 fertilizer, while they were 9.4, 22.3 and 5.7 at 110 days, respectively with $(NH_4)_2SO_4$ fertilizer for the previous parameters. Leidi et al. (1991) found that NO_3 -N was a better N source than NH_4^+ for wheat grown in salt affected areas. Also Irshad et al. (2002) found that the nitrate-treated plants took up substantially more total N than other N-source treated plants.

The effect of inoculation and N-sources on nodulation:

It is noticed from Tables 3 and 4 that there were a significant differences among fertilizer treatments at all studied parameters compared with control at 40 and 110 days.

The number of nod./plant, nodule weight (mg/plant) and soil inorganic-N (ppm) (NH_4^+-N + NO_3^+-N) they affected by inoculation with Rhizobium compared with control for each of salinity levels (S_1 and S_2). The increasing percentages were 66.7, 62.5, 63.7, 57.1, and 64.7 after 40 days, while they were 58.3, 59.3, 61.8, 62.2 and 60.0 at 110 days, respectively, for the previous parameter by addition of NH_4NO_3 fertilizer, in S1 salinity level.

Contrarily, the percentages at S_2 level were 75.0, 63.6, 69.5, 71.7 and 66.7 at 40 days, while they were 66.7, 64.5, 69.0 and 69.2 at 110 days, respectively, for the previous parameters, with $(NH_4)_2SO_4$ fertilizer. Mekhemar (2001) found that there was a significant increase in number and dry weight of nodules by 83.7 and 66.7% with inoculation over the uninoculated treatment.

The effect of salinity and N-sources on nodulation:

Data obtained show that there were significant differences between salinity levels at all studied nodule stage compared with control at 40 and 110 days. The increasing percentages of S_2 over S_1 were 1.9, 3.1, 3.8, 5.4 and 0.3 at 40 days with NH_4NO_3 fertilizer, but they were 15.0, 8.6, 9.9, 20.8 and 11.1 by using $(NH_4)_2SO_4$ fertilizer, respectively for the previous parameters.

However, at 110 days, the increasing percentages were 4.9, 4.3, 3.2, 5.0 and 3.6 by addition of NH_4NO_3 fertilizer, while they were 16.7, 16.4, 11.7, 9.6 and 10.9 with $(NH_4)SO_4$ fertilizer, respectively for the previous parameters. This finding agreed with Koreish (1997) found that nodulus plant biomass and its N-content decreased gradually with the increase in salinity level regardless of soil type.

Harvest measurements affected by inoculation, salinity and N- sources:

Data in Table 4 show that, the pod/plant, seed number/pod, seed weight/ pod. (g), seed weight/plant (g), 100 seeds weight (g), were affected by the inoculation and salinity significantly compared with control. The increasing percentages were 62.5, 50.0, 54.0, 63.8 and 63.3 with NH_4NO_3 fertilizer, while they were 72.0, 50.0, 63.2, 68.4 and 68.0 with $(NH_4)_2SO_4$, respectively for the previous parameters.

Table (2) : N-source, salinity and inoculation effects on plant height, number of branches and (fresh or dry) weight planting of faba bean plants after 40 days.

Treatments	Plant height (Cm)				Number of branches				Fresh weight planting (g/m²)				Dry weight planting (g/m²)			
	S_1		S_2		S_1		S_2		S_1		S_2		S_1		S_2	
	Inc*	F.inc**	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc
Control	18	14	20	15	2	2	3	2	18	13	20	14	2.0	1.5	2.4	1.7
NH_4NO_3	26	16	29	18	4	2	4	3	26	16	34	21	2.9	1.7	3.4	2.0
$(NH_4)_2SO_4$	28	18	33	20	3	3	4	3	40	27	46	27	3.7	2.2	4.0	2.3
$CO(NH_2)_2$	26	18	31	21	3	2	3	3	32	20	42	26	4.4	3.0	4.2	2.7
$Ca(NO_3)_2$	26	19	30	22	3	3	3	3	29	21	33	23	4.6	3.1	4.1	2.7
F-test	**		**		N.S.		N.S.		**		**		**		**	
LSD5% source	1.40		1.6		0.61		0.59		1.70		1.60		0.16		0.23	
LSD5% of interaction	N.S.		N.S.		N.S.		N.S.		2.40		2.20		0.23		0.33	

