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Effect of Some Agricultural Practices on Mitigating the Harmful of Soil Salinity for Faba Bean (*Vicia faba L.*) Productivity

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ABSTRACT

Management of saline soils is the main concern of many specialists in order to mitigate or reduce the salinity problems on the plant for increases its ability to produce crops. Thus, a field experiment was carried out during the winter season of 2014/2015, on a sandy loam soil at a newly reclaimed area of Sahl El-Tina, Galbana Village No.7, North Sinai, Egypt., to evaluate some of agricultural practices proposed *i.e.* agricultural system (raised beds or furrow row system) and Zn SO_4 foliar application on alleviate salinity stress and faba bean yield and yield components. The results can be summarized as follows ; the raised bed system contributed in good manage of salt accumulation, where the soluble salts were pushed from the root zone of bed shoulder towards bed middle as a result of dawn and lateral irrigation movements. Thus, the gradually decreasing in soil salinity with the consecutive irrigations had significantly positive effect on plant heights, number of branches/plant, number of pods/plant, straw yield, seed yield, weight of 100 grains and protein contents (%) in seeds of faba bean plants under raised bed system compared to furrow row system. In addition to, the amounts of macronutrients uptake by plant and its chlorophyll content were significantly increased with using raised bed system. In contrast, the prolien content of faba bean plant was decreased with fading the salinity stress problems under this condition. Furthermore, Zn SO_4 foliar application treatments gave the same trend particularly with 200 mg L^{-1} as individual treatment, except number of branches/plant and protein contents (%). This positive effect was higher clearly with the interaction between raised beds system and 200 mg L^{-1} (Zn SO_4) treatment.
Keywords: Agricultural practices, soil salinity, manage accumulation and faba bean crop.

INTRODUCTION

Salinity is one of the main environmental factors that limiting crop productivity in many regions like Egypt, most of the salinity problems are often more complex, which are caused by increasing the root zone soluble salts. These salts accumulate often appeared in the arid and semi-arid climates as consequence to irrigation water or seepage of groundwater evaporates, leaving minerals behind. These excess amounts of salts which soluble in saline soils inhibit seed germination, growth of plant and vigor (Memon, *et al.,* 2010 and Fayez and Bazaid, 2014), by altering water uptake and causing ion-specific toxicities or imbalances, which induced the generation of hydrogen peroxide, increased tissue levels of Na^+ and Cl^-, reduced K^+ and Ca^{2+}, and K^+: Na^+ and Ca^{2+}: Na^+ ratios. (Tester and Davenport, 2003, Tejada *et al.*, 2006 and Rasheed *et al.,* 2016). Also, many of studies underline the adverse effect of salinity on biochemical processes and reduce the photosynthetic pigments content in the treated plants. (Murillo-Amador *et al.,* 2007; Abdul Qados, 2011)

Although several approaches can reduce the quantities of soil salts, which are either impossible or too costly to achieve low salinity levels. Saline soils cannot be treated by chemical amendments or fertilizers, they only can be reclaimed by removing the salts from the root zoon by increasing the irrigation water applied than plant need to sufficient leaching requirement. The reduction of soil salinity may be a result of increasing the volume of percolated water below the root zone (Petersen, 1996). Sometimes, selecting crops tolerance to salt stresses may be needed to management saline soils.

Recently attention was given to several agricultural practices used as alternative approaches and techniques to combat salt stress and improve the productivity of salt affected soil, e.g. 1- Agricultural systems; (Raised beds system) where the planting location and the furrows are distinctly and permanently separated. Soil amount is moved from the furrows and added to the bed location (crop zone), slightly raising the surface level of the raised bed. Beecher, *et al.,* (1997) reported the advantages of raised bed system where improved internal and surface drainage of the soil, improved the structure of crop zone soil, and reduced tillage requirements. In addition to, Amer, *et al.,* (2011) used this system to reclaim saline soil, where raised beds have been constructed by farmers and was filled by organic matter recommended, these results explained that the chemical properties of soil were improved, the soil salinity reduced more than 50% approximately, especially for Cl^- and Na^+ in the root zone of maize under raised beds system. On the other hand, increasing nitrogen efficiency and maize yield component were recorded the best values with raised beds system. Also, raised beds system was used to reclaim the sodicity soil by Amer, (2017) with some modification, where the beds were filled with rice straw and using flooding irrigation system to leaching the upper layer of raised bed completely and prevent return the salts to the beds surface, this develop raised beds system was combined with plant growth regulators (PGRs) for maximizing wheat production in this harmful conditions. 2- Using foliar application of certain micronutrients to induce increases in tolerance of growing plants of faba bean to salinity by alleviating Na^+ and Cl^- injury to plants (El-Fouly *et al.,* 2002). However, it was found that 2000 and 5000 mg kg^{-1} soil Na Cl inhibited nutrient uptake and growth of faba bean plants, while micronutrients spraying either before or after the salinity treatments can restore the harmful effect of salinity on dry weight and nutrients uptake of plants (El-Fouly *et al.,* 2010).

Zinc plays an important role in various host plant metabolic processes, nodule growth and N_2 fixation processes as an essential nutrient (Fageria, 2009), for optimum growth of crops, and helps in protecting vital cellular components such as chlorophyll by preventing their oxidation (Cherif *et al*., 2010). In addition to, salt stress was reported to be mitigated by Zn. Zinc can reduce the adverse effects of Na Cl. Tavallali, *et al*., (2010) concluded that, Zn supplement efficiently reduced all the negative effects of salt stress. Jiang *et al*., (2014) reported that zinc has been previously reported to combat salinity stress in plants and the low concentration of Zn was ineffective in alleviating stress while the higher zinc concentration inhibited plant growth a cause of his toxicity to plants. The foliar application zinc sulfate at 15 µmol L^{-1} was reported to be the most appropriate at salinity stress levels. Numbers of studies have found that zinc used to relieve of salt stress, the high amounts of continuous soil application from zinc sulfate is not recommended because it may be result a zinc accumulation in the soil, which is undesirable, but the spray of zinc sulfate in small amounts is more feasible and applied on the plants when required.

