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SIGNIFICANCE OF CROP YIELD WHEN SALINITY COEXISTENCE PRINCIPLE BE APPLIED IN MANY LEVELS OF SOIL SALINITY

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Abstract

This study was conducted at spring season 2018 in the fields of Technical Institute of Shatrah – Southern Technical University to realize the effect of planting in furrows as one of coexistence methods with soil salinity in comparing with planting in the plots, so to realize the ability of utilizing the salt affected soil instead of leaving it without cultivation or investment when the reclamation is difficult, and to determine the salinity limits that is this method (furrows method) had been active with them. Four soil salinity levels and two planting methods (planting in furrows and planting in plots) for each level with three replicates according to the Completely Randomized Design was applied. The results showed the using of furrows as a planting method of coexistence with salt affected soils proved their significance to achieve high production from the land through the high efficiency of furrows to get rid of salts by leaching and redistribution these salts and leading or moving them to the tops of furrows away of root zone, the salt concentration significantly decreased to a limits which allow to create the salt affected soils more suitable for cultivation to produce high production.

Key words : Coexistence with soil salinity, planting in furrows, planting in plots.

Introduction

Salinization of soil is one of the major factors limiting crop production, particularly in arid and semi-arid regions. Irrigation, evaporation, shallow water table depth and the insufficient annual rainfall to leach down the salts from the plant rooting zone cause excessive accumulation of soluble salts in soils of arid and semi-arid regions (Joardar, *et al.,* 2018). So (Machado and Serralheiro, 2017) pointed to same salinity reasons, and explained that 20% of cultivated land in the world, and 33% of irrigated land, are salt-affected and degraded, when (Shrivastava and Kumar, 2015) referred that with inadequate irrigation management, secondary salinization affect 20% of irrigated land worldwide. Therefore and When salinity is considered, yields tend to be much lower (Heidecke& Kuhn, 2007), Whether the source of salinity is soil or irrigation water, (Hussain *et al.*, 2011) explained that the irrigation water that affected by alkalinity or salinity caused maximum reduction in plant growth and the yield of sunflower crop.

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The decrease in seed yield per plant under salt stress was more pronounced, associated with a reduced number of seed per pod and 100 seed weight, and the delayed maturity due to salt stress pushes the plant to produce shriveled seeds (Shakil, 2009). (Machado and Serralheiro, 2017) and (Abd El-Kader *et al.*, 2006) confirmed that the yield and its components responds to salinity in adversely way. Also it had been found that yield of studied crop decreased in relation to salinity, there for the highest yield was obtained in the low salinity treatment, followed by medium salinity and high salinity treatments (Escalante and Rodríguez, 2010), so (Mohamedin *et al.,* 2004) referred to the grain yield was significantly declined under the high saline conditions, and (Mabood *et al.,* 2017) found too that the yield be reduced for every unit which increased in soil salinity.

Salinity affects in many directions such it increases uptake of Na, Mg and chloride ions, and the sodium ion that is presented in saline soil reduces the uptake of potassium due to ion antagonism (Ullah, *et al.,* 1994), in addition to the salinity reduces water availability for plant use, because of high salt levels hinder water absorption, inducing physiological drought for plant in spite of the soil contains adequate water, so soil salinity affected crop total nitrogen uptake (Van Hoorna, *et al.,* 2001). Soil salinity affects too in many things such days to flowering, days to end of flowering, days to maturity, plant height and seed yield (Rameeh and Gerami, 2015), for examples it had been found that rice yields decrease by 12 % for every unit (dSm^{-1}) increase in ECe above 3 dSm^{-1} (Pradheeban, *et al.*, 2017), and for maize the yield reduction ranges from 30 to 100% (Mehari, *et al.* 2006), relative yields were reduced too as a result of soil salinity for each salinity unit increases above the threshold (Graifenberg, *et al.,*1996), height of plant was decreased gradually with increased levels of salinity, tiller number of plants was decreased significantly at 15.62 dsm^{-1}, It was also observed that the biomass of plant decreased significantly from 7.81 dsm^{-1} level of salinity (Gain, *et al.*, 2004).

