Effect of different levels of superabsorbent and deficit irrigation on drainage salinity changes

H. Taheri[1] and A. Soltani Mohammadi[2]

[1-]M. Sc. Student of Irrigation and Drainage, Faculty of Water Sciences Engineering, Shahid Chamran University of Ahvaz, Ahvaz, Iran. h.taheri15193@gmail.com
[2-]Assistant professor of Irrigation and Drainage, Faculty of Water Sciences Engineering, Shahid Chamran University of Ahvaz, Ahvaz, Iran, A.soltani@scu.ac.ir

Abstract: This study investigates the quality of discharged drainage from soil containing different levels of superabsorbent polymers. This experiment was conducted in a completely randomized design factorial with two treatments of irrigation regime at three levels (50, 75 and 100 percent of crop water requirement) and four superabsorbent hydrogel application (0, 4, 6 and 8 g per kg of soil) in three replication in the research field of Faculty of Water Sciences Engineering, Shahid Chamran University of Ahvaz. The discharged drainage was studied after irrigation in days of 26, 51 and 85 after planting the lettuce to the pot. The results showed that superabsorbent polymers reduce the electric conductivity of the drainage by absorbing the salt of the soil. The lowest amount of electric conductivity was observed in the treatment of 6 gram.

Keywords: Superabsorbent, Drought stress, Drainage.

1. Introduction

Superabsorbent polymers are a group of water storing matters and soil conditioner which have been confirmed in agriculture sector, but there's a little information about their effect on physical and chemical properties of the soil (Bai et al., 2010). Ability to absorb a lot of water, high rate of absorption and gel strength is the features of the superabsorbent. Improving the root medium by polymers leads to increase of reserving the water in growth environment of the plant, improve the soil texture, increase the irrigation interval, increase of water influx, decrease of erosion and run off, increase of germination and rapid growth of the plant (Abedi Koupaee and Mes Foroosh, 2009). By testing the discharged water of the soil which is hybrid with hydro gel, Wang (1989) found that the EC of the tested soil is very low and thus concluded that hydrogel maintain the added soil and elements. Behbahani et al. (2005) measured the degree of nutrients of zinc, manganese, iron, nitrogen, potassium, phosphor, calcium, magnesium, cation exchange and ph of plant bed by using hydrogel per 10, 20 and 30 volume percent of the growth of greenhouse cucumber which is a mix of cocopeat and perlite and also by using deficit irrigation in the form of irrigation with 70, 86, 90 and 100 percent of water requirement. They concluded that there's a significant difference between treatments in the possible level of 1% in storing the nutrient of studied bed and also in storing the nutrients, it has the highest effect in storing phosphor and nitrogen and the lowest effect in maintaining the manganese. The degree of cation exchange in treated beds, with 30% superabsorbent replacement, was 94 percents more than the control treatment. Banj Shafiee (2015) in a flowerpot experiment investigated the confounding effects of a kind of hydrophilic polymer on soil and also its effect on nitrogenous fertilizer leaching in three kinds of light, average and heavy soil in irrigation period of 4, 8 and 12 days. The effect of polymer on irrigation drainage showed that the amount of nitrogen leaching from 880 mg N/1 in control treatment decrease to 550 mg N/1 by polymer. Abraham et al. (1995) also reported that using superabsorbent polymers in soil reduce the ammonium leaching to a large extent. Shokouhi Far et al. (2014) investigated the effect of three levels of superabsorbent polymers (0, 0.3, and 0.6 weight percent), three levels of water salinity of irrigation (2.6, 4 and dS/m) and two kinds of superabsorbent polymers (A200 made by Iran Polymer and Petrochemical Institute and A200 made by France) on qualitative and quantitative changes of drainage. They explained that there's a significant difference in drainage electric conductivity between different levels using superabsorbent and control treatment. But according to the results obtained from using superabsorbent in the presence of saline water and soil it is not recommended because of the reduction of polymer performance and increase of soil salinity.

Bai et al. (2010) investigated the effect of superabsorbent polymers and physical and chemical properties of the soil under different cycles of moisture and dryness. In this research sandy soil was mixed with four different kinds of superabsorbent

(BF, JP, BJ and WT) in five levels of superabsorbent (0, 0.05, 0.1, 0.2, 0.3 weight percent). The results showed that soil moisture increased by 6.2-32.8 percent and bulky specific mass decrease by 5.5 to 9.5 in comparison with control treatment. Soil phosphor increases a little while potassium increases significantly. The effect of different superabsorbent on increase or decrease of electric conductivity and soil acidity was different. We can use WT, JP and BJ (except the 0.05 concentration of weight percent) for reducing the electric conductivity.

The purpose of the research was to investigate the effect of using superabsorbent and drought stress on drainage salinity discharges from the soil during the lettuce plantation period.