Faba bean (*Vicia faba* L.) is moderately tolerant to salinity with growth reduction at EC 6 dS m^{-1} and more for irrigation water (Al-Tahir and Al- Abdulsalam 1997). It considered as one of the important winter season legume crops produced worldwide, especially in Egypt as its high yield makes it attractive to producers and its high protein and even carbohydrates content makes it attractive to consumers (Daur *et al.,* 2010 and Reda, *et al.,* 2014). Abdelhamid, *et al.,* (2010) reported that the ratios K^+/Na^+ and Ca^{2+}/Na^+ in faba bean leaves decreased by increasing salinity levels gradually, and reached their lowest values at the highest level of salinity. Although, faba bean plants were more sensitive to high levels of salinity (EC). The main target of this study was conducted to identify some scientific approaches i.e. agricultural practices (Raised beds or furrow row system) with Zn foliar application levels for mitigating the harmful effect of soil salinity on faba bean productivity.

MATERIALS AND METHODS

To achieve the aforementioned target, a field experiment was conducted on a sandy loam soil that is suffering from salinity stress and Zn-deficient at a newly reclaimed area of Galbana Village No. 7, Sahl El-Tina, North Sinai, Egypt during a growing winter season of 2014/2015 to investigate the effect of agricultural practices; agricultural system (Raised bed and furrow row) and Zn SO_4 foliar application levels, whether alone or combined with both on alleviating the negative effect of soil salinity stress and faba bean productivity. Some chemical and physical properties of surface soil layer (0 – 30 cm) were determined according to standard methods after Page *et al*., (1982) and Klute, (1986), and presented in Table (1).

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

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	23.00	44.81	27.94	53.00	1.57	1.53	54.87	70.92	8.79	11.00
10-20	9.35	23.00	38.00	25.64	44.51	4.05	2.08	54.94	55.18	7.89	10.08
20-30	8.25	23.00	31.00	21.15	47.43	4.40	2.25	57.66	44.07	9.29	11.52
mean	9.47	23.00	37.94	24.91	48.31	3.34	1.95	55.82	56.72	8.66	10.87

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	Zn
15.8	55.2	12.9	16.1	Sandy Loam	0.88	7.70	8.00	40.10	5.80	185.00	0.75

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 kg P_2O_5 fed^{-1}. The designed experimental area was laid out in a split plot design with four replicates. The main plots were two agricultural systems, Raised bed (which make manual according to the described methods after Amer *et al.,* (2011)) or furrow row systems, sub plots were three rates of Zn SO_4. $7H_2O$, which dissolved in water and added foliar spray on plants with rate of 0.0, 100 and 200 mg Zn SO_4 L^{-1}, the spray solutions were twice sprayed at 45 and 60 days after sowing. The experimental area was included 6 treatments with four replicates, (24 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. Faba bean seeds (*Vicia faba,* L. Noubaria 1) were soaked in 2 % Urea for ~18h before planting for obviation salt damage and enhance the germination under saline conditions according to El Azab, *et al.,* (2011). The soaked seeds were cultivated in hills (by rates of 3 seeds/ hill ~ 40 plant m^2) on shoulder bed and in the 1/3 top of row ridge (in 16 November 2014) and all the other usual agricultural practices were followed according to the usual methods recommended by Ministry of Agriculture (fertilizer Nitrogen and Potassium fertilizers were added in the form of ammonium sulfate (21.5% N) and potassium sulfate (48 % K_2O), at recommended doses (45 units of N fed^{-1} and 24 units of K_2O fed^{-1}, respectively) and inoculation by Rhizobium was done. The experimental soil was flood irrigated for immerge the bed with mixed water (Nile water + drainage water) derived from El-Salam Canal (1.8 dS m^{-1}). Managing irrigation schedules (amounts and timing), irrigation was done every 8 days till crop maturity.

Soil sampling

Soil samples were collected two days after irrigation and before each follow irrigation to the primary fourth follows irrigations and at harvest. Each time, samples were taken from twelve points (top (2 ,5) , furrow ridge (3, 6) and bottom (1,4,7) of the furrows, middle of raised bed (10), two bed shoulders (9, 11), bottom of both sides of bed (8, 12) (Fig. 1) with three replications in each main treatment (cultural practices).

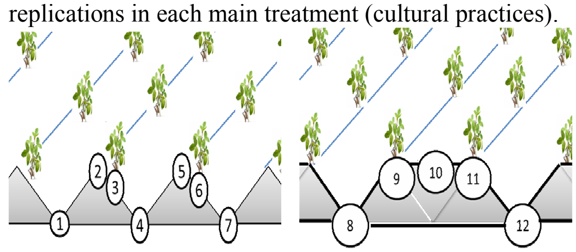

Fig. 1. Vertical cut through a furrows and raised bed management agricultural practices in saline soil.

Samples were taken at every10 cm soil depth down to 40 cm using a tube auger, air dried and chemical analyzed for electrical conductivity (EC) and soluble cations and anions were determined in soil paste extract according to Page *et al*., (1982). Available nutrients (*i.e.,* N, P, K and Zn as mg kg^{-1} soil) were determined at harvest in the rhizospheric soil (root zone) for each plot, according to the method described by Cottenie *et al.,* (1982).

Plant sampling:

1-Chlorophyll determination:

At ages of 90 days, one gram of fresh tissue leaves of faba bean plants, taken and extracted with dimethylformamide and was determined Spectrophotometrically by the method of Inskeep and Bloom (1985).