Some genotypes are with high amounts of seed yield in all salinity levels were considered as tolerant genotypes (Rameeh and Gerami, 2015), and the effects of salinity are expressed through substitution of sensitive crops by resistant ones, which are generally less valued (Zekri & Albisu, 1993), these two selections (tolerant genotypes and substitution of sensitive crops by resistant ones) be regarded as one of the mechanisms of coexistence with soil salinity. In addition to desalination effects of different regulatory methods, such straw mulching that was recommended as the main regulatory method to improve saline soils with soil structure conditioner that be regarded a suboptimal method, which could be applied in concert with straw mulching (Maomao *et al.,* 2014) that be regarded another mechanism to coexist with soil salinity.

Iraqi soils were strongly affected by salinity and the large area of agricultural lands had rated as unproductive. These soils characterized by electrical conductivity of soil paste extract and exchangeable sodium percentage are more than 4 dsm^{-1} and 15% respectively, for that and according to (Eynard *et al.,* 2005), these soils be regarded saline – sodic soils. Salt affected soils in Iraq were very wide as a result of many factors such as arid climate and high level of saline water table ..... etc, these wide areas can not be cultivated because of very low productivity, so the deficiency of leaching water prevents from reclamation, this case leads either to leaving these lands without cultivation or to be cultivated according to the principle of coexistence with salinity. This principle includes cultivation of tolerant crops or tolerant species, utilizing furrows as a method of cultivating and depending on a certain irrigation method such drip irrigation which be very suitable for salt affected soils to achieve an economic return. This study was conducted to evaluate the signification of land production when the furrows were utilized as a method of cultivation to coexist with soil salinity, and to determine the limit of salinity that the cultivating in furrows which be suitable to it.

Materials and Methods

This study was conducted in the field of Technical Institute of Shatrah – Southern Technical University at spring season 2018. Completely Randomized Design was used to achieve four separated experiments with two treatments (planting in furrows, and planting in rows inside of the plots and three replicates at four soil salinity levels), and the crop which be selected was sunflower (*Helianthus annuus* L). Four convergent areas with similar common soil texture (silt clay loam) were selected according to the variation in soil salinity, to compare the methods of planting (furrows and plots) at four levels of soil salinity, each one of these four areas had dimensions 10.4 × 7.5 m and were divided into 6 plots, any one of these plots with dimensions 2.8 × 3 m, and were surrounded by 50 cm wide earthen bunds. The furrows were done in the randomly selected half of the plots in each one of four areas and the another half of plots were left to cultivate the crop on lines or rows inside them. The salinity of soil in the selected four areas was tested before which had been divided in to plots to ensure that the salinity of soil of these areas represented four levels of salinity. So the soil salinity of each experimental units were determined in the end of agricultural season (as showed in table 1). Four furrows were done in each plot of half randomly selected plots with spacing 70 cm and with a plant to plant spacing of 25 cm, so in the another half of plots the seeds of crop had planted in rows, the distance of plant to plant 25 cm and row to row distance 70 cm, according to this dimensions the density of plants was 57142 plants per hectare.

Four sunflower seeds were sown in the furrows and in the rows according to above distances with depth 4 cm at 9 March of 2018. When seedlings appeared, excess seedlings be thinned after 14 days of the seedling appearance to one plant only. Then all agricultural processes had been achieved to the full maturity stage of the crop at end of July. The heads of all plants that be presented in each two middle furrows, so the heads of all plants that be presented too in each two middle rows for whole replicates were harvested and exposed to sun dried for three days, after that the seeds was separated and weighed to get the mean production for each square meter, so one soil sample was got from each experimental unit to determine soil salinity in the plots and furrows, then the results had been statistically analyzed according to the depended experimental design.

