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Saline Soil Management to Improve its Fertility and Productivity by some Agricultural Practices Application

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ABSTRACT

A field study was conducted during winter season of 2015/2016 at saline soil of Sahl El-Tina, North Sinai Governorate, Egypt, to study the effect of agricultural practices (raised bed system, nitrogen fertilizer rates and seed soaking in concentrations of cobalt solution) whether alone or combined with both on improving the fertility of saline soil and its productivity for faba bean *(Vicia faba L. cv. Nobaria 1*). Results declared that, the decreasing in soil salinity values (EC) was more clearly in the raised bed shoulder than furrow ridge with increasing the number of irrigations. All growth parameters and yield component were increased to highest percentage at using the raised bed compared to furrow row system. Also, each of seed and straw yield (kg fed^{-1}) were increased significantly with gradually increasing the levels of N application up to 100 % combined with 12 mg L^{-1} of cobalt, but with increasing the concentration in soaking solution up to 18 mg Co L^{-1} gave negative significantly effect on all the growth parameters studied. Macronutrients contents in faba bean plants were significantly increased with raised bed system, they reached to 34.3, 36.7 and 37.9 % for N, P and K, respectively compared to furrow row system. Also, they were increased with increasing each of N application rates combined with Co concentration (12 mg L^{-1}) then decreased with the highest concentration of Co (18 mg L^{-1}). The residual available N in soil rhizospher was significantly increased at using all agricultural practices as individual factors. In contrast, there are insignificantly effects of these practices on P and K available contents in soil rhizosphere. Cobalt concentration in seed soaking solution has no effect on increasing its content in plant or soil.
Keywords: Saline soil, raised bed, furrow row, nitrogen, cobalt, and faba bean.

INTRODUCTION

Management of Saline soil has been a challenge for the researchers for many years. Now with the advancements in the field of science has made it possible to overcome such problems, which this soil can be only reclaimed by removing salts from the plant root zone as using some seasonal agricultural practices, such as the raised bed system and / or the practices of the fertilization and irrigation which aim to prevent or mitigate the deleterious effects of soil salinity. Lockerman *et al.* (1983) stated that faba bean is moderately salt tolerant, decreasing to 50 % of maximum yield at about EC 11 dS m^{-1}, which the detrimental effect of salinity not only depends on the concentration of soluble salts (EC) but also on the nature of the salts. Generally, Abdelhamid *et al.* (2010) reported that salinity significantly decreased several nutrients in faba bean leaves while significantly increasing sodium and chloride. Thus, saline soil management is the main concern of many specialists in order to mitigate or reduce the salinity problems on the plants for increases its ability to produce crops (EL Azab and Mahmoud 2017).

Although, several approaches presented in the litterateur can reduce the quantities of soil salts, saline soils cannot be treated by chemical amendments or fertilizers, they only can be reclaimed by removing the salts from the rihzospher soil (root zoon) by increasing the amount of irrigation water applied than plant need to sufficient leaching requirement or increasing the volume of percolated water below the root zone (Petersen 1996). Recently, many studies by (El Azab 2015, Amer 2017 and EL Azab and Mahmoud 2017) applied several alternative approaches and techniques to combat salt stress as well as improve the productivity of salt-affected soil, e.g. seasonal agricultural practices; Raised bed system, soil amendments, manipulations fertilizer, seed soaking, plant growth regulators and…etc. which applied to improve and reclaim saline soil to avoid using the chemicals as soil amendments, and reduce the salt concentration in the soil upper layers. On the other hand, addition of organic matter is one of the soil improving measures for mitigating the detrimental effect of salinity (Aydin *et al.* 2012). It plays an important role in soil biogeochemical processes, especially the mobility and bioavailability of trace elements. Therefore, it is an essential factor for assessment of plant responses under salinity conditions or other varying ecological (Matijevic *et al.* 2014). The physical, chemical and biological properties of saline soils can be improved by the application of organic matter, consequently enhancing plant growth and development (Cha–um and Kirdmanee 2011).

In this context, Beecher *et al.* (1997) reported the advantages of raised bed system where improved internal and surface drainage of the soil, the structure of root zone soil, and reduced tillage requirements. Amer *et al.* (2011) applied this system to reclaim saline soil at Sahl El Tina, where raised beds have been constructed by farmers and was filled by organic matter recommended. The chemical properties of this soil were improved by using this practice, which the soil salinity reduced more than 50% approximately, especially for Cl^- and Na^+ in the root zone of maize under raised bed system, led to increase of availability nutrients to crops and nutritional balances. Akbar *et al.* (2016) showed the prospects of improved soil physical properties and water productivity by adopting controlled traffic raised bed farming (CTRBF) system, which may be helpful for agriculture sustainability and food security. Recently, EL Azab and Mahmoud (2017) indicated that the raised bed system application is the candidate strategy for reduction of salt stress in root zone at a newly reclaimed soil, which the faba bean plants were able to complete its life cycle despite high soil salinity, as consequence to realize good manage for salt accumulation under raised bed condition.

Many investigations on salinity-nitrogen issue were focused either on nitrogen influence on plant (Ozer *et al.* 2004 and Svoboda and Haberle 2006) or on salinity as limiting plant growth factor (i.e., Burger and Celkova 2003, Orak and Ates 2005 and Supanjani and Lee 2006). Fertilization with N may be contributing to soil salinization and increase the negative effects of soil salinity on plant performance during a specific growth stages (Villa-Castorena *et al.* 2003). In this context, Amer *et al.* (2011) founded that addition N fertilizer in forms of ammonium sulfate gave the pest results for yield, yield component and N- use efficiency compared to the other forms under saline soil conditions.

Faba bean (*Vicia faba* L.) is the most important grain legume crops grown in winter season, in addition, legumes play an important role in improving soil fertility by providing a substantial input of nitrogen fixation. So it enters in crop rotation to improve soil conditions (Carmen *et al*. 2005 and kandil 2007). Many workers found that legumes depend upon symbiotic N_2 fixation seems to require cobalt (Co) in trace amounts for the proper functioning of the nodules (Abdel-Ghaffar 1982, Yadav and Khanna 1988, Gad 2006 and Gad *et al.* 2011). It is an evident on the importance of Co amendments as a limiting factor for yield production of faba bean plants in infertile soil.

Cobalt is a component of vitamin B12 which is a component of enzymes and co-enzymes involved in nitrogen fixation in legume nodules (Mathur *et al.*, 2006), it is an essential element for certain microorganisms, particularly those fixing atmospheric nitrogen in particular, for nodules formation (Gad, *et al.* 2011). The proper doses of cobalt may help in better nodulation and consequently a better growth and yield, but at high level cobalt reduced the bacterial population in the rhizosphere and as a result nodulation was hampered which led to a lower growth arid yield of crop (Jana *et al*. 1994), also the excess of Co causes oxidative stresses (Tewari *et al.* 2002) and may result in phytotoxicity to plants (Chatterjee and Chatterjee 2003). In this connection, common bean, soaking seeds with cobalt nitrite at 1 and 5 mg L^{-1} significantly improved nodulation, dry matter, nitrogen and grain yield (Mohandas 1985). Addition of 20 mg kg^{-1} cobalt as fertilizer soil application, improved all the growth and yield parameters as well as macro and micronutrients content of faba bean plants without human health hazard (Kandil 2007). Recently, Atiia *et al.* (2016) reported that soaking the faba bean seeds for 24 h before sowing in Co solution at two rates (0.07 and 0.14 g kg^{-1} seeds) was more efficient than the spraying one for higher yield. Therefore, the objective of this study is showing the effect of different agricultural practices on saline soil reclamation and improving its fertility and productivity.