2-Proline analyses:

The leaf tissue proline content was measured following the method described by Troll and Lindsley (1955) and streamlined and developed by Dreier and Göring (1974) Thus, 100 mg of fresh leaf material was homogenized in 2 ml of 40% methanol, and then heated in a water bath at 85°C for 60 min. The absorbance was measured at 528 nm in a spectrophotometer .

3-Yield and yield components:

At harvest, the plants in ten hills were randomly collected from each plot to determine the 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}). Plant samples (seed and straw) were dried at 70 ^{0}C, crushed and wet digested using a mixture of H_2SO_4 + $HClO_4$ acids to determine nutrient contents in aliquots of the digested solutions, i.e., N, P, K, Na (%) and Zn in mg kg^{-1} (Ryan *et al*., 1996). Crude protein content (%) in seeds was determined by multiplying the nitrogen percentage by 6.25 according the method described by A.O.A.C., (1984).

4-Statistical analysis

The obtained data were exposed to proper 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 agricultural systems on salt accumulation:

Data presented in Table 2 (a & b) and fig. 2 (a & b) indicated that the mean values of soil salinity obtained were decreased with using the cultural practice treatments compared with the initial data before sowing (control), whether measured after irrigation or before the next irrigation directly. It was observed that the mean values of soil salinity gradually decrease with increasing the number of irrigations, where salinity decreased in the root zone area of bed shoulder before the second irrigation, third, fourth and fifth respectively, this decrease was more pronounced after the first irrigation, second, third and fourth respectively in the same bed shoulder, which helps to reduce the negative effects of salt stress on plant growth. Also, at using the furrow row system, the decreasing in salinity values (EC) take the same trend but less frequently. On the contrary, the salts were moved and accumulated towards the middle of the beds (unplanted) and the top of the furrow row which negatively effects on plant growth in this agricultural system (furrow row system) compared to raised bed system.

Table (2, a and b). Effect of agricultural systems on salinity distributions (dS m^{-1}) in soil profile after and before irrigation.

(a) Furrow row system

Agricultural systems and time of analysis		Depth (cm)	first irrigation			2^er^ irrigation			3^er^ irrigation			4 irrigation			after harvesting		
			Top of row	furrow ridge	bottom of furrow	Top of row	furrow ridge	bottom of furrow	Top of row	furrow ridge	bottom of furrow	Top of row	furrow ridge	bottom of furrow	Top of row	furrow ridge	bottom of furrow
Furrow row	After irrigation	0-10	7.4	7.0	6.4	7.6	6.3	5.6	7.4	5.8	5.2	7.2	5.2	5.0			
		10-20	6.9	6.2	5.8	6.8	5.1	5.1	6.1	4.9	4.6	5.7	4.2	4.2			
		20-30	6.1	7.2	6.1	5.1	5.8	6.1	4.8	5.0	5.5	4.2	4.6	5.9			
		30-40	8.1	9.2	9.5	8.8	8.4	10.1	8.3	8.0	9.8	8.1	7.9	10.0			
	before the follow irrigation	0-10	9.7	8.8	7.0	9.8	8.2	6.8	10.8	7.8	6.1	11.1	6.4	5.8	13.2	9.8	7.1
		10-20	7.0	7.5	6.5	7.5	7.2	6.0	8.1	6.7	5.4	8.4	5.2	5.0	10.1	8.5	6.7
		20-30	7.1	8.1	6.7	6.8	7.8	6.3	7.1	7.6	6.5	7.7	6.3	6.1	9.2	6.3	9.4
		30-40	10.1	9.3	10.5	9.8	8.9	9.6	9.9	8.7	9.8	10.0	8.5	10.1	10.1	8.4	9.8

(a) Raised bed system

Agricultural systems and time of analysis		Depth (cm)	first irrigation			2^er^ irrigation			3^er^ irrigation			4 irrigation			after harvesting		
			Center of bed	bed shoulder	bottom of bed	Center of bed	bed shoulder	bottom of bed	Center of bed	bed shoulder	bottom of bed	Center of bed	bed shoulder	bottom of bed	Center of bed	bed shoulder	bottom of bed
Raised beds	After irrigation	0-10	8.1	6.4	5.5	9.5	5.0	5.1	10.0	4.2	4.7	10.7	3.7	4.2			
		10-20	7.8	5.8	5.3	8.9	4.3	5.1	9.1	3.8	4.3	9.5	3.4	3.8			
		20-30	7.1	6.7	8.2	7.2	4.9	8.2	9.1	4.1	7.8	9.7	3.8	6.9			
		30-40	9.7	9.5	9.2	9.1	8.6	9.3	9.6	7.8	9.8	10.1	7.1	9.8			
	before the follow irrigation	0-10	10.9	10.2	7.6	11.9	9.2	6.8	12.6	8.8	6.5	14.1	7.0	6.4	14.7	7.1	7.1
		10-20	9.1	9.2	6.8	10.8	7.0	6.3	11.6	6.5	6.3	12.9	5.3	6.2	13.0	6.1	6.4
		20-30	7.9	8.2	8.1	8.9	6.5	8.1	9.4	5.7	8.2	10.1	4.4	7.8	11.5	5.8	8.7
		30-40	9.8	9.2	9.9	9.5	8.9	9.2	9.2	7.2	9.3	9.7	7.8	9.8	10.1	9.4	9.2