After 110 days

Treatments	Plant height (Cm)				Number of branches				Fresh weight planting (g/m²)				Dry weight planting (g/m²)			
	S_1		S_2		S_1		S_2		S_1		S_2		S_1		S_2	
	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc
Control	50	39	55	40	3	2	3	2	55	42	61	46	4.8	3.6	5.1	3.7
NH_4NO_3	80	54	91	60	4	2	4	3	80	46	97	53	8.4	4.9	10.1	6.1
$(NH_4)_2SO_4$	110	79	131	81	4	3	4	3	110	73	111	63	12.3	7.6	12.1	7.2
$CO(NH_2)_2$	105	79	114	83	4	2	4	3	105	71	104	67	10.4	7.1	11.8	7.8
$Ca(NO_3)_2$	100	78	120	90	3	2	4	3	92	66	111	76	11.1	7.4	12.0	8.0
F-test	**		**		*		*		**		**		**		**	
LSD5% source	2.54		1.71		N.S.		N.S.		1.61		1.13		0.23		0.16	
LSD5% of interaction	0.59		2.40		N.S.		N.S.		2.27		1.60		0.32		0.23	

* Inoculation with Rhizobia

** Free inoculation.

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Table (3) :N-source, salinity and inoculaiton effects on number of nod./plant, nodule weight/plant and soil inorganic-N of faba bean plants after 40 days.

Treatment	Number of nod./plant								Nodule weight mg/plant								Soil inorganic-N (ppm)							
	Crown				Lateral				Fresh				Dry				NH_4^+-N				NO_3^--N			
	S_1		S_2		S_1		S_2		S_1		S_2		S_1		S_2		S,		S2		Si		S,	
	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc
Control	10	7	13	9	6	3	9	4	80	59	87	62	7	5	9	6	1	1	2	1	18.7	13	23	16
NH_4NO_3	14	8	18	11	13	8	16	10	14.3	68	129	77	11	7	13	8	2	1	2	2	28	17	33	20
$(NH_4)_2SO_4$	16	10	21	12	14	8	16	11	142	89	151	95	16.6	11	17	9.9	4	1	3	1	28	18	35	21
$CO(NH_2)_2$	18	11	26	15	22	15	25	17	162	102	179	108	20	13	17	11	5	2	6	2	29	20	35	22
$Ca(NO_3)_2$	17	11	24	15	18	13	20	14	134	98	147	103	14	10	19	13	3	1	4	2	29	21	34	24
F-test of salinity	**		**		**		**		**		**		**		**		**		**		**		**	
LSD5% of source	1.09		1.60		1.06		1.20		1.99		1.71		0.84		1.10		0.77		1.06		1.30		1.20	
LSD5% of interaction	1.55		2.24		1.05		1.70		2.81		2.42		1.26		1.55		1.09		1.50		1.84		1.70	

After 110 days

Treatment	Number of nod./plant								Nodule weight mg/plant								Soil inorganic-N (ppm)							
	Crown				Lateral				Fresh				Dry				NH_4^+-N				NO_3^--N			
	S_1		S_2		S_1		S_2		S_1		S_2		S_1		S_2		S,		S2		Si		S,	
	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc
Control	12	9	15	11	29	19	35	23	91	-	100	-	12	-	18	-	1	1	2	1	10	7	11	8
NH_4NO_3	19	12	31	19	43	27	54	33	352.7	218	409	247	73	145	97	58	2	1	4	2	16	10	18	11
$(NH_4)_2SO_4$	24	16	35	21	40	27	51	31	492	818	506	304	110	69	120	71	2	1	3	1	19	12	22	13
$CO(NH_2)_2$	37.7	30	46	32	49	33	57	35	311	302	363	227	53	35	61	40	3	2	3	3	15	10	20	13
$Ca(NO_3)_2$	33	23	41	28	37	26	47	30	276	207	307	226	42	30	69	49	1	2	2	2	16	11	18	11.7
F-test of salinity	**		**		**		**		**		**		**		**		**		**		**		**	
LSD5% of source	2.40		1.99		1.13		1.06		1.45		1.09		1.13		1.71		0.61		0.16		1.20		1.30	
LSD5% of interaction	3.39		2.80		1.60		1.50		2.05		1.55		1.60		2.40		0.87		0.23		1.70		1.84	

Table (4) : N-Sources, salinity and inoculation effectson harvested measuremets, yield and protein content of faba bean plants.

Treatments	Harvest measurements															
	Pod./plant				Seed number/pod				Seed weight/pod(g)				Seed weight/plant(g)			
	S_1		S_1		S_1		S_2		S_1		S_2		S_1		S_2	
	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc
Control	9	7	11	8	2	2	3	3	15	11	19	13	30.4	231	36	26.4
NH_4N0_3	13	8	17	10	3	2	4	3	20	13	26	16	70.6	43.1	89	53.7
$(NH_4)_2SO_4$	12	8	19	11	3	2	4	3	27	18	31	19	811.7	511	884	525
$CO(NH_2)_2$	12	8	15	9	3	3	4	4	25	17	31	20	771.7	487	811	505
$Ca(N0_3)_2$	13	9	16	10	3	3	4	4	24	16	30	19	787.3	500	810	506
F-test of salinity	**		**		N.S.		N.S.		**		**		**		**	
LSD5% of source	1.34		1.20		1.13		1.42		1.25		1.13		1.58		1.99	
LSD5% of interaction	N.S.		N.S.		N.S.		N.S.		1.77		1.60		2.24		2.81	

