Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.6, No.18, 2016

Effect of Different Levels of Saline Water on Tomato Production Under Saline Soil Condition

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Abstract
In 2013/2014 and 2014/2015 a research was conducted in Al-Mafraq city, Jordan. The study design used was the Randomized Complete Block Design (RCBD). The main treatments that were used in the farm were different amounts of irrigation by 50%, 75%, 100% and 125%. Also, the flowering of both seasons used fresh water by 0.7ds/m, saline water by 5.5 ds/m and alternative fresh water. There are three sub-main water quality treatments. By using these sub-main treatments, the research showed that there was an increase in tomato production every season due to the increase in the amount of irrigation. The products that could be marketed increased in a huge way, for instance in the first season, fresh treatment achieved 34.67 ton/ha in 2013/2014, and the alternate treatment achieved 31.96 ton/ha over the saline treatment by 22.99ton/ha for 125% of irrigation level. In this period, it was shown that there was a significant increase in the total soluble solids that improved saline treatment by 6.8% compared to fresh water treatment by 5.2% that was before 5.57%. In this season, due to the use of 60.13gm water treatment instead of 54.04 of saline treatment under 125% irrigation level, it led to a massive significant increase in the average fruit weight. In the second season, which occurred during the period of 2014/2015 where the prior treatment was 0.91ton/ha which improved realty to 1.47ton/ha while the treatment for saline used 10.66ton/ha for 125% of irrigation level. In this season however, the highest total soluble solids (TSS) value for the saline treatment was 7.24% with 50% of irrigation level, so, there was a decrease in soluble solids. In this second season of 2014/2015, the use of saline treatment was 33.24gm and fresh water treatment was 47.35% under 125% of irrigation level, which led to an increase in fruit weight transforming it from the average weight to higher weight by 50.55%gm. It has been found that salinity of the surface layers decrease under the50% and 75% irrigation levels while the decrease in salinity for the other depths was related to the higher levels of applied water by 100% and 125%. Therefore, the salinity development in a soil varies in the amount of water irrigation.
Keywords: Saline water, Tomato, Saline soil, Irrigation, Al-Mafraq-Jordan.

1. Introduction

Most of the Arab regions, particularly Jordan, suffer from water scarcity as they receive only 200mm of rainfall. Accordingly, they are forced to use saline water for agriculture which also requires good management to succeed. However, this saline water can be only used for irrigation if water is available. The re-use of this water should be done only if it is assured that the properties of the soil will not deteriorate due to the long term use of the saline treatment. when the fresh water gets mixed up with saline waters or when they are alternated, they became feasible (Abdelgawad, 1993 & 1995; Rhaodes,1987). Arid areas that use saline waters in irrigation succeeded for over 15 years and these areas get at least 400mm of rainfall. Water that is conventionally classified to be too saline for agriculture, can be used to irrigate certain crops that will be conducive to such environment and will not cause loss in yield nor to the quality of products.

There are some of examples in different countries that use saline waters, such as Algeria, where there are palm trees which grow with water ranging up to 5000 mg/l, Jordan and Tunisia have olive oils which are irrigated with saline water by 4200mg/l, also the cotton in Palestine is commercially grown with3000 mg/l of saline water. Kahlaoui et al conducted a field experiment on the effects of drip irrigation (DI) and subsurface drip irrigation (SDI) with saline water (6.57 dS m-1) on three tomato cultivars (Lycopersicon esculentum Mill., cvs. Río Tinto, Río Grande and Nemador) was carried out with the purpose to quantify physiological responses. They concluded that SDI can be included as an effective option for tomato production in Tunisia. In another research investigated by Zhai et al in 2015, A 3-year study on the effects of saline water irrigation on tomato yield, quality and blossom-end rot (BER) was conducted at different lower limits of soil matric potential (-10 kPa, -20 kPa, -30 kPa, -40 kPa and -50 kPa). In this research, saline water differing in electrical conductivity (EC) (3 dS/m, 4 dS/m, 4.5 dS/m, 5 dS/m and 5.5 dS/m) was supplied to the plant after the seedling establishment. It was concluded that, the critical salinity level that produced significant increases in the BERi was 3 dS/m~4 dS/m. Following the increase in BERi under saline water irrigation, marketable tomato yield (Ym) decreased by 8.9%~33.8% in 2012, 5.1%~30.4% in 2013 and 10.1%~32.3% in 2014 compared with CK. In Palestine, a field study was conducted ,by Rahil et al in 2013, on the experimental farm of ministry of agriculture, to investigate the effects of saline water irrigation through three irrigation intervals on yield of tomato crop and soil properties. Statistical analysis showed significant differences in yield reduction between every second day and every three days

irrigation intervals under 5 and 7 dS/m saline irrigation levels, while there was no significant difference between irrigation intervals under 3 dS/m salinity level.