(a) Furrow row system. ***(a) Raised bed system.***

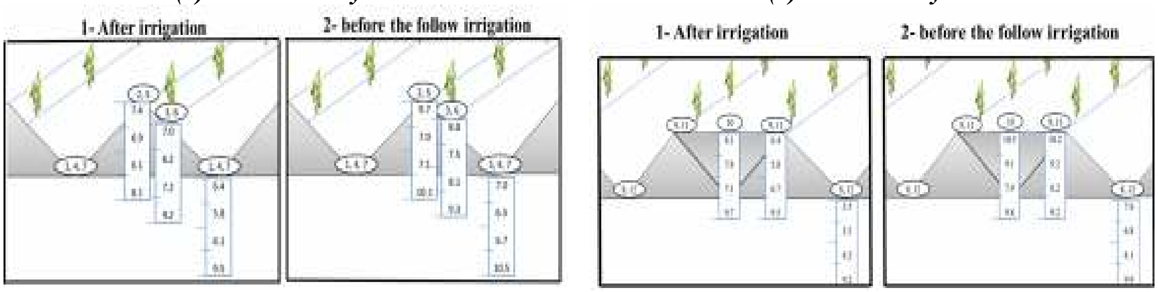

Fig. 2, a and b. The mean values of EC (dS m^{-1}) for soil profile (0- 40 cm) after the first irrigation and before the 2er irrigation.

Although, increasing the salinity values measured in the soil profile before irrigation compared to after irrigation under the same conditions, the salts accumulation in the middle of raised bed was immediately higher than in the top of furrow row. This is due to two main factors; evaporation process, which water evaporates from the raised bed surface leaving the salts on the surface through draying time. The second factor is the lateral movement of water from the furrow towards the middle of raised bed through irrigation time, which salts are ‘pushed’ across the bed from the irrigated side of the furrow. Figure (3) illustrate the salt manage accumulation in this manner. The goal is to ensure the zones of salt accumulation stay away from germinating seeds and plant roots zone. Without uniform distribution of water by this method, salts will build up in areas where the germinating seeds and seedling plants will experience growth reduction and possibly death. where, on the basis of the equal quantity of irrigation water for each experimental plot, the number of furrow in raised bed system is less than the number of furrow in furrow row system, thus the large amounts of water irrigation in the furrow around the raised bed system able to move and push the salt in two ways, down with percolation and lateral with water movement towards the middle of raised bed through bed shoulders. So, the bed shoulder were exposed to two types of leaching, percolation at the beginning of flood irrigation and leaching with lateral movement of irrigation water at deceases the amount water on the raised bed surface. Finally, salts are most efficiently leached from the bed shoulders immediately under higher frequency irrigation (shorter irrigation intervals) to prolong saline field productivity.

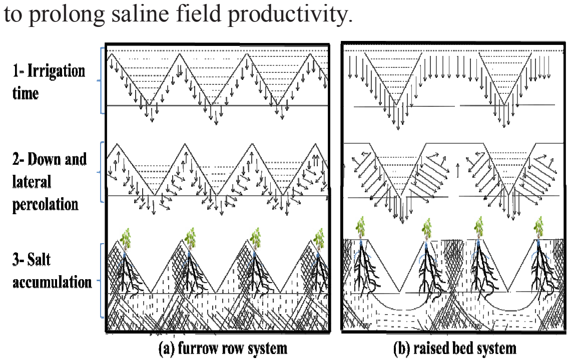

Fig. 3. Salt manage accumulation as affected by different agricultural systems (a, and b).

Effect of agricultural practices on available macro and micronutrients in root zone at harvesting time.

Data in Table (3) showed the effect of treatments on the residual of available macronutrients in soil at harvest. The statistical analyses of data revealed that there are only significantly differences between both the agricultural practices on N and Zn contents in the root zone. Each available values of N and Zn (mg kg^{-1}) was significantly increased with raised bed compared to the furrow row, This finding presumably may be attributed to decrease the salinity in bed shoulder particularly in root zone, which enhances and improve root penetration and plant growth as a consequence of increasing the microorganism activity and nitrogen fixation. In contrast, there aren’t significantly effects of the agricultural practices on P and K available contents in root zone, while the decreasing in residual P and K contents in root zone of raised bed system may be attributed to increasing the uptake of P and K nutrients as a consequence of increasing the plant growth. Also, there aren’t significantly effects of the Zn foliar application rates on the available values of macro and micronutrients studied in the root zone.

Effect of agricultural practices on total macronutrients uptake by faba bean plant

Data in Table (4) showed significantly increasing in total N, P and K uptake as a resulted from the individual treatments application, whether agricultural system (raised beds and furrow row) or Zn SO_4 foliar application rates on faba bean plants, while increases in the amounts uptake from N, P and K nutrient reached to 43.7, 38.3 and 52.4% respectively at raised bed compared to furrow row system. This finding may be attributed to the advantages of raised bed system, i.e. which recorded the highest reduction in EC values in root zone of bed shoulder that exposed to down and lateral percolation, so the concentration of Na^+ and Cl^- 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) and Amer, (2017) who reported that the excess of Na^+ and Cl^- in soil solution inhibited uptake of mineral nutrients, especially N, P and K. In addition to, the amounts of macronutrients uptake by plant were significantly increased with increasing the rates of Zn SO_4 foliar spray, it reached to 18.6, 21.1 and 19.3% for N, P and K respectively with addition 200 mg L^{-1} from (Zn SO_4 solution) as foliar application compared the control (zero concentration), but the obtained increases in macronutrient uptake values at using 100 mg L^{-1} of Zn SO_4 solution were insignificant particularly in case of N and K nutrients.