2. Material and Methods

This research was done in the research farm of Agriculture College of Shahid Chamran University, Ahvaz in November, 2016 in a completely randomized design factorial with two treatments of irrigation regime at three levels (50, 75 and 100 percent of crop water requirement) and four superabsorbent hydrogel application (0, 4, 6 and 8 g per kg of soil) in three replication. For this purpose, 36 flowerpots were prepared for the research. The water used in the research was from Karoun river. Cylindrical plastic flowerpots with 20 cm height and 22cm length were used for the experiment. The level of the soil was 5cm away from the brim of the flowerpot because of polymer inflation. After getting soil from the depth of 0-30 cm of the farm soil, some properties including soil texture (by hydrometric method) and moisture in field capacity point and wilting point and bulk density by metal cylinder with an specific volume. Soil chemical properties was also done after distillation (by vacuum pump) EC meter. The results are presented in table 1.

Different amount of superabsorbent per each kilo of pot soil was distributed and kept in plastic bag in advance and was mixed with pot's soil. The superabsorbent which was used was A200. Some of the features of the polymer were presented in table 2 (Abedi Koupaie and Mesforoush, 2009).

Table 1- Physical and chemical properties of soil and water Used

Water	Electrical conductivity (dS/m)	1.5
soil	soil texture	Sandy loam
	Electrical conductivity (dS/m)	0.8

Table 2- A200 super absorbent polymer properties

The content of Moisture (Percent)	Density (g/cm^3)	pH	Particle size (μm)	The maximum lifetime (year)	Water absorption capacity (gr/gr)		
					Distilled water	water	0.9 % sodium chloride solution
5-7	1.4 – 1.5	6-7	50- 150	7	220	190	45

After preparing the pots, lettuce seedlings, longifolia, which were prepared before transplanted into the pots. In each pot a seedling was planted. After planting the seedlings, the treatments were irrigated. The time of irrigation was determined by weight method. After absorbing the readily available water of the soil, the irrigation was done by manual method and by graduated bushel. By determining the water need of the plant, the treatments of 100% were irrigated completely and water need of the treatments of 75 and 56 percent was 3/2 and 1/2 respectively. Each pot placed in a plastic bucket with 19 cm diameter so that the discharge drainage of the pot discharged completely into the bucket. Sampling of the collected drainage of the bucket was done in the days of 26, 51, and 8 after transplanting the seedling to the pots. Then the sample was taken to the laboratory for determining the electric conductivity. Data were analyzed graph which has been designed by excel software.

3. Results and Discussion

According to the graphs obtained from the experiment data, we observed that in all irrigation treatment, using superabsorbent leads to a significant difference in salinity of the discharged drainage in comparison with the control treatment (without superabsorbent). Drainage salinity has an increasing trend in all three irrigation treatment by passing of the time and during the lettuce growth. We can observe it in figures (1), (2) and (3). Input irrigation water of the pot contains solvable salt. Some of the salt and superabsorbent were observed along with the plant. The rest remains in the pot and the water evaporated from the soil level and the salt accumulated in the soil. The salt discharged from the soil during the next irrigations and also by leaching. This is the most important reason of the increase of the drainage salinity. What is observable from all three figures is that the control treatment salinity has an increasing trend and increased in comparison with the first irrigation. The degree of the increase in the treatment

of 100% water need was 2.5 more than the initial amount, in the treatment of 75% water need it was 2.4 more than the initial amount and in the treatment of 50% water need it was 1.3 more than the initial amount. Because of the low volume of the input water and in fact the reduction of the input salt of the soil, the degree of salinity in treatment with deficit irrigation has a lower growth, especially in the treatment of 50 % water need in comparison with that of 100% water need. Based on the figures of (1), (2) and (3) using superabsorbent in all treatments reduce the salinity in comparison with the control treatment. This shows that superabsorbent can absorb some of the solvable salt of the water. This is consistent with the results of Wang (1989) and Bai et al. (2010).

According to the figure (1) the degree of salinity in treatments with superabsorbent has decreased in comparison with the control treatment (without superabsorbent). Using 6 gram superabsorbent in each

kilogram of pot soil has the most absorption of the salt than 4 and 8 gram superabsorbent, so that the degree of salinity decreases to half. This trend is observable in figure (2) and the treatment of 6 gram has the greatest effect on reducing the salinity of the drainage.