MATERIALS AND METHODS

A field experiment was conducted on a sandy loam soil that is suffering from salinity stress at a newly reclaimed area of Galbana Village No. 7, Sahl El-Tina, North Sinai, Egypt, during winter season 2015/2016 to study the effect of agricultural practices on saline soil reclamation and improving its fertility and productivity, e.g. raised bed and furrow row system, nitrogen fertilizer application rates and seed soaking in different concentrations of cobalt solution, whether alone practices or combined with both on mitigate the negative effect of salinity stress and faba bean productivity. A representative soil sample was taken after soil preparation and before fertilization from the experimental sites (0-30 cm depth). It was air dried, grinded and passed through a 2 mm pores sieve to be analyzed for chemical characteristics. Data are shown in Table (1). Particle size distribution and soil texture were determined according to Klute (1986). Contents of organic matter, $CaCO_3$ %, EC, pH, soluble cations and anions, SAR and ESP were evaluated according to Black *et al.* (1982) and Page *et al*., (1982). Available N, was determined using K_2SO_4 (1%) according to the method described by Cottenie *et al.* (1982) and measured according to the modified Kjeldahal method. Available P, K, and cobalt were extracted using the method described by Soltanpour (1985).

Table 1. Some physio-chemical and fertility characteristics of the studied soil

Particle size distribution (%)				**Texture**	**O.M (%)**	**$CaCO_3$ (%)**	**pH**	**Available macro and micronutrients (mg kg^{-1} Soil)**			
C. Sand	**F. Sand**	**Silt**	**Clay**					**N**	**P**	**K**	**Co**
15.8	55.2	12.9	16.1	Sandy Loam	0.88	7.70	8.00	40.1	5.8	185.0	0.55

Soil depth (cm)	EC (dS m^{-1})	SP	Soluble Ions (meq. L^{-1})							SAR	ESP
			Cations				Anions				
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$HCO_3^{=}$	Cl^{-}	$SO_4^{=}$		
0------10	10.8	23.0	44.8	27.9	53.0	1.6	1.5	54.9	70.9	8.8	11.0
10-----20	9.4	23.0	38.0	25.6	44.5	4.1	2.1	54.9	55.2	7.9	10.1
20 ----30	8.3	23.0	31.0	21.2	47.4	4.4	2.3	57.7	44.1	9.3	11.5
mean	9.5	23.0	37.9	24.9	48.3	3.3	2.0	55.8	56.7	8.7	10.9

Experimental area were ploughed twice in two ways for seeds bed preparation after received superphosphate fertilizer (15.5 % P_2O_5) at rate of 45 unite of P_2O_5 fed^{-1} and 5 Mg fed^{-1} of farmyard manure. While, Potassium sulphate (48 % K_2O) was applied as the recommended dose (24 units of K_2O fed^{-1}) in two equal doses after 21 and 45 days from sowing. The designed experimental area was laid out in a split split plot design with three replicates. The main plots were two agricultural systems, Raised bed (which make manual according to the described methods after Amer *et al.* (2011)) and furrow row systems. Sub plots were four rates (0.0% , 50%, 75% and 100% of Nitrogen recommended doses; (45 units of N fed^{-1}), which added in the form of ammonium sulfate (21.5% N) in two equal doses after 21 and 45 days from sowing. Sub sub plots were seed soaking in mixed nutrient solution (N and Co). Faba bean (*Vicia faba, L. Noubaria 1*) seeds were supplied from Food Legumes Department, Field Crop Research Institute, Agriculture Research Center, Giza, Egypt and were divided into four portions, each part was soaked for 24h in one concentration of cobalt sulfate solution (0.0, 6.0, 12.0 and 18.0 mg cobalt L^{-1}), each above solutions content 2% of urea. The faba bean seeds were inoculated with selective strain of *Rhizobium leguminosarum var.*, then sown directly in hills by hand (3 seeds / hill) on shoulder bed and in the 1/3 top of row ridge (in16 November 2015). Plants were thinned out to one plant per hill after 21 days from planting.

The experimental area was included 32 treatments (2*4*4) with three replicates, (96 plots). Each plot area was 10.5 m^2 (3.5 m x 3m) content six rows which make a three raised bed for each plot. Other standard agricultural practices for growing faba bean were carried out according to the usual recommended by Egyptian Ministry of Agriculture. The experimental soil was flood irrigated for immerge the bed with mixed water derived from El-Salam canal, its EC =1.8 dS m^{-1} (Nile water + drainage water, 1:1). During the growth period all plots were weeded manually. No serious incidence of insect or disease was observed and no pesticide or fungicide was applied.

Soil sampling

Soil samples were collected two days after irrigation and before each follow irrigation to the first, third, fifth, last irrigation and at harvest. Each time, samples were taken from root zoon profile of furrow ridge and bed shoulders of the furrows and raised bed system respectively, for three randomized replications in each main treatment (agricultural practices). Samples were taken at every10 cm soil depth down to 40 cm using a tube auger, air dried and chemical analyzed according to Page *et al.* (1982).

Plant sampling:

At harvest, the plants in ten hills were harvested randomly from each plot to determine plant height (cm), number of branches/plant, number of pods/plant and 100-seed weight. Each plot was harvested, weighed and separated to seed and straw yields and calculated in (kg fed^{-1}). Each of seed and straw samples were dried at 65-70 ^{0}C, crushed in stainless steel mill and wet digested using of H_2SO_4 + $HClO_4$ acid to determine nutrient contents (Ryan *et al.* 1996). Macronutrients and cobalt concentration were measured in the digested solution and soil samples extracted (taken from root zone) after the harvest using the standard method described by Cottenie *et al.* (1982) and Page *et al.* (1982), available Cobalt was determined by using Inductively Coupled Plasma (ICP) Spectrometry (Ultima 2 JY Plasma) according to the procedure described by "Environmental Protection Agency" EPA. (1991). Crude protein content (%) in seeds was calculated by multiplying the (N %) x 6.25 according to the method described by A.O.A.C. (1995).

Statistical analysis:

All the obtained data were subjected to statistical analysis of variance (ANOVA) by using Minitab computer program and least significant differences (LSD) values were calculated at levels 5 % (Barbara and Brain, 1994).