Table 3. Effect of agricultural practices on availability of macro and micronutrients in soil after the harvest

Treatments		Available macro and micronutrients in soil (mg kg^{-1})			
Agricultural system (a)	Zn SO_4 foliar application (mg L^{-1}) (b)	N	P	K	Zn
Furrow rows	0	35.86	5.58	184.00	0.87
	100	40.53	5.21	186.25	0.96
	200	29.80	5.01	181.00	0.92
Raised beds	0	42.40	4.92	178.25	0.99
	100	40.53	4.40	178.65	1.03
	200	44.27	4.35	179.65	1.07
LSD at 0.05 level (a*b)		ns	ns	ns	ns
Mains of agricultural system	Furrow rows	35.40 b	5.26 a	183.75 a	0.91 b
	Raised beds	42.40 a	4.55 a	178.85 a	1.02 a
LSD at 0.05 level (a)		5.75	ns	ns	0.07
Mains of Zn SO_4 foliar application	0	39.13	5.24	181.12	0.93
	100	40.53	4.80	182.45	0.99
	200	37.03	4.67	180.32	0.99
LSD at 0.05 level (b)		ns	ns	ns	ns

Values are means (n = 4). Values followed by different letters are significantly different, $p < 0.05$.

Table 4. Effect of agricultural system and Zn SO_4 foliar application on total macronutrients uptake (kg fed^{-1}) by faba bean plants at harvest

Treatments		Total macronutrients uptake by faba bean (kg fed^{-1})		
Agricultural system (a)	Zn SO_4 foliar application (mg L^{-1}) (b)	N	P	K
Furrow rows	0	47.89	25.31	33.86 d
	100	51.50	28.29	35.68 d
	200	54.59	28.66	37.07 d
Raised beds	0	67.20	33.53	48.46 c
	100	72.30	37.58	52.94 b
	200	81.87	42.63	61.15 a
LSD at 0.05 level (a*b)		ns	ns	3.91
Mains of agricultural system	Furrow rows	51.32 b	27.41 b	35.54 b
	Raised beds	73.78 a	37.91 a	54.18 a
LSD at 0.05 level (a)		4.16	2.11	2.76
Mains of Zn SO_4 foliar application	0	57.54 b	29.41 c	41.16 b
	100	61.89 b	32.93 b	44.31 b
	200	68.23 a	35.64 a	49.11 a
LSD at 0.05 level (b)		5.10	2.59	3.38

Values are means (n = 4). Values followed by different letters are significantly different, $p < 0.05$.

Effect of agricultural practices on seed and straw yield, yield components and crude protein (%) of faba bean plant

The variances of faba bean yield parameters were statistical analyzed and recorded in Table (5), the data revealed that, plant heights, number of branches/plant, number of pods/plant, straw yield, seed yield, weight of 100 grains and crude protein % in seeds of faba bean plants were significantly increased as a result of using raised bed system compared to furrow row system. The highest percentage increases was noticed in seed yield, which reached to 28.7% and 16.4% at using raised bed system and the foliar application (200 mg L^{-1} Zn SO_4) as individual treatments compared to the furrow row system and the foliar application treatment (zero mg L^{-1} Zn SO_4), respectively.

Table 5. Effect of agricultural system and Zn SO_4 foliar application on seed and straw yield, yield components and crude protein (%) of faba bean plant

Treatments		Yield components				Straw yield Kg fed^{-1}	Seed yield Kg fed^{-1}	Crude protein %
Agricultural system (a)	Zn SO_4 foliar application (mg kg^{-1}) (b)	Plant heights (cm)	Number of branches / plant	Number of pods /plant	Wt. of 100 seed (g.)			
Furrow rows	0	59.3	4.3	12.3	79.5	1328.1	1047.2	17.8
	100	61.6	4.3	13.0	82.0	1344.0	1129.5	17.5
	200	67.0	4.5	13.0	85.0	1390.6	1167.6	18.4
Raised beds	0	67.0	4.8	14.3	85.0	1581.1	1306.7	20.6
	100	69.0	5.0	15.0	89.7	1642.7	1424.3	20.6
	200	73.0	5.8	16.0	93.0	1708.0	1573.6	21.2
LSD at 0.05 level (a*b)		ns	ns	ns	ns	ns	45.2	ns
Mains of agricultural system	Furrow rows	62.6 b	4.3 b	12.7 b	82.1 b	1354.2 b	1114.7 b	17.9 b
	Raised beds	69.7 a	5.1 a	15.1 a	89.2 a	1643.9 a	1434.8 a	20.8 a
LSD at 0.05 level (a)		4.0	0.5	0.4	1.3	42.0	32.0	1.3
Mains of Zn SO_4 foliar application	0	63.1 b	4.5 a	13.2 c	82.2 c	1454.6 b	1176.9 c	19.2 a
	100	65.3 ab	4.6 a	14.0 b	85.8 b	1493.3 b	1276.9 b	19.1 a
	200	70.0 a	5.1 a	14.5 a	89.0 a	1549.3 a	1370.6 a	19.8 a
LSD at 0.05 level (b)		4.9	ns	0.5	1.6	51.4	39.2	ns

Values are means (n = 4). Values followed by different letters are significantly different, $p < 0.05$.

Also, number of branches/plant and protein content (%) in seeds were significantly increased by 25.0 and 16.0 % respectively, at raised bed compared to the furrow row system. The aforementioned findings were agreed with many studies (*i.e.* Amer, 2017). This increasing was attributed to advantage of raised bed system which capable to loosen the root zoon and ameliorates the soil physical action, thus increase water percolation, root penetration, microorganism activity and N fixation. These actions followed by ameliorate the chemical properties particularly decreasing salinity, which in turn promote plants growth, improve general faba bean plant vigor, and encourages their biological yields and seed quality. In contrast, the studied parameters didn't show significantly increases with each of Zn foliar application treatments compared to the control, this result is in agreement with Lewis and Hawthorne, (1996) who reported that faba bean had much smaller yield responses to Zn addition. Also, Bolland, *et al.,* (2000) reported that addition of Zn had no statistically effect on number of pods per plant, nor on the number of seeds per pod or the mean seed weight.