Results and Discussion

It is appeared from table (1) that the electrical conductivity ranges of soil paste extract in the furrows reduced in sharply way, they became (3.28 – 3.59), (4.21 – 4.82) , (5.71 – 6.54) and (8.02 – 9.18)d sm^{-1} after the soil salinity levels were in the plots (4.57 – 8.63), (12.61 – 17.37), (18.16 – 24.19) and (32.69 – 50.21) dsm^{-1} in series. This reduction in soil salinity was due to high efficiency of furrows to get rid of salts by leaching and moving them to the tops of furrows away from root zone. This reduction in soil salinity followed by increasing of the yield because of inverse relation between salinity and soil production, for that the means of yield had been with high value in the first salinity level (plots and furrows) and be reduced to 60.17% in second salinity level, in the third salinity level became 28.5% and in the fourth salinity level reduced to 15.76% of the mean of production in the first salinity level, it is clear according to above percentages that the yield lost the percentages : 39.83, 71.5% and 84.24% of the yield that be obtained from the first salinity level, this results revealed that a high percentage of yield had lost as a result of salinity effects when the planting method of sunflower crop is plots, the yield reduction was explained by (Shrivastava and Kumar 2015) that this reduction is a result of salinity effects on germination, vegetative growth and reproductive development, so soil salinity imposes ion toxicity, osmotic stress, nutrient (N, Ca, K, P, Fe, Zn) deficiency and oxidative stress on plants, and thus limits water uptake from soil, in addition to the soil salinity significantly reduces plant phosphorus (P) uptake because phosphate ions precipitate with Ca ions. In the plots method soil salinity at the end of agricultural season was almost the same salinity in the beginning season and did not reduce significantly, while the soil salinity when the planting method was in furrows had be reduced to the very low levels therefor and as a result of this significant changes in soil salinity the yield was in high values when the planting method was the furrows in comparative with planting in plots, the means of yield were : 84.37%, 63.11% and 39.20% in the second, third and fourth salinity levels in series as a percentages of the mean of yield in the first salinity level, this explains that the means of yield reduced with low percentages according to increasing of salinity as the following : 15.63%, 36.89% and 60.80%. The high means of yield were a result of planting in furrows that lead the soil to low salinity with high ability for production, therefor the depending on furrows as one of techniques which be used to achieve coexistence principle with soil salinity must be applied.

So table 1 revealed that the experimental units differed in their quantities of yield at the same salinity level because the salinity in any level differed too, for an example the ECe in the first salinity level ranged between 4.57 and 8.63, and without any doubt this difference in salinity caused differences in the quantity of yield per area unit as a result of salinity effect, (Eynard, *et al.*, 2005) found same results and referred to alteration of various metabolic processes in plants under salt stress, and negative effects of salt excess that include increased osmotic pressure limiting water uptake (physiological drought), abnormal pH, and ionic competition limiting nutrients uptake as the reasons of yield reduction in salt

Table 1: Yield of sunflower seeds inplots and furrows ($g.m^{-2}$).

Salinity level $ds.m^{-1}$for $ds.m^{-1}$for plots & furrows	Replicate 1		Replicate 2		Replicate 3		Meang $.m^{-2}$
	plot	furrow	plot	furrow	plot	furrow	
Experiment 1							
P* (4.57 – 6.89 - 8.63)	97.16	....	51.69	....	62.18	....	70.34
F**(3.28 - 3.39 - 3.59)	....	119.22	....	137.03	....	108.74	121.66
Experiment 2							
P(12.61 - 14.81 - 17.37)	48.11	....	37.82	....	41.07	....	42.33
F (4.21 - 4.38 - 4.82)	....	98.41	....	102.58	....	106.97	102.65
Experiment 3							
P(18.16 - 20.40 –24.19)	24.15	....	17.04	....	18.96	....	20.05
F (5.71 – 6.12 - 6.54)	....	78.54	....	68.71	....	83.12	76.79
Experiment 4							
P(32.69 –39.87-50.21)	13.94	....	10.06	....	9.28	....	11.09
F (8.02– 8.77 - 9.18)	....	54.33	....	38.95	....	49.81	47.70

P* means plots treatments, F** means furrows treatments.

affected soils.