RESULTS AND DISCUSSION

Effect of irrigations number on salt mobility and its accumulation under different agricultural systems:

Data presented in Table (2) indicated that the mean values of soil salinity before and after irrigation were decreased with using the agricultural practice (furrow row and raised bed system) compared to the initial data before sowing (control). It was observed that, the mean values of soil salinity gradually decrease with increasing the number of irrigations, this decreases in root zone salinity was move down and up after irrigation and before the next irrigation. Although, the decreasing in salinity values (EC) take the same trend in both agricultural systems, it was more clearly in the bed shoulder than furrow ridge for raised bed and furrow rows system, which helps to reduce the negative effects of salt stress on plant growth, that is leads to the success of faba bean growth cycle until maturity under soil salinity condition. After last irrigation and with soil drought, the salts were moved up and accumulated in soil surface. These results are agreed with that the obtained by Devkota *et al.* (2015) and EL Azab and Mahmoud (2017) who discussed the salt manages accumulation under the different agricultural systems with irrigation. They indicated that a raised bed system was preferable compared to the furrow row system as a result to salinity decreasing highly.

Table 2. Effect of irrigations number on salt concentration (dSm^{-1}) in soil depths under furrow rows and raised bed systems

Agricultural system and time of analysis		Depth (cm)	before sowing	first irrigation	3th irrigation	5th irrigation	last irrigation	after harvesting
Furrow ridge	After irrigation	0 --- 10	10.8	8.3	6.1	5.2	4.6	
		10 --- 20	9.4	7.5	5.4	4.1	3.9	
		20 --- 30	8.3	8.1	5.8	4.0	3.5	
		30 --- 40	9.3	9.4	8.1	8.0	8.1	
	before the follow irrigation	0 --- 10	10.8	9.2	7.3	5.6	5.0	9.8
		10 --- 20	9.4	7.9	6.6	5.0	4.3	8.5
		20 --- 30	8.3	8.0	7.1	6.1	4.8	6.3
		30 --- 40	9.3	9.3	8.7	9.2	8.7	8.4
Raised bed shoulder	After irrigation	0 --- 10	10.8	6.1	3.9	2.5	2.1	
		10 --- 20	9.35	5.7	3.6	2.2	1.5	
		20 --- 30	8.25	6.5	4.1	2.1	1.4	
		30 --- 40	9.3	9.5	7.2	5.3	4.1	
	before the follow irrigation	0 --- 10	10.8	8.8	6.9	5.1	3.2	7.2
		10 --- 20	9.35	8.0	5.4	3.2	2.1	6.8
		20 --- 30	8.25	7.9	5.0	2.4	1.8	6.1
		30 --- 40	9.3	9.2	8.8	6.9	5.9	8.1

Effect of agricultural practices on faba bean growth Parameters and yield component.

Data presented in Table (3) indicate that plant height, number of branches/plant, number of pods/plant, weight of 100 seeds (g), seed and straw yields/fed and crude protein (%) were significantly affected by the applied nitrogen levels along with cobalt concentration, whether under the furrow row or the raised bed system. yield and yield components recorded the highest values with raised bed system compared to furrow row system. Furthermore, each of studied practices individually effects on growth parameters and yield component which increased to highest percentage with using raised bed system compared to furrow row system, it reached to 28.8, 23.8 and 19.3 % for number of branches/plant, seed and straw yields/fed, respectively, while number of pods/plant, plant height, crude protein (%) and weight of 100 seeds (g) were significantly increased by 18.2, 17.7, 12.9 and 4.5% respectively, with using raised bed system. These significantly increasing in faba bean growth parameters and yield component under the raised bed system may be attributed to salt decreases in root zone greatly compared to furrow row system which allows an increase root penetration, increases nodules number and efficiency which enables fixation of atmospheric nitrogen. The same trend was obtained by other author (Amer *et al.* (2011) and EL Azab and Mahmoud (2017)) who indicated the positive effect of raised bed system on plant growth and yield component compared with the furrow row system particularly with saline soil.

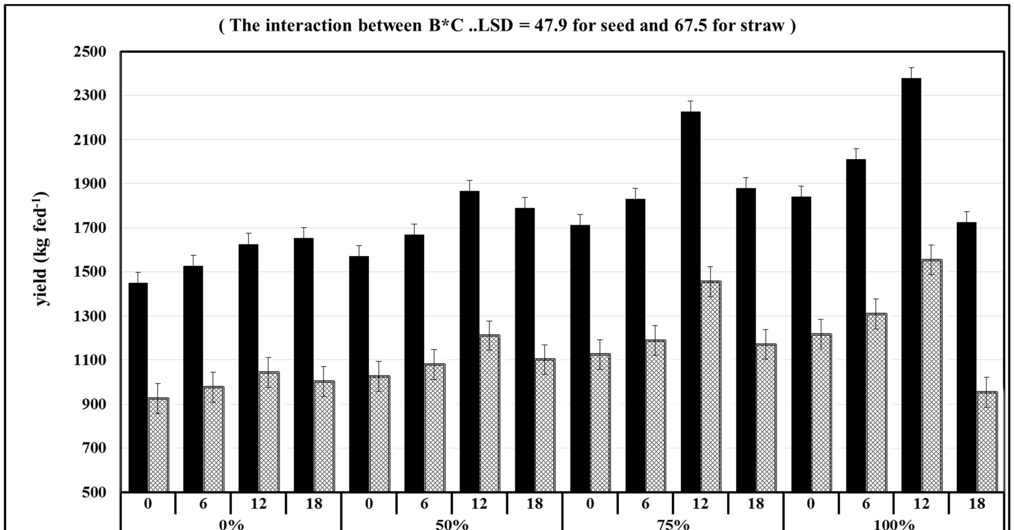
Table 3. Effect of practices interaction on growth parameters of faba bean yield and yield component