Effect of agricultural practices on Zn, Na content and K/Na in straw and seed of faba bean plants at harvest

Data in Table (6) showed that faba bean Na concentration (straw and seed) significantly decreased with raised bed system compared to furrow row system, these results may be due to decreased root zone salinity which, can affect Na plant uptake. Vice versa, Gaballah and Gomaa, (2004) reported that, each of Na and proline and hydrogen peroxide contents in leaves of certain faba bean varieties were increased with increasing salinity levels.

Table 6 . Effect of agricultural system and Zn SO_4 foliar application on Zn, Na content and K/Na in straw and seed of faba bean plant at harvest

Treatments		Straw			Seed		
Agricultural system (a)	Zn SO_4 foliar application (mg L^{-1}) (b)	Na%	K/Na	Zn (mg kg^{-1})	Na%	K/Na	Zn (mg kg^{-1})
Furrow rows	0	3.42 cd	0.39 d	9.10	0.25	6.07	18.23 d
	100	2.93 c	0.46 c	13.47	0.27	5.99	24.03 b
	200	3.16 c	0.43 c	14.13	0.26	6.09	24.33 b
Raised beds	0	1.90 b	0.90 b	10.50	0.15	11.59	20.70 c
	100	1.83 b	0.95 b	15.33	0.16	11.00	24.51 b
	200	1.27 a	1.43 a	15.80	0.17	11.53	28.87 a
LSD at 0.05 level (a*b)		0.33	0.16	ns	ns	ns	0.92
Mains of agricultural system	Furrow rows	3.17 b	0.43 b	12.23 b	0.26 b	6.05 b	22.20 b
	Raised beds	1.66 a	1.1 a	13.87 a	0.16 a	11.37 a	24.70 a
LSD at 0.05 level (a)		0.23	0.11	0.32	0.02	0.76	0.65
Mains of Zn SO_4 foliar application	0	2.66 b	0.64 b	9.80 c	0.20	8.83	19.46 c
	100	2.38 a	0.71 b	14.40 b	0.21	8.49	24.27 b
	200	2.21 a	0.93 a	14.96 a	0.21	8.81	26.60 a
LSD at 0.05 level (b)		0.28	0.14	0.40	ns	ns	0.80

Values are means (n = 4). Values followed by different letters are significantly different, $p < 0.05$.

On the other hand, Na concentration in straw showed significantly decreased with increasing the rates of Zn foliar application as treatments alone or its interaction with agricultural system, particularly at raised bed. In contrast, there was insignificantly difference between Na concentration in seed of control plants and plants treated with the rates of Zn SO_4 foliar application alone or its interaction with agricultural system. With respect to the Na concentration (%) in the straw is always more than in seed with all treatments. Furthermore, the K/Na ratio in straw and seed take the same above trend for the same reason, this fending was agreement with Abdelhamid, *et al.,* (2010). Also, in current study, the K/Na ratio in straw significantly increased with using the 200 mg L^{-1} of Zn SO_4 foliar application, raised bed system and the interaction among them. But this ratio in seeds was significantly increased only with raised bed system. On the other hand, faba bean Zn concentration (straw and seed) significantly increased with application raised bed system or using the maximum rates (200 mg L^{-1}) of Zn SO_4 foliar application as individual treatments or combined with them.

Effect of agricultural practices on chlorophyll and proline contents in leaves of faba bean plants

Statistical analysis for data in Table (7) showed a highly significant difference between all treatments application whether used as individually factors or it's combined with them on chlorophyll and proline contents in faba bean leaves, because these treatments had direct effect on soil salinity. Decreasing the salinity level in root zone area of shoulder bed as consequence to application raised bed system encourage and increases leaves chlorophyll content, this increases reached to 16.7 %, 76.9 % and 30.9 % for chlorophyll (a) , chlorophyll (b) and total chlorophyll (a + b), respectively, compared to its values measured in leave of faba bean cultivated in furrow row system. On the other hand, Zn SO_4 foliar application at 100 and 200 mg L^{-1} had significantly increased for all components of photosynthetic pigments (contents of chlorophyll (a), (b) and total chlorophyll) of faba bean, especially with the used greater concentration. Consequently, the effect of raised bed system was more effective on photosynthetic pigments of plants (increases reached to 30.9%) compared to Zn SO_4 foliar application alone (increases reached to 20.7%), but at the combination of both, the highest values of photosynthetic pigments of plants were recorded especially in faba bean plants cultivated on raised bed system and treated by 200 mg. L^{-1} Zn SO_4 (increases reached to 58.8%). In contrast, proline is considered an indicator of stress, where the accumulation of proline in the case of stress gives it the role of osmoticum in the cytosol, this amino acid contributes to the osmoprotection in several species, when exposed to osmotic stress (Slama *et al.*, 2006). Thus, all agricultural practices that alleviate soil salinity stress had indirect effect on proline content in plants cultivated. Under this condition, proline contents in leaves of faba bean were decreased with fading the salinity stress problem.

Table 7. Effect of agricultural systems and Zn SO_4 foliar application on Chlorophyll and Proline contents in leaves of faba bean plants

Treatments		Chlorophyll (mg.g^{-1} F.Wt)			proline
Agricultural system (a)	Zn SO_4 foliar application (mg L^{-1}) (b)	Chlorophyll a	Chlorophyll b	Chlorophyll (a +b)	(µmol g^{-1} F. Wt)
Furrow rows	0	0.40 f	0.11 f	0.51 f	3.84 f
	100	0.42 e	0.13 e	0.55 e	3.52 e
	200	0.44 d	0.15 d	0.59 d	3.02 d
Raised beds	0	0.46 c	0.19 c	0.65 c	3.34 c
	100	0.50 b	0.21 b	0.71 b	2.77 b
	200	0.53 a	0.28 a	0.81 a	2.36 a
LSD at 0.05 level (a*b)		0.013	0.009	0.015	0.045
Mains of agricultural system	Furrow rows	0.42 b	0.13 b	0.55 b	3.46 b
	Raised beds	0.49 a	0.23 a	0.72 a	2.82 a
LSD at 0.05 level (a)		0.009	0.006	0.010	0.032
Mains of Zn SO_4 foliar application	0	0.43 c	0.15 c	0.58 c	3.59 c
	100	0.46 b	0.17 b	0.63 b	3.14 b
	200	0.48 a	0.22 a	0.70 a	2.69 a
LSD at 0.05 level (b)		0.011	0.008	0.013	0.039

Values are means (n = 4). Values followed by different letters are significantly different, p < 0.05.