So it is shown from the same table that the mean of yield in the plots was at high value in low salinity level and had been decreased whenever soil salinity increased to reach to low value in the plots that characterized by high salinity (fourth level), while the mean of yield took different values in the other salinity levels which were controlled by inversely proportional relation, this results were similar with what (Abd El-Kader *et al.* 2006) had found, and referred to the salinity and nutrients interactions were reduced crop yield in average by 20% depends upon the salinity level and composition of salts, so (Kumar *et al.*, 2014) explained that higher salinity has adverse effects because of toxic and osmotic effects of salinity and ion accumulation creating drought – like conditions for the plant.

The yield of furrows corresponded with what was referred to the yield of plots that the yield reduces with increasing of salinity, therefor the furrows in low salinity levels produce high quantity of seeds and in high salinity the yield be reduced, (Escalante and Rodríguez, 2010) found same thing and explained that the highest yield of sunflower was obtained in the low salinity treatment followed by moderate salinity and high salinity treatments. And because of the ability of furrows to get rid of salts is very efficient, for that the salinity in the furrows be very low in comparative with soil salinity before digging of furrows, this Low salinity in furrows caused to produce high yield in comparative with plots, so (Oad *et al.*, 2001) found too that the furrows produced high yield in comparative with plots. In addition to that the yield of furrows in replicates of the same salinity level at any level was not different because of active furrows ability to get rid of salts and create the salinity of furrows soil with convergent values.

It is appeared too from shape (1) that the yield of sunflower severely decreased when soil salinity increased to more than nearly 20 dsm^{-1}, but this decreasing in yield be gradually when soil salinity continued to increase, so (Mohamedin, *et al.,* 2004) referred to, that the grains yield of sunflower was significantly declined under the high saline conditions, this reduction in the yield is as a results of problematic soils conditions which have negatively affect water and nutrients movement and uptake, thus seriously hampering crop production. While shape (2) revealed gradually decreasing of the yield when the furrows be utilized as a planting method, the decreasing in yield was due to increasing of salinity in salinity levels while graduality was a result of furrows activity for leaching and redistribution of the salts, and therefore the whole furrows became with low salts concentration.