Item studied	Treatments	Furrow Row					Raised beds					mean (C)	LSD at 0.05 level
		Rate of N fertilizer from recommended doses											
	Co rates ($mg\ L^{-1}$)	0 %	50 %	75 %	100 %	mean (A*C)	0 %	50 %	75 %	100 %	mean (A*C)		
plant highest	0	40.7	46.3	51.0	44.7	45.7	53.7	54.0	55.7	56.3	54.9	50.3	(A : 2.2)
	6	49.3	50.0	59.3	49.3	52.0	58.7	58.7	61.0	63.7	60.5	56.3	(B: 3.1)
	12	51.7	57.3	63.3	61.7	58.5	61.7	64.7	67.7	73.0	66.8	62.6	(C : 3.1)
	18	58.3	55.3	59.3	53.3	56.6	69.3	69.7	70.0	64.0	68.3	62.4	(A*B : ns)
mean (A*B)		50.0	52.2	58.2	52.3	53.2	60.8	61.8	63.6	64.3	62.6	57.9	(A*C : ns) (B*C : ns) (A*B*C : ns)
Number of branches / plant	0	4.3	6.0	6.3	6.3	5.7	6.7	8.7	8.7	8.3	8.1	6.9	(A : 0.6)
	6	5.7	7.0	8.0	9.0	7.4	7.0	9.0	9.0	10.7	8.9	8.2	(B: 0.8)
	12	6.7	7.7	8.3	8.0	7.7	8.3	9.0	10.3	10.0	9.4	8.5	(C : 0.8)
	18	6.0	6.3	6.7	5.7	6.2	9.0	9.0	8.8	6.7	8.4	7.3	(A*B : ns)
mean (A*B)		5.7	6.8	7.3	7.3	6.8	7.8	8.9	9.2	8.9	8.7	7.7	(A*C : ns) (B*C : 1.6) (A*B*C : ns)
Number of pods /plant	0	11.3	12.3	12.7	13.7	12.5	12.3	13.7	14.7	15.7	14.1	13.3	(A : 0.4)
	6	12.0	12.7	13.3	14.3	13.1	13.0	14.3	15.7	17.7	15.2	14.1	(B: 0.5)
	12	12.7	14.3	17.0	17.7	15.4	13.7	15.3	17.3	19.0	16.3	15.9	(C : 0.5)
	18	11.7	11.7	11.0	10.3	11.2	14.3	16.3	18.3	15.3	16.1	13.6	(A*B : 0.7)
mean (A*B)		11.9	12.8	13.5	14.0	13.0	13.3	14.9	16.5	16.9	15.4	14.2	(A*C : 0.7) (B*C : 1.0) (A*B*C : ns)
Wt. of 100 seed (g.)	0	80.1	82.5	85.6	85.6	83.5	83.5	86.3	89.4	89.4	87.2	85.3	(A : 0.4)
	6	80.8	83.2	86.1	85.6	83.9	84.5	87.0	90.0	89.5	87.7	85.8	(B: 0.6)
	12	81.6	84.0	86.4	86.4	84.6	85.3	87.8	90.3	90.3	88.4	86.5	(C : 0.6)
	18	79.0	81.4	82.0	79.2	80.4	82.7	85.0	85.8	82.7	84.1	82.2	(A*B : ns)
mean (A*B)		80.4	82.8	85.0	84.2	83.1	84.0	86.5	88.9	88.0	86.9	85.0	(A*C : ns) (B*C : 1.2) (A*B*C : ns)
straw yield	0	1367.7	1489.9	1583.5	1681.9	1530.8	1532.7	1653.3	1843.7	1997.6	1756.8	1643.8	(A : 23.7)
	6	1429.6	1526.4	1669.2	1827.8	1613.3	1624.7	1810.7	1989.7	2195.9	1905.3	1759.3	(B: 33.7)
	12	1545.4	1767.5	2121.7	2273.7	1927.1	1708.8	1965.9	2332.7	2486.3	2123.4	2025.3	(C : 33.6)
	18	1512.1	1532.7	1480.4	1424.8	1487.5	1794.8	2047.1	2278.5	2027.8	2037.1	1762.3	(A*B : 47.5)
mean (A*B)		1463.7	1579.1	1713.7	1802.1	1639.6	1665.3	1869.3	2111.2	2176.9	1955.6	1797.6	(A*C : 47.5) (B*C : 67.5) (A*B*C : 95.0)
seed yield	0	863.5	949.2	1019.2	1097.6	982.4	988.4	1100.4	1230.6	1338.4	1164.5	1073.4	(A : 16.9)
	6	904.4	977.2	1072.4	1164.2	1029.6	1050.0	1183.0	1306.2	1454.6	1248.5	1139.0	(B: 24.0)
	12	981.4	1125.6	1363.6	1448.7	1229.8	1107.4	1296.4	1544.8	1659.0	1401.9	1315.9	(C : 24.0)
	18	883.1	894.6	863.5	782.6	856.0	1121.4	1309.0	1479.8	1125.6	1259.0	1057.5	(A*B : 33.9
mean (A*B)		908.1	986.7	1079.7	1123.3	1024.4	1066.8	1222.2	1390.4	1394.4	1268.4	1146.4	(A*C :33.9) (B*C :47.9) (A*B*C : 67.7)
Crude protein %	0	16.5	17.3	17.7	17.8	17.3	18.9	19.7	20.1	20.0	19.6	18.5	(A : 0.7)
	6	15.8	17.9	18.0	19.0	17.7	18.1	20.3	20.3	21.4	20.0	18.8	(B: 1.0)
	12	17.2	17.8	18.3	19.2	18.1	19.5	20.1	20.6	20.9	20.3	19.2	(C : 1.0)
	18	16.8	17.7	17.5	17.5	17.4	19.1	20.1	19.8	19.9	19.7	18.5	(A*B : ns)
mean (A*B)		16.6	17.7	17.9	18.4	17.6	18.9	20.0	20.2	20.5	19.9	18.8	(A*C : ns) (B*C : ns) (A*B*C : ns)

Cobalt / Nitrogen interaction effect on faba bean growth parameters and yield component.

Statistical values also presented in Table (3) showed that the other practices (level of N application or cobalt doses) as alone treatment have significantly effect on the above mentioned growth parameters which appeared increasing significantly with increasing the level of N application or Co doses up to 75% of recommended dose and 12 $mg\ L^{-1}$ respectively. The interactions between the agricultural technique and level of N application (A*B) or between the agricultural technique and Co application rates (A*C) in Table (3) showed positively effect in increasing the values recorded of faba bean yield and yield component, these increases were insignificant in most of component studied except the number of pods /plant, seed and straw yields (kg fed^{-1}) were increased significantly, that gave the best values recorded at the raised bed combination with using 75% of recommended dose of N for number of pods / plant, and seed yields (kg fed^{-1}) or the raised bed combination with using 100 % of recommended dose of N for straw yields (kg fed^{-1}), it were 16.5 pods / plant, 1390.4 and 2176.9 (kg/fed), respectively. Also, the highest values of the number of pods / plant, seed and straw yields (kg /fed) were obtained from the combination between the raised bed combinations with using 12 mg L^{-1} dose of Cobalt. It were 16.3 pods / plant, 1315.9 and 2025.3 (kg fed^{-1}) respectively.

In addition to, the interactions between the levels of N and Co application rates (B*C) showed insignificantly effect with the plant highest and crude protein (%), but significantly increasing in number of branches / plant, number of pods / plant and weight of 100 seeds (g), with increasing both of N and Co rates until (75 or 100%) and (12 mg L^{-1}) respectively, where gave the best values compared to the other combination (B*C). This high capacity for producing healthy plants may be due to the parallel role for Co and N to enhance and increases in the nodule formation process resulted in increasing the efficiency of *Rhizobium* bacteria to perform with N fixation, and consequently more protein accumulation that led to increasing seed yield, the same findings were obtained by Gad *et al.* (2011). It was also observed that, the difference between values obtained of these above mentioned components at using 75 or 100 % of N recommended combined with 12 mg L^{-1} of Co were insignificant, while increasing the rates of Co to 18 mg L^{-1} gave a negative significantly effect on all the growth parameters studied may be due to its harmfully effect on soil microbiology and then plant growth.