Also, data in Table (7) showed that the mean values of proline content (µmol g^{-1}) in leaves of faba bean cultivated with raised bed system was less than in the plant cultivated with furrow row system, where decreased by 18.5%. This finding is indicator to the decreasing the salinity in root zone under this condition. Furthermore, with Zn SO_4 foliar application treatments, the mean values of proline content were gradually decreased with increasing the concentration of Zn SO_4 solution. The reduction in proline content reached to 12.5 and 25.0% in plants treated by 100 and 200 mg L^{-1} Zn SO_4 solution compared to the proline content in plant un treated (control) respectively. This result may be attributed to the essential role to Zn in plant metabolic processes that could reduce all the adverse effects of salt stress (Tavallali, *et al.,* 2010). On the other hand, the reduction in proline content was increased up to 58.8% in faba bean plant in case of the interaction among treatments, particularly using raised bed system with 200 mg L^{-1} Zn SO_4 foliar application treatment.

CONCLUSION

In this context, the raised bed system application is the candidate strategy for reduction of salt stress in root zone at a newly reclaimed soil, where the faba bean plants were able to complete its life cycle despite high salinity soil, as consequence to realize good manage for salt accumulation. In addition to this advantage, foliar spraying of zinc sulfate (as individual treatment) was positively effective on yield and yield components of faba bean plant, particularly at the rate of 200 mg L^{-1}. Also, the combination among them gave the best result for most parameters studied as indicators to overcome the hazards of soil salinity.

REFERENCES

Al-Tahir O. A. and M. A. Al-Abdulsalam 1997. Growth of faba bean (*Vicia faba L.*) as influenced by irrigation water salinity and time of salinization. Agric. Water Manage 34: 161-167.

A. O. A. C. 1984. “Official Methods of Analysis of the association of Official Analytical Chemists”.14 ed. Association of Official Chemists, the Washington D.C., U.S.A.

Abdelhamid, M. T., M. B. Shokr and M. A. Bekheta, 2010. Effect of induced salinity on four vicia faba cultivars differing in their broomrape tolerance. Fourteenth International Water Technology Conference, IWTC 14, Cairo, Egypt

Abdul Qados, Amira, M. S., 2011. Effect of salt stress on plant growth and metabolism of bean plant *Vicia faba* (L.) Journal of the Saudi Society of Agricultural Sciences Volume 10, Issue 1, Pages 7-15

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., Kadria M. EL Azab, S. F. Mansour and M. M. M. Ahmed, 2011. Management of salinity problems at sahl ELTina-North Sinia. J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2(11):1099– 1114.

Barbara, F. R. and L. J. Brain, 1994. "M Handbook" D . A Imprint of Wad Sworth Publish. Comp. Belonont California, U.S.A.

Beecher, H. G., J. A. Thompson, D. W. Mc Caffery and J. S. Muir, 1997. Cropping on raised beds in southern NSW. Agfact P1.2.1, first edition.

Bolland, M. D. A., K. H. M. Siddique, and R. F. Brennan, 2000. Grain yield responses of faba bean (*Vicia faba L.*) to applications of fertilizer phosphorus and zinc. Australian Journal of Experimental Agriculture, 40, 849–857

Cherif, J., N. Derbel, M. Nakkach, H. V. Bergmann, F. Jemal, and Z. B. Lakhdar, 2010. Analysis of *In vivo* Chlorophyll Fluorescence Spectra to Monitor Physiological State of Tomato Plants Growing under Zinc Stress. J. Photoch. Photobio. B., 101: 332–339.

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

Daur, I., H. Sepetoglu, K. B. Marwat, M. N. Geverek, 2010. Nutrient removal, performance of growth and yield of faba bean (Vicia faba L.). Pak J Bot 42 (5): 3477 3484.

Dreier, W., and M. Göring, 1974. Der Einfluss hoher Salzkonzentration auf verschiedene physiologische Parameters von Maiswurzeln. Wiss. Z. der Humboldt Univ. Berlin, Reihe/Math. Naturwiss. 23, 641-644.

El-Azab Kadria M., A. Kh. Amer, A. E. Hegab, and T. A. Abou El-Defan, 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-Fouly, M. M., Z. M. Mobarak and Z. A. Salama, 2002. Micronutrient foliar application increases salt tolerance of tomato seedlings. Proc. Symp. Techniques to Control Salination for Horticultural Productivity. Akosy U. *et al*., Eds. Acta Hort., 573:377-385.

El-Fouly, M. M., Z. A. Mobarak and Z. A. Salama, 2010. Improving tolerance of Faba bean during early growth stages to salinity through micro-nutrients foliar spray. Not Sci. Biol., 2 (2): 98-102

Fageria, N. K., 2009. The use of nutrients in crop plants. Boca Raton, FL: CRC Press.

Fayez K. A. and S. A. Bazaid, 2014. Improving drought and salinity tolerance in barley by application of salicylic acid and potassium nitrate. Journal of the Saudi Society of Agricultural Sciences.13, 45-55.

Gaballah, M. S. and A. M. Gomaa, 2004. Performance of faba bean varieties grown under salinity stress and biofertilized with yeast. Journal of Applied Sciences 4 (1): 93-99.