Treatments	Harvest measurements				Yield kg/fad.								Protein percentage			
	100 seeds weight(g)				Seeds				Straw				Seeds			
	S_1		S_2		S_1		S_2		S_1		S_2		S_1		S_2	
	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc	Inc	F.inc
Control	38.2	29.4	46.1	34.2	775	526	863	573	419	291	439	303	6.11	4.6	8.4	6.18
NH_4N0_3	63.5	39.0	66.7	40.2	1114.71	684	1170	706	783	464	831	490	17.11	10.3	20.6	12.29
$(NH_4)_2SO_4$	53	33.6	61	36.6	1289.3	797	1351	815	705	421	804	465	20.89	13.1	24.3	14.45
$CO(NH_2)_2$	51.4	33.3	60	38.1	1141.3	709	1189.1	737.1	780	489	841	518	16.94	10.9	21.10	13.12
$Ca(N0_3)_2$	52	34.7	61	40.2	1105	699	1167	733	750	500	793	509	20.95	14.0	21.8	14.33
F-test of salinity	**		**		**		**		**		**		**		**	
LSD5% of source	0.33		0.60		3.11		2.54		1.22		1.59		2.02		1.70	
LSD5% of interaction	0.46		0.88		4.39		3.59		1.73		2.24		1.02		2.40	

Yield, straw and protein content affected by inoculation, salinity and N-sources:

Data obtained show that there were a positively effects of the inoculation and salinity. The increasing percentages were 63.0, 68.8 and 66.1 using NH_4NO_3 fertilizer, while $(NH4)_2SO_4$ fertilizer gave 85.8, 72.9 and 68.2 respectively for the previous parameters. On the other hand, the increasing percentages for salinity levels of S_2 over S_1 were 2.8, 0.8 and 1.5 with NH_4NO_3 fertilizer, while 4.0, 5.4 and 8.7, with $(NH_4)_2SO_4$ fertilizer. Kore-ish (1997) found that the inoculated plants showed increases in plant dry weight and nitrogen content over the un-inoculated control plants.

Thus, it could be concluded that the inoculation of faba bean with the stimulative dose of N-fertilizers [i.e., (S_1) with $(NH_4)_2SO_4$ and (S_2) with NH_4NO_3] help to obtain a good and high yield under the salt affected soils.

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مجلة الأزهر للبحوث الزراعية
العدد (٣٧) يونيو ٢٠٠٣

تأثير مصادر النيتروجين على النمو والإنتاج والمحتوى البروتيني لنبات الفول البلدي في الأراضي المتأثرة بالأملاح

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صممت تجربتان حقليتان بمحطة البحوث الزراعية بتاج العز – محافظة الدقهلية خلال موسمى ١٩٩٧ -١٩٩٨ و ٢٠٠١-٢٠٠٢ لدراسة تأثير أربعة مصادر نيتروجينية ومستويان من الملوحة والتلقيح بالريزوبيا على القياسات الخضرية وكمية المحصول والمحتوى البروتيني لنبات الفول البلدي في الأراضي المتأثرة بالأملاح، شملت التجربة ٢٠ معاملة وكررت كل معاملة ثلاث مرات.

أظهرت النتائج المتحصل عليها أنه يوجد فروق معنوية بين المعاملات ومعظم الصفات المدروسة مقارنة بالكنترول. وأدى التلقيح إلى زيادة النسبة المئوية في مرحلة النمو ومرحلة تكوين العقد الجذرية والقياسات عند الحصاد وكمية المحصول والمحتوى البروتيني للبذور مع إضافة سماد نترات الأمونيوم حيث كانت هى الأفضل عند مستوى الملوحة ($4.7\ dSm^{-1}$) مقارنة بالكنترول. بينما إضافة سماد سلفات النشادر كانت الأفضل عند مستوى الملوحة ($4.2\ dSm^{-1}$).

وجدت زيادة معنوية بين مستويات الملوحة والمعاملات حيث أعطى مستوى الملوحة ($4.2\ dSm^{-1}$) أعلى قيم عن مستوى الملوحة ($4.7\ dSm^{-1}$) في وجود أو غياب التلقيح للصفات تحت الدراسة.

وكذلك أدى التلقيح لنبات الفول البلدي مع مصادر النيتروجين زيادة النسبة المئوية (حوالي ٤٠%) بينما أعطت الملوحة أعلى قيم في مستوى الملوحة ($4.2\ dSm^{-1}$) عن مستوى الملوحة ($4.7\ dSm^{-1}$).