	0%				50%				75%				100%			
	0	6	12	18	0	6	12	18	0	6	12	18	0	6	12	18
■ straw yield	1450.2	1527.2	1627.1	1653.5	1571.6	1668.5	1866.7	1789.9	1713.6	1829.4	2227.2	1879.4	1839.7	2011.9	2380.0	1726.3
▨ seed yield	926.0	977.2	1044.4	1002.3	1024.8	1080.1	1211.0	1101.8	1124.9	1189.3	1454.2	1171.7	1218.0	1309.4	1553.9	954.1

Fig. 1. Effect of cobalt / nitrogen interaction on faba bean yield

On the other hand, Fig. (1) showed the effect of the cobalt / Nitrogen interaction on faba bean yield, the values of seed and straw yield (kg fed^{-1}) were increased significantly with gradually increasing the level of N application up to 100 % combined with 12 mg L^{-1} of cobalt, which gave the highest values compared to other treatments. Using the highest concentration in soaking solution (18 mg L^{-1}) combined with application of N fertilizers levels reduced faba bean yield compared to other doses of cobalt, these negative effect were more clearly with the highest level of N application (100 % of recommended) particularly in seed yield. Whereas in cases of zero N treatments, faba bean yield significantly increased with increasing cobalt concentration in soaking solution up to 12 mg L^{-1}, then increased insignificantly at using the highest concentration of Cobalt (18 mg L^{-1}).These results are in harmony with those obtained by Kandil *et al.* (2013) who found that cobalt concentration above 12 mg kg^{-1} had an adverse effect on plant growth.

Effect of agricultural practices on macronutrients (NPK) and Co content in whole faba bean plants at harvesting (kg fed^{-1})

Data presented in Table (4) show that all the practices applied had a positive significantly effective on faba bean macronutrients and cobalt as individual factor. N, P and K content in plant were significantly increased to 34.3, 36.7 and 37.9 % respectively with using raised bed system compared to furrow row system, while the cobalt content was decreased. This finding may be due to the highest reduction in EC values in root zone of raised bed system, as a result to down and lateral percolation compared to furrow row system. So, EC concentration arrived to the lowest values or acceptable levels that hadn't any negative effect on macronutrient uptake. This result is in agreement with Tejada *et al.* (2006), Amer (2017), and EL Azab and Mahmoud (2017) who indicated that the excess of Na^{+} and Cl^{-} concentration in soil solution inhibited uptake of macronutrients. It was also noticed that, the increases in used N fertilizer rates up to 100 % from N recommended were followed by gradually increasing in plant macronutrients content, also the content of macronutrients gave the same trend with increasing Cobalt dose up to 12 mg L^{-1}, while using cobalt levels more than 12 mg L^{-1} resulted in significant reduction in concentrations of these nutritive elements. These data are in harmony with those obtained by Kandil *et al.* (2013) who showed that cobalt had positive effect of nutrient contents in soybean plants.

Table 4. Effect of agricultural practices interaction on N, P, K and Co content (kg fed^{-1}) in whole faba bean plants at harvesting (sum of seed and straw values)

Faba bean NPK and Co content (kg fed^{-1}) at harvesting	Treatments	Furrow Row					Raised beds					Mean (C)	LSD at 0.05 level
		Rate of N fertilizer from recommended doses											
	Co rates (mg L^{-1})	0 %	50 %	75 %	100 %	mean (A*C)	0 %	50 %	75 %	100 %	mean (A*C)		
N	0	32.4	42.3	47.0	51.2	51.2	43.1	54.6	63.1	68.0	57.2	54.2	(A : 2.18)
	6	34.1	44.5	49.9	58.2	58.2	44.7	60.1	67.3	78.0	62.5	60.4	(B: 3.08)
	12	39.8	51.0	63.9	72.1	72.1	50.0	65.7	80.4	88.3	71.1	71.6	(C : 3.08)
	18	37.4	42.7	42.2	38.7	38.7	50.2	62.8	72.1	55.5	60.1	49.4	(A*B : 4.36)
mean (A*B)		35.9	45.1	50.7	55.0	46.7	47.0	60.8	70.7	72.4	62.7	66.7	(A*C : ns) (B*C : 6.2) (A*B*C : ns)
P	0	21.5	24.4	27.2	30.1	30.1	26.2	30.3	34.5	38.5	32.4	31.2	(A : 1.87)
	6	24.5	26.4	30.5	32.1	32.1	33.0	37.5	44.9	46.1	40.4	36.3	(B: 2.65)
	12	24.7	28.9	35.6	38.9	38.9	29.8	36.3	46.3	48.3	40.2	39.5	(C : 2.65)
	18	26.0	27.3	29.4	22.1	22.1	35.7	42.3	46.4	38.4	40.7	31.4	(A*B : ns)
mean (A*B)		24.2	26.7	30.6	30.8	28.1	31.2	36.6	43.0	42.8	38.4	40.2	(A*C : 3.75) (B*C : 5.3) (A*B*C : ns)
K	0	20.1	26.7	31.6	35.3	35.3	27.5	32.9	37.8	42.5	35.2	35.3	(A : 3.19)
	6	20.3	28.7	33.1	36.1	36.1	31.4	37.2	40.9	47.5	39.3	37.7	(B: 4.51)
	12	27.8	35.1	39.7	46.8	46.8	35.7	45.3	55.6	56.6	48.3	47.5	(C : 4.51)
	18	28.3	31.6	31.5	30.7	30.7	41.6	52.2	58.8	50.4	50.7	40.7	(A*B : ns)
mean (A*B)		24.1	30.5	34.0	37.2	31.5	34.0	41.9	48.3	49.2	43.4	45.7	(A*C : 6.37) (B*C : ns) (A*B*C : ns)
Co	0	1.1	1.1	1.2	1.3	1.3	1.0	1.2	1.3	1.4	1.2	1.2	(A : 0.07)
	6	1.5	1.5	1.7	1.8	1.8	1.1	1.2	1.4	1.6	1.3	1.6	(B: 0.09)
	12	1.7	2.1	2.4	2.7	2.7	1.4	1.6	1.9	2.0	1.7	2.2	(C : 0.09)
	18	2.0	2.2	2.1	2.0	2.0	1.9	2.1	2.5	2.2	2.1	2.1	(A*B : ns)
mean (A*B)		1.6	1.7	1.8	1.9	1.8	1.3	1.5	1.7	1.8	1.6	1.7	(A*C : 0.13) (B*C : 0.2) (A*B*C : ns)

On the other hand, the interaction between the practices application (A*B) showed significantly increasing in plant content from N. But the interaction between (A*C) appeared significantly increasing in plant macronutrients content particularly with P and K nutrients, this may be due to the positive role of cobalt in water movement and its tendency towards the rhizospher area near the plant root zone and consequently the enhancement occurred in the minerals uptake by the growing plants particularly in cases studied (Raised bed system), these data are relevant with the finding of (Raj and Rao 1996) who found that the combined treatment of *Rhizobium* and Cobalt had increased the minerals uptake by legumes. Moreover, the interaction between the rates of N and Co application (B*C) (in fig. 2) showed that the macronutrients content removed to plant from N untreated soil (control) were the lower values, although it was inoculated with *Rhizobium*. The plant macronutrients content were increased significantly with increasing Cobalt doses application in combination with *Rhizobium*, particularly at the use of the large dose of cobalt (12 or 18 mg L^{-1}) compared with the seeds cobalt untreated (control), this results indicated on successfully the interaction between *Rhizobium* inoculation and seed soaking in cobalt solutions. Also, these increases in macronutrients content (N and P) were more pronounced with increasing the rate of N application where increased gradually up to the concentration of Co (12 mg L^{-1}) then decreased with the highest concentration of Co (18 mg L^{-1}) as resulted to the negative effect on the plant growth particularly in presence the high rates of N applied.