Inskeep, W. P. and P. R. Bloom, 1985. Extinction coefficient of chlorophyll a and b in N,N-dimethylformamide and 80% acetone. Plant Physiol 77:483-485.

Jiang, W., X. H. Sun, H. L. Xu1, N. Mantri, and H. F. Lu1, 2014. Optimal Concentration of Zinc Sulfate in Foliar Spray to Alleviate Salinity Stress in Glycine soja. J. Agr. Sci. Tech.Vol. 16: 445-460.

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

Lewis D. C. and W. A. Hawthorn, 1996. Critical plant and seed concentrations of phosphorus and zinc for predicting response of faba beans (*Vicia faba L.*). Australian Journal of Experimental Agriculture 36(4) 479 - 484

Memon, S. A., X. Hou, and L. J. Wang, 2010. Morphological analysis of salt stress response of pak Choi. EJEAFChe 9 (1), 248–254.

Murillo-Amador, B., S. Yamada, T. Yamaguch, E. R. Puente, N. A. Serrano, L. G. Hernandez, R. L. Aguilar, E. T. Dieguez, and A. N. Garibay, 2007. Salinity toxicity influence of calcium silicate on growth physiological parameters and mineral nutrition in two legume species under salt stress., J. Agron. Crop Sci., 193 (6), pp. 413- 421.

Page, A. L., R. H. Miller, and D. R. Keeney, 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.

Rasheed R., A. Wahid, I. Hussain, M. Saqib and A. Parveen, 2016. Partial repair of salinity-induced damage to sprouting sugarcane buds by proline and glycinebetaine pretreatment. Protoplasma 253:803–813

Reda, Fatma, Magdi, T. Abdelhamid and Safaa R. El-Lethy, 2014. The Role of Zn and B for Improving *Vicia faba L.* Tolerance to Salinity Stress. Middle East Journal of Agriculture Research, 3(4): 707-714, ISSN 2077-4605

Ryan, J., S. Garabet, K. Harmsen and A. Rashid, 1996. A soil and plant analysis Manual Adapted for the west Asia and North Africa Region. ICARDA, Aleppo, Syria, 140 pp.

Slama, I., D. Messedi, T. Ghnaya, S. Arnould, and C. Abdelly 2006. Effects of water deficit on growth and proline metabolism in Sesuvium portulacastrum. Environmental and Experimental Botany 56 , 231–238.

Tavallali, V., M. Rahemi, , S. Eshghi, , B. Kholdebarin, and A. Ramezanian, 2010. Zinc Alleviates Salt Stress and Increases Antioxidant Enzyme Activity in the Leaves of Pistachio (Pistacia vera L. 'Badami') Seedlings. Turk, J. Agri. For., 34: 349-359.

Tejada, M., C. Garcia, J. L. Gonzalez, and M. T. Hernandez, 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.

Tester, M. and R. Davenport, 2003. Na tolerance and Na transport in higher plants. Annals of Botany, 91:503-527.

Troll, W. and J. Lindsley, 1955. A photometric method for the determination of proline. J. Biochem., 215, 655-660.

تأثير بعض الممارسات الزراعية على التخفيف من ضرر ملوحة التربة على إنتاجية الفول البلدى

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تعتبر إدارة التربة المالحة الشغل الشاغل للعديد من المختصين من أجل التخفيف أو التقليل من حدة مشاكل الملوحة على نمو النبات وزيادة قدرتها على إنتاج المحاصيل الحقلية ، ولذلك تم إجراء تجربة حقلية خلال فصل الشتاء 2015/2014 على تربة رملية طينية في منطقة سهل الطينة المستصلحة حديثا في قرية جلبانة رقم (7) شمال سيناء بمصر، لتقييم بعض الممارسات الزراعية (نظام الزراعة على مصاطب أو الزراعة على خطوط) وكذا استخدام محلول الرش من كبريتات الزنك على تخفيف الإجهاد الملحي ومحصول الفول البلدي ومكوناته. ويمكن تلخيص النتائج كما يلي: ساهم نظام الزراعة على مصاطب في إدارة تراكم الملح بشكل جيد ، حيث تم دفع الأملاح القابلة للذوبان من منطقة انتشار الجذور من حافتي المصطبة إلى منتصف المصطبة نتيجة لإتجاة حركة مياه الري لأسفل ونحو الجانبين. وبالتالي، فإن الانخفاض التدريجي في ملوحة التربة مع الري المتتالي كان له تأثير إيجابي عالي المعنوية على ارتفاع النباتات وعدد الفروع / نبات وعدد القرون / نبات ومحصول القش والبذور ووزن ال 100 حبة ومحتوى البروتين (٪) في البذور لنباتات الفول البلدي تحت نظام المصاطب مقارنة مع نظام الخطوط . بالإضافة إلى ذلك، تم زيادة كميات المغذيات الكبرى الممتصة بواسطة نباتات الفول البلدي ومحتواها من الكلوروفيل بشكل ملحوظ باستخدام نظام المصاطب. وعلى النقيض من ذلك، انخفض محتوى البر ولين في أوراق نبات الفول البلدي مع تلاشي مشاكل الإجهاد الملحي نتيجة استخدام نظام المصاطب. وعلاوة على ذلك، أعطت معاملة الرش بكبريتات الزنك ($Zn\ SO_4$) نفس الاتجاه السابق وخاصة مع التركيز العالي (200 مليجرام / لتر) كمعامله فردية باستثناء عدد الفروع / نبات و محتوى البذور من البروتين (٪)، وكان هذا التأثير الإيجابي أعلى بشكل واضح على معظم الصفات المدروسة في حاله التداخل بين نظام المصطبة مع الرش ب 200 مليجرام / لترمن محلول كبريتات الزنك.