In support to the discussion above, the research was conducted in Al-Mafraq, in a private farm in the northeast part of Jordan where the weather is hot and dry during summer and very cold in winter. The average of rainfall there is 150mm but due to over pumping water, it increased from 600ppm to 4800ppm according to the chemical analysis and this is because of the over pumping that usually exceeds the rainfall. This research was the first ever study conducted in this area; hence, further research is needed to explore more discussion of the results. Therefore, the objective of this work was to investigate the effect of different levels of saline water, using different amounts of irrigation by 50%, 75%, 100% and 125%, on tomato production under saline soil condition.

2. Methodology

The methods used in this study involved the following mechanisms; split block that were randomized to a complete block design (RCBD), the use of four irrigation levels which were 50% 75&, 100% and 125%. The experiment carried out 5.5 ds/m by 0.7 ds/m of fresh water that was used during the whole growing period of the alternate water. These were used as three sub-main treatments in the quality of water irrigation. In regards to the alternative treatment, it occurred when fresh water is necessary during the first stages of the growth and it was added from 50% of the total water using drip irrigation. According to this methodology, the study reported that different plants, water and soil affect the growing of tomato yield as well as there was a reduction in the fruit weight, TSS% and monitoring the salinity of both irrigation and soil.

3. Results

Total production of tomato (biological yield): The table 1 below shows the relationship between (ton/ha) and (m3/ha) in the production of tomato. In the season of 2013/2014 and 2014/2015 the highest tomato yield was 40.6 ton/ha which was achieved by having 125% of irrigation of fresh water treatment. It showed that tomato production has the chance of increasing the amount of water used for irrigation except for the saline treatment. During both seasons of experiment, there was no relationship between products. During both seasons of experiment, there was no relationship between the production and amount of irrigation that were put under different levels of irrigation treatment.

Table (1): Relationship (liner & quadratic) between tomato yield (ton/ha) and irrigation (m3/ha) for irrigated tomato crop with different qualities of water at a private farm, 2014, 2015.

		Linear		
Treatment	**A**	**B**	**C**	**R^2**
Fresh	-7.67	0.0022		0.35
Saline	0.34	0.00105		0.15
Alternative	3.24	0.00168		0.22
		Quadratic		
Fresh	5.67	-0.00105	$1.819*10^{-7}$	0.37
Saline	5.73	-0.00022	$7.14*10^{-8}$	0.19
Alternative	-0.73	0.001	$3.405*10^{-8}$	0.25

Salinity Development: According to the study, the amount of irrigation determines the different saline soil in different depths of the soil. It shows that, to reduce the level of soil salinity, there must be an increase in the amount of irrigation water. As explained above, Table 1 and 2 shows the amount of salt accumulated in the layers of land, and the irrigation level is 50% and 75%, and the salt in the deep layers of soil is 100% and 125% of irrigation level

Fruit Weight: Fruit weight reduced to the lowest percentage during the two seasons 2013/2014 and 2014/2015. This is because the treatment used in the irrigation in both seasons was the alternate water method. However, irrigation that was under 50% of saline water treatment caused a percentage of reduction in both seasons, the first season reduced to 20.53% in 2013/2014 and 21.34% in the second season of 2014/2015. This was the highest percentage of reduction in both seasons. The results show that the production of tomato increased greatly by using125% of irrigation level of the fresh water treatment in 2013/2014, the yield increased to 92.62% and in the second 2014/2015 by 80.8%.

Total Soluble Solids Percentage (TSS %): During the experiment, the results showed that in both seasons of 2013/2014 and 2014/2015, the increase of water amount used in irrigation caused a decrease in the percentage of total soluble. In both cases, the only highest percentage was under 50% and this was under saline water treatment which was equal to 7.6% in the first season 2013/2014 and 7.24% in the second season 2014/2015.

Average of Fruit Weight: The average of fruit weight in both seasons greatly increased and this was because of the increased amount of water used in the irrigation in both seasons. Irrigation treatment was under 125% of alternate water in both seasons, which caused an increase in the average of fruit weight. In the first season

2013/2014, the highest average of fruit weight was 60.13gm while in the second season 2014/2015, it was 50.55gm

4. Conclusion

From the results obtained from this study, the following can be concluded; (1) Biological yield increased by using the amount of irrigation water except for the saline treatment. And the highest biological and marketable yield for both seasons achieved 125% of freshwater treatment; (2) Total soluble solids decreased with increasing the amount of irrigation. And the highest TSS% for both seasons was achieved under the 50% saline water treatment; (3) Total soluble solids decreased with increasing the amount of irrigation. And the highest TSS% for both seasons was under 50% of saline water treatment; (4) In both seasons 2013/2014, 2014/2015 alternative water treatments were the lowest in decreasing fruit weight. And the highest reduction percentage was under 50% of saline water treatment; (5) The amount of irrigation water determines the development of soil salinity where there is an increase in the amount of water irrigation, the soil salinity decreases.

5. Acknowledgement

This research was financially supported by the Deanship of Scientific Research at Jerash University, Jordan.

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