Effect of agricultural practices interaction on the residual of available macronutrients in soil rhizosphere at harvesting time

Data in Table (5) showed the effect of agricultural practices applied on residual available macronutrients in soil rhizosphere at harvest. The statistical analyses of data revealed that there are significantly differences effects for raised bed system on residual available macronutrients in the root zone. N available values (mg kg^{-1}) significantly increased compared to the available values under the furrow row system. This data obtained presumably attributed to salinity decrease in bed shoulder (root zone) in raised bed system, which enhanced and improved root penetration and plant growth as a consequence of increasing the microorganism activity and nitrogen fixation particularly with cobalt treatments. So, this amount of nitrogen may be sufficient to growth and over with its needed. These data are in agreement with those obtained by Amer *et al.* (2011) who found that the using raised bed technology followed by improving soil physicochemical and biological properties that led to increase nitrogen use efficiency.

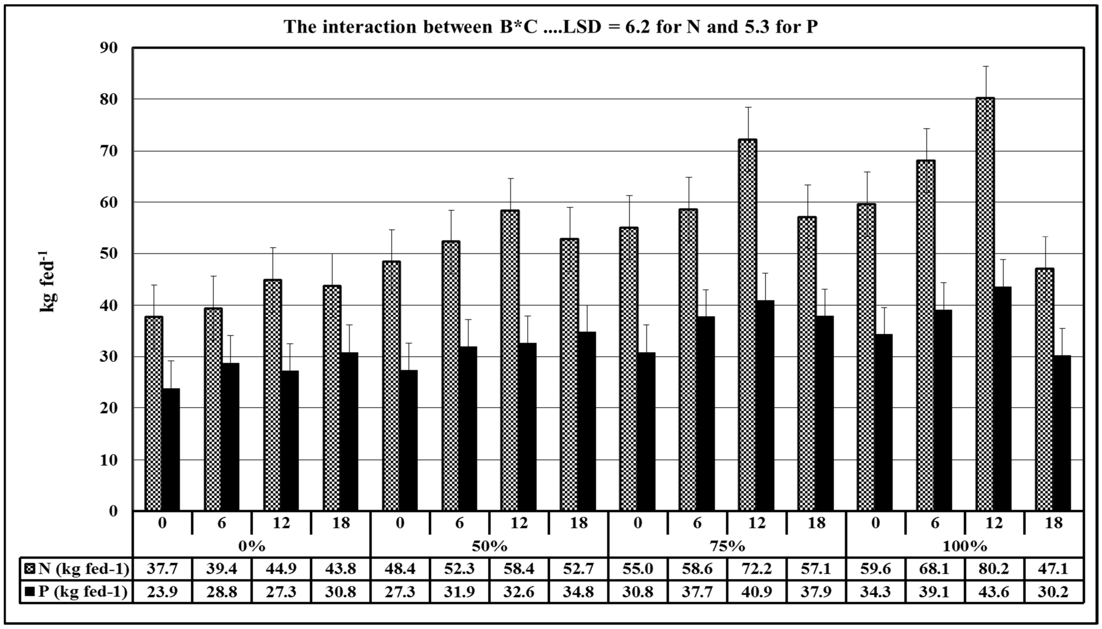


Fig. 2. Effect of cobalt / nitrogen interaction on faba bean macronutrients contents

Table 5. Effect of practices interaction on residual available macronutrients (N, P, K) in soil (kg fed^{-1})at harvesting.

Item studied	Treatments	Furrow Row					Raised beds					mean (C)	LSD at 0.05 level
		Rate of N fertilizer from recommended doses											
	Co rates (mg L^{-1})	0 %	50 %	75 %	100 %	mean (A*C)	0 %	50 %	75 %	100 %	mean (A*C)		
Residual available macronutrients in soil (kg.fed^{-1}) N	0	23.6	29.9	35.5	36.8	36.8	31.4	34.0	39.9	43.3	37.1	37.0	(A : 2.81)
	6	29.9	32.7	36.4	41.3	41.3	34.0	36.6	36.7	42.2	37.4	39.3	(B: 3.97)
	12	31.7	38.6	38.8	42.9	42.9	33.6	40.1	42.4	45.4	40.4	41.7	(C : 3.97)
	18	30.2	34.9	28.6	25.0	25.0	28.4	41.5	35.8	32.6	34.6	29.8	(A*B : ns)
	mean (A*B)	28.9	34.0	34.8	36.5	33.5	31.8	38.1	38.7	40.9	37.4	38.8	(A*C : ns) (B*C : ns) (A*B*C : ns)
P	0	4.5	5.3	5.2	5.9	5.9	4.0	4.7	4.7	5.2	4.7	5.3	(A : 0.41)
	6	4.7	5.6	6.0	5.7	5.7	4.2	5.0	5.4	5.1	4.9	5.3	(B: ns)
	12	5.0	5.4	5.5	4.2	4.2	4.5	5.2	4.9	4.7	4.8	4.5	(C : ns)
	18	5.3	5.3	5.1	4.8	4.8	4.8	4.5	4.8	4.6	4.7	4.7	(A*B : ns)
	mean (A*B)	4.9	5.4	5.4	5.2	5.2	4.4	4.8	4.9	4.9	4.8	4.9	(A*C : ns) (B*C : ns) (A*B*C : ns)
K	0	184.0	186.3	181.0	178.3	178.3	168.3	170.1	167.2	168.1	168.4	173.4	(A : 2.36)
	6	178.7	179.7	184.0	186.3	186.3	163.1	168.4	170.5	170.1	168.0	177.2	(B: ns)
	12	181.0	178.3	178.7	179.7	179.7	164.5	173.1	173.3	177.4	172.1	175.9	(C : ns)
	18	184.0	186.3	181.0	178.3	178.3	168.3	170.1	170.5	164.7	168.4	173.4	(A*B : ns)
	mean (A*B)	181.9	182.7	181.2	180.7	181.6	166.0	170.4	170.4	170.1	169.2	170.0	(A*C : ns) (B*C : ns) (A*B*C : ns)

In contrast, there are insignificantly effects of raised bed system on P and K available contents in soil rhizosphere (bed shoulder), while the decreasing in residual P and K contents in root zone of raised bed system may be attributed to increasing the consumption of P and K nutrients as a consequence of increasing the plant growth without compensation of these nutrients. Also, the other practices like N fertilizer rates applied or cobalt concentration in soaked solution had significant indirect effect on residual available N in soil rhizosphere at harvest particularly with the highest rates of N fertilizer applied or 12 mg L^{-1} of Cobalt concentration as an individual treatments compared with the control (untreated). In contrast, each of N or Co practices had insignificantly effect on the available P and K nutrients in soil rhizosphere. Furthermore, the statistical analyses for data showed that, all the interaction between the agricultural practices whether (A*B), (A*C), (B*C) or (A*B*C) insignificantly effected on residual available N, P and K in soil rhizosphere. On the other hand, the available Co concentrations measured at harvest in soil treated were very small, so ignored.