Figure (3) shows the increasing and decreasing trend of the salinity. The increasing trend is related to the control treatment (without superabsorbent), which is created because of the input salt to soil. But the decreasing trend is related to the superabsorbent treatment which was able o educe the drainage salinity. It is not consistent with the results of Shokouhi et al. (2014). The degree of decrease in comparison with control treatment, was 23% in 8 gram superabsorbent treatment, 31% in 6 gram superabsorbent treatment and 46% in 4 gram superabsorbent treatment. These figures show the positive effect of using superabsorbent in reducing the drainage salinity.
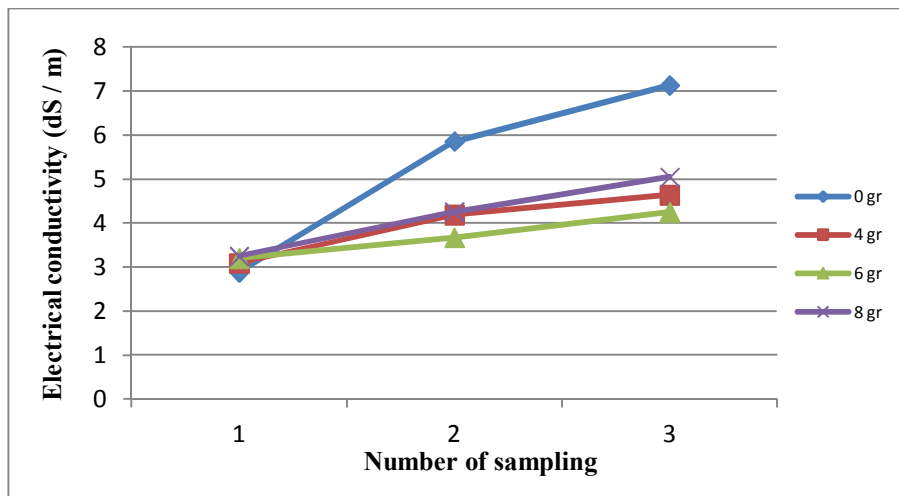

Figure 1- Drainage water salinity changes with the use of super absorbent and 100 Percent water requirement
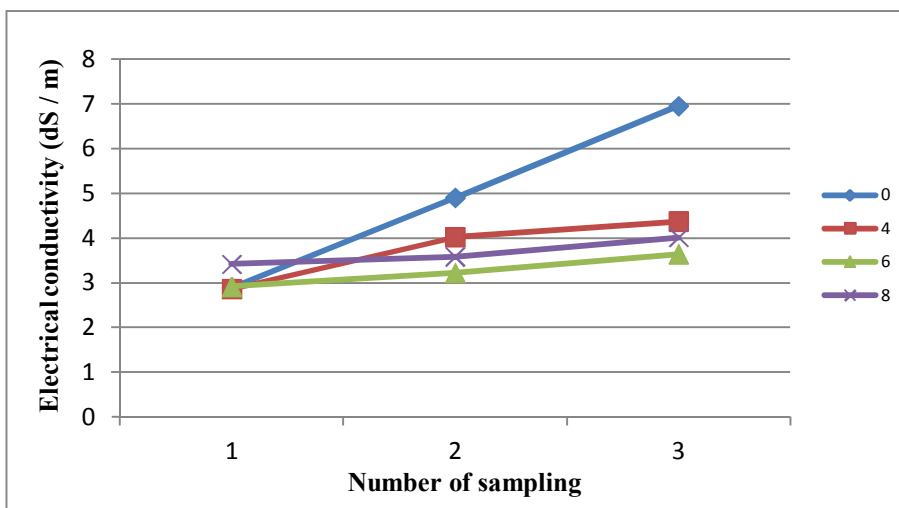

Figure 2- Drainage water salinity changes with the use of super absorbent and 75 Percent water requirement
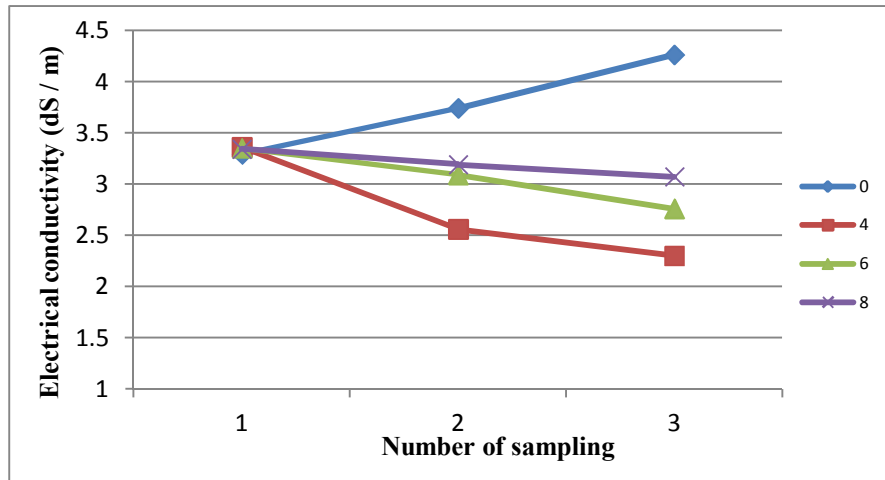
Figure 3- Drainage water salinity changes with the use of super absorbent and 50 Percent water requirement

4. Conclusion

The results of the research show that superabsorbent polymer can absorb the salt of the soil and reduce the salinity in all irrigation treatment. The highest salt absorption was seen in 50% water need treatment and using 4 grams of polymer. But using 6 gram per one kilogram soil is recommended because it has a high salt absorption in all irrigation treatment.

Corresponding Author:
Haniyeh Taheri, M. Sc.
Student of Irrigation and Drainage, Faculty of Water Sciences Engineering, Shahid Chamran University of Ahvaz, Ahvaz, Iran.
h.taheri15193@gmail.com

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