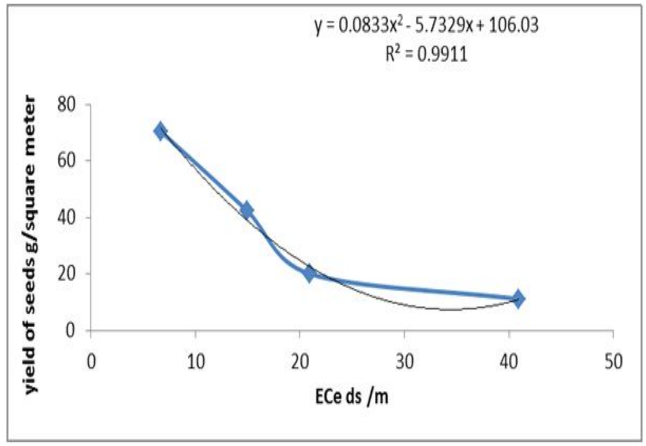

Fig. 1: Relation of the yield with soil salinity

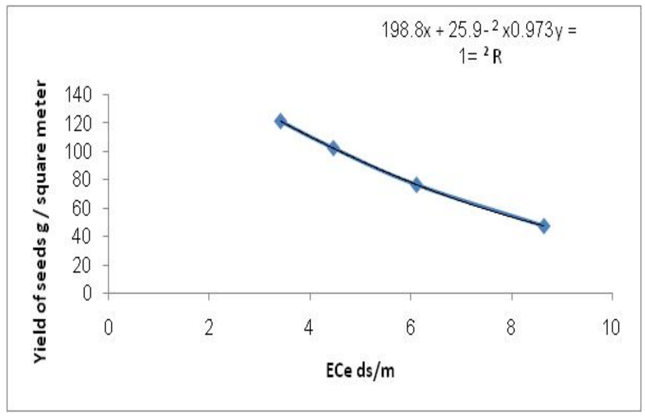

Fig. 2: Relation of the yield with soil salinity

When the results that were shown in the table 1 had statistically analyzed it is appeared that the calculated (f) for the firstsalinity level (experiment 1) (10.24) while the table (f was (7.708) at 0.05, this means that there are significant differences between the two planting methods (furrows and plots) in the means of yield, so the difference between the mean of yield for furrows method (121.66) gm^{-2} and the mean of yield for plots (70.34) gm^{-2} is more than LSD value (44.51), this result revealed significance of furrows method. But the value of table (f) at 0.01 is larger than its calculated value, this result because the high yield of plots that due to relative reduction in soil salinity of plots which causes a high yield in the plots, in addition to that the sunflower is appropriately classified as moderately tolerant to salinity (Francois, 1996).

In the second salinity level, the value of calculated (f) (237.39) is more than its table values at 0.05 and at 0.01 (7.708 and 21.198) in series, therefor there are high significant differences, so the difference in the mean of yield for furrows method (102.65) gm^{-2} and the mean of yield for plots method (42.33) gm^{-2} is larger than LSD value at 0.01 (14.66). This high significance is due to low concentration of salts in the furrows soil which resulted by high efficiency of furrows to get rid of salts from root zone. So there are high significant differences between furrows method and plots method in the third and fourth salinity levels because of the calculated (f) at 0.01 for third and fourth level were 147.57 and 58.50 in series are more than table (f) at 0.01 for third and fourth level 21.198 for each one, then the difference in the means of yield for furrows and plots in the third level (76.79 and 20.05) and in the fourth level (47.69 and 11.09) are more than the value of LSD in the third level (17.80) and in the fourth level (17.93) at 0.01. The reduction of yield when the planting in the plots was a result of salinity effects because the yield of sunflower affected by salinity stress through the effect on stomatal conductance, osmotic potential and transpiration rate (Hebbara *et al.,* 2003), so the soil salinity be regarded the main limiting factor for sunflower vegetative (Tao *et al.,* 2016), or because of low germination percentage under saline conditions as a results from either reduction in imbibition of water by seed due to osmotic potential created by NaCl, or toxic effects due to uptake of excessive Na^+ and Cl^- ions by germinating seeds (Kaya, 2009), in addition to the sunflower crop showed significant variations in the number of achenes per head, 100- achene weight and achene yield when grown under saline conditions (Hussain, *et al.* 2012), while the high mean of yield for furrows method in comparing with plots method are due to active ability of furrows to leach the salts and deliver them to the tops of furrows away of root zone. The furrows method and according to reduction of soil salinity to un effect level followed by high mean of yield be regarded of the best and active techniques for coexistence with soil salinity.

These results gave high conviction to conclude that the utilization of furrows in salt affected soils as a coexistence technique is very convincing for a wide range of salinity that studied in this research, so this method gave high significant yield in comparing with another method of planting such as planting in plots, and it is from necessary to recommend to study the suitability of furrows as a planting method for soil when the electrical conductivity for soil paste extract is more than 50 dsm^{-1} (high limit of studied salinity), in addition to test the another techniques that be regarded as the coexistence methods with soil salinity such improvement of soil physical properties or utilizing drip irrigation and another techniques to exploit the salt affected soil and to obtain a part of land production instead of loss the whole of that production as a result of leaving the land which be regarded the important source of production without investment of that source.

Conclusion

The yield of cultivated crop (sunflower) achieved high significantly differences when the planting in furrows be depended as an important method of coexistence with soil salinity in comparing with planting in plots when the electrical conductivity of soil paste extract less than 50 dsm^{-1} that was the upper limit of soil salinity which be tested in this study, and according to this results the study recommends to use the furrows as a benefitial method to coexist with saline soils.

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