CONCLUSION

Soil salinity is a problem too difficult to overcome, requiring salt removal from the root zone (reclamation) to control salinity levels. This is perhaps the most effective strategy to minimize or even eliminate detrimental effects of salinity. Our practices included soil reclamation by using raised bed system with manipulation of fertilizers application (Cobalt / N interaction) for optimizing the faba bean production under saline soil conditioner at a newly reclaimed area. Based on the aforementioned discussions, the best management practices for improving soil properties and increasing faba bean productivity under saline soil were the combination between the Cobalt and N application rates (12 mg L^{-1} and 75% of recommended doses for Co and N respectively) under the raised bed system.

REFERENCES

Abdel-Ghaffar, AS. (1982). Nodulation problems and response to inoculation. Proceeding of the first OAU/STRS International African Conference On biofertilizers, Cairo, Egypt 22-26.

Abdelhamid, M. T., Shokr M. M. B., and Bekheta, M. A. (2010). Growth, root characteristics and leaf nutrients accumulation of four faba bean (Vicia faba L.) cultivars differing in their broomrape tolerance and the soil properties in relation to salinity. Commun Soil Sci Plant Anal 41: 2713–2728.

Akbar, G., Ahmad, M. M., Asif, M., Hassan, I., Hussain Q., and Hamilton, G. (2016). Improved soil physical properties, yield and water productivity under controlled traffic, raised-bed farming. *Sarhad Journal of Agriculture,* 32 (4):325-333.

Amer, A. Kh. (2017). Role of soil amendments, plant growth regulators and amino acids in improvement salt affected soils properties and wheat productivity. *J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (3):123 – 131.*

Amer, A. Kh., El Azab K. M., Mansour S. F. and Ahmed, M. M. M. (2011). Management of salinity problems at Sahl El-Tina, North Sinai. *J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (11): 1099 – 1114.*

A.O.A.C, 1995. Method of analysis. Association of Official Agriculture Chemists. 16th Ed., Washington, D.C.USA.

Atiia, M. A., AbdAlla, M. A. and Allam, S. M. M. (2016). Effect of zinc and cobalt applied with different methods and rates on the yield components of *Vicia faba* L. World Wide Journal of Multidisciplinary Research and Development, 2 (2): 52-58.

Aydin, A., Kant, C., and Turan, M. (2012). Humic acid application alleviate salinity stress of bean (Phaseolus vulgaris L.) plants decreasing membrane leakage. Afr. J. Agric. Res. 7 (7): 1073–1086.

Barbara, F. R. and Brain, L. J. (1994).''Minitab Handbook''. Duxbury press. An Imprint of Wadsworth Publish. Comp. Belmont California, U.S.A.

Beecher, H. G., Thompson, J. A., McCaffery, D. W. and Muir, J. S. (2003). Cropping on raised beds in southern NSW, Agfact P1.2.1, (Revised June 2003) www.agric.nsw.gov.au

Black, C. A. Evans, D. D., Ensminger, L. E., White, J. L., and Clark, F. E. (1982). Methods of Soil Analysis. Am. Soc. of Agron. Inc. publisher Madison, Wisconsin, USA.

Burger, F. and Celkova, A. (2003). Salinity and sodicity hazard in water flow processes in the soil. Plant Soil Environ., 49: 314–320.

Carmen, M. A., Carmen, Z. J., Salvador, S., Diego, N., Maria Teresa R. M. and Maria, T. (2005). Detection for organic traits in faba bean (*Vicia faba* L.). Agric. Conspec. Scie., 70 (3):17-20

Chatterjee, J. and Chatterjee, C. (2003). Management of phytotoxicity of cobalt in tomato by chemical measures. Plant Sci., 164:793-801.

Cha–um, S., and Kirdmanee, C. (2011). Remediation of salt-affected soil by the addition of organic matter – an investigation into improving glutinous rice productivity. Sci Agric 68 (4): 406–410.

Cottenie, A., Verloo, M., Kikens, L. Velghe, G. and Camerlynck, R. (1982). Analytics Problems and Methods in Chemical Plant and Soil Analysis. Handbook, Ed. A. Cottenie, Gent, Belgium.

Devkota, M., Martius, C., Gupta, R. K., Devkota, K. P., McDonald, A. J., and Lamers, J. P. A. (2015). Managing soil salinity with permanent bed planting in irrigated production systems in Central Asia. Agric. Ecosyst. Environ. 202, 90–97.

EL Azab, K. M. and Mahmoud, A. A. (2017). Effect of some agricultural practices on mitigating the harmful of soil salinity for faba bean (*Vicia faba L.*) productivity *J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (6): 285 – 292.*

EL Azab K. M., Amer, A. Kh., Hegab, A. E., and Abou El-Defan, T. A. (2011). Compacting the negative effect of soil salinity stress at Sahl El- Tina area on maize growth and productivity using some fertilization manipulations. Fayoum J. Agric. Res. & Dev., 25 (1):107-123.

EL Azab, K. M. (2015). Alleviation of some problems in newly reclaimed salt affected soil at north by using bio-conditioner to maize production. *J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 6 (10): 1281 – 1303.*

EPA, (1991). Environmental protection agency. methods for the determination of metals in environmental samples. office of research and development. Washington DC, USA.

Gad, N. (2006). Increasing the efficiency of nitrogen fertilizer through cobalt application to pea plant. Research Journal of Agricultural and Biologecal Sciences 2 (6), 433- 442.

Gad, N. Abdel-Zaher, F. H., Abdel-maksoud, H. k., and Abdel-Moez, M. R. (2011). Response of faba bean (*Vicia faba* L.) to cobalt amendments and nitrogen fertilization. The African J. of Plant Science and Biotechnology, (5)1:41-45.

Jana, P. K., Karmakar, S., Ghatak, S., Barik, A., Naybri, A., Soud, G., Nukher, A. K., and Saren, B. K. (1994). Effect of cobalt and *rhizobium* on yield, oil content and nutrients concentration in irrigated summer groundnut. Ind. J. Agric. Sci, 64:630-632.

Kandil, H., Farid, I. M., and El-Maghraby, A. (2013). Effect of cobalt level and nitrogen source on quantity and quality of soybean plant. *J. Basic. Appl. Sci. Res.*, 3(12)185-192.

Kandil, H. (2007). Effect of cobalt fertilizer on growth, yield and nutrients status of faba bean (*Vicia faba* L.) Plants. Journal of Applied Sciences Research, 3(9): 867-872.

Klute, A. Ed. (1986). "Methods of Soil Analysis." No. 9 Part 1, Amer. Soc. Of Agron., Inc. Madison, Wisconsin, USA.

Lockerman, R. H., Kisha, T. J., Sims, J. R., and Abdel-Ghaffar, A. S. (1983). The effect of soil salinity on nitrogen fixation and yield of faba bean *(Vicia laba* L.). FABIS Newsletter 7: 24-25.

Mathur, N., Singh, J., Bohra, S., Bohra, A. and Vyas, A. (2006). Effect of Soil Compaction Potassium and Cobalt on Growth and Yield of Moth Bean. International J. Soil Science, 1(3):269-271.

Matijevic, L., Romic, D., Romic, M., Maurovic, N., and Kondres, N. (2014). Faba bean (*Vicia faba* L.) salt stress response under different soil organic matter content. Agric. Conspec. Sci. Vol. 79 No.1.

Mohandas, S. (1985). Effect of presowing seeds treatment with molybdenum and cobalt on growth, nitrogen and yield in bean (*Phaseolus vulgaris* L.) Plant Soil, 86,283-285.

Orak, A. and Ates, E. (2005). Resistance to salinity stress and available water levels at the seedling stage of the common vetch (*Vicia sativa L.*). Plant Soil Environ., 51: 51–56.

Ozer, H., Polat T., and Ozturk, E. (2004). Response of irrigated sunflower (*Helianthus annuus L.*) hybrids to nitrogen fertilization: growth, yield and yield components. Plant Soil Environ. 50: 205–211.

Page, A. L., Miller, R. H., and Keeney, D. R. (1982). "Methods of Soil Analysis". II. Chemical and Microbiological Properties 2nd Ed. Madison, Wisconsin, U.S.A.

Petersen, F. H. (1996). Water testing and interpretation. In: Reed, D.W. (ed.) Water, media, and nutrition for greenhouse crops. Batavia: Ball, cap.2, p.31-49.

Raj A. K., and Rao, D. S. R. M. (1996). Effect of Rhizobium inoculation, nitrogen and phosphorus on yield and yield attributes of groundnut. Legume research 19(3-4), 151-154.

Ryan, J., Garabet S., Harmsen K., and Rashid, A. (1996). A Soil and Plant Analysis Manual Adapted for the West Asia and North Africa Region. ICARDA, Aleppo, Syria, 140 pp.

Soltanpour, N. (1985). Use of ammonium bicarbonate - DTPA soil test to evaluate elemental availability and oxicity. Soil Sci. Plant Anal., 16: 3, 323- 338.

Supanjani, E. and Lee, K. D. (2006). Hot pepper response to interactive effects of salinity and boron. Plant Soil Environ., 52: 227–233.

Svoboda, P. and Haberle, J. (2006). The effect of nitrogen fertilization on root distribution of winter wheat. Plant Soil Environ., 52: 308–313.

Tejada, M., Garcia, C., Gonzalez, J. L., and Hernandez, M. T. (2006). Use of organic amendment as a strategy for saline soil remediation: Influence on the physical, chemical and biological properties of soil. Soil Biology & Biochemistry 38, 1413–1421.

Tewari, R. K., Kumar, P., Sharma, P. N., and Bisht, S. S. (2002). Modulation of oxidative stress responsive enzymes by excess cobalt. Plant Sci. 162:381-388.

Villa-Castorena, M., Ulery AL., Catalan-Valencia, EA., Remmenga, MD. (2003). Salinity and nitrogen rate effects on the growth and yield of chile pepper plants. Soil Sci. Soc. Am. J. 67:1781–1789

Yadav, D.V., and Khanna, S. S. (1988). Role of cobalt in nitrogen fixation: A review. Agricultural Review 9 (4), 180 -182.

إدارة التربة الملحية لتحسين خصوبتها وإنتاجيتها عن طريق تطبيق بعض الممارسات الزراعية

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أجريت دراسة ميدانية خلال الموسم الشتوى 2016/2015 على تربة ملحية بسهل الطينة ، محافظة شمال سيناء ، مصر ، لدراسة تأثير الممارسات الزراعية المختلفه (نظام المصاطب ، معدلات الأسمدة النيتروجينية ونقع البذورفى محلول الكوبالت) سواء أكانت بمفردها أو مقترنًه معاً على تحسين خصوبة التربة الملحية وإنتاجيتها لنبات الفول البلدى صنف نوبارية (1). أوضحت النتائج أن: إنخفاض قيم ملوحة التربة (EC) كان أكثر وضوحاً في كتف المصطبة عنه فى جنب الخط أى فى منطقة إنتشار الجذور لكل من المصاطب والخطوط على التوالى مع زيادة عدد الريات. كل من صفات النمو ومكونات المحصول التي تمت دراستها سجلت أعلى نسبة عند إستخدام نظام المصاطب مقارنة بنظام الخطوط. أيضا ، تم زيادة كل من محصول البذور والقش (كجم / فدان) بشكل ملحوظ مع زيادة تدريجية لمستويات السماد النتروجينى المستخدم حتى 100٪ من الموصى به مصحوبا ب 12 مجم / لتر من الكوبالت ، ولكن مع زيادة تركيزالكوبالت في محلول النقع حتى 18 مجم / لتر يظهر التأثير السلبي الكبير على جميع صفات النمو ومكونات المحصول التي تمت دراستها. زيادة محتوى نبات الفول البلدى من المغذيات الكبرى بشكل كبير مع تطبيق نظام الزراعة على المصاطب ، حيث وصلت إلى 34.3 و 36.7 و 37.9٪ لكل من النتروجين والفوسفور والبوتاسيوم على التوالي مقارنة بنظام الزراعة فى خطوط. أيضا ، تم زيادة محتوى المغذيات الكبرى بزيادة كل من معدلات إستخدام السماد النتروجينى مصحوبا ب 12 مجم / لتر من الكوبالت ثم إنخفضت مع زيادة التركيز الى 18 مجم / لتر. إزداد المتبقي من عنصر النيتروجين المتاح بشكل ملحوظ في منطقة إنتشار الجذورمن التربة عند إستخدام جميع الممارسات الزراعية كعوامل فردية. في المقابل ، هناك آثار ضئيلة لهذه الممارسات على المحتويات المتاحة من عنصرى الفوسفور والبوتاسيوم فى منطقه إنتشار الجذور بالتربة. تركيز الكوبالت فى محلول نقع البذور ليس له تاثير على زيادة محتواه فى النبات أو التربة. حيث كانت تركيزاتة قليلة جدا فى النبات ومتناهية فى الصغر فى التربة وعليه تم إهمالها.