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The effect of different types of zeolite on drain water volume and nitrate leaching under tomato cultivated

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Abstract: Zeolites are hydrated aluminosilicate minerals that contain alkali or alkaline soil metals, especially sodium, potassium, magnesium, calcium, strontium and barium. In this study that was conducted at the lysimetery scale, the effects of three types of zeolite (sodium zeolite powder form, sodium zeolite broken form and calcium zeolite) drain water volume and nitrate leaching in tomato cultivated were studied compared to soil without zeolite (control treatment). The results showed that the lowest drain water volume was observed in the lysimeters containing calcium zeolite with an average value of 0.03 liter. Maximum of the drain water volume was measured in control treatment with the 1.86 liter amount. The results also showed that the highest and lowest concentrations of nitrate in outlet drain water was observed in soil without zeolite and calcium zeolite with average amounts of 83.5 and 6.8 mg/lit respectively.

Key words: Drain water; Lysimeters; Tomato; Zeolite

1. Introduction

Application of natural compounds such as zeolite minerals in lands can have an effective role in reduction of nitrogen leaching due to the increase of cation exchange capacity of soil and its high tendency to absorb and retain ammonium. Furthermore, as the majority of the soils within the province own heavy textures and zeolites improve physical properties of the soils, the application of zeolites can both prevent nitrogen leaching and improve physical properties of the soils. It is possible to use gross zeolites to reduce the cost and price. Zeolites have increasingly been used in many industrial, agricultural and environmental applications (Polat et al., 2004).

Zeolites can be added to fertilizers as thinner to improve the physical conditions and moisture retention in soil (Kavoosi and Rahimi, 2000). Using Zeolite will cut fertiliser and water costs by holding the nutrients and water in the root zone until the plant is ready to utilise them. Siasatkhah and Yusefi (2007) investigated the effect of calcium and magnesium zaolite on retention of nitrate and ammonium in soli under saturated humidity conditions and found that the total amount of nitrate ion emitted from soil in treatments with 0, 2, 4, and 8 g zeolite per 1kg of soil was respectively as much as 95, 87.7, 74.7, and 63% of the added amount to the soil surface. George and Vamachi (2004) examined ammonium removal from synthetic wastewater by natural zeolite. They found that in many samples 50% of ammonium was absorbed by natural zeolite in initial moments. Moreover, finer absorbent particles were more capable of absorbing ammonium. Torma et al (2014) investigated the influence of natural zeolite on nitrogen dynamics in soil, the results showed The nitrate nitrogen contents in the soil decreased by 66% to 78% in comparison with the control variant in the autumn period; therefore, the amount of nitrate leaching from the soil horizons to the groundwater was less. In this research, the effect of three types of zeolite on retention of water and nitrogen in soil under lysimetric conditions has been studied.

2. Materials and Methods

The experiments in this research were carried out in lysimeters in faculty of agriculture, Islamic Azad University, Dezful. This area is located at latitude 32'16" and longitude 48'25" and it is 137m above the sea level. This study was conducted in lysimetric conditions so that through the control of water and soil conditions during the experiments and necessary measurements, the volume of drainage and also the concentration of nitrate in output drainage could be estimated. To do so, three treatments including sodium zeolite powder, sodium granules (1-2 mm) and calcium zeolite were selected and one control treatment (without adding zeolite) was also considered. Lysimeters with 95 cm height and 40 cm diameter with fiberglass cover and aluminum coat were applied so that the medium within the lysimeter was not affected by external environment and temperature difference was minimized. At the end of lysimeters (90 cm depth) PVC lattice tubes equipped with filters with 5 cm

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diameter were considered as drains so that the output drainage could be measured. Lysimeters were filled with the loam soil of the field. For irrigation, water of the city with EC of about 0.56 dS/m was used. The selected plant for the research was tomato and the amount of irrigation water was calculated based on Penman-Monteith method and was applied for the treatments. Fertilizer need of product at area unit of lysimeter was calculated at the beginning of the experiment and added to lysimeters' soil. The level of added zeolite to the soil was considered to be 10 g/kg. After each irrigation, the drainage volume was measured by graded utensils and nitrate concentration in drainage samples was calculated through spectrophotometer. In order to draw the diagrams EXCEL 2007 was used and to analyze data SPSS 13 was applied.

Fig. 1 shows the changes of lysimeter output drainage volume during the last six irrigations. As it is observed, in control treatment (without adding zeolite) the highest volume of drainage was observed. The lowest volume of drainage belonged to calcite zeolite treatment and then to broke sodic zeolite and sodic powder. Therefore, the addition of zeolite has led to the reduction of output drainage volume. In other words, the presence of zeolite in soil has led to increased water retention in soil. The increased volume of output drainage in sodium zeolite treatments can be attributed to increased hydraulic conductivity of soil which results from the increase of sodium in soil. These results are consistent with the findings of Zheobin and Zhanbin (2001) who studied zeolite application in enhancing water penetration into soil and its retention there.

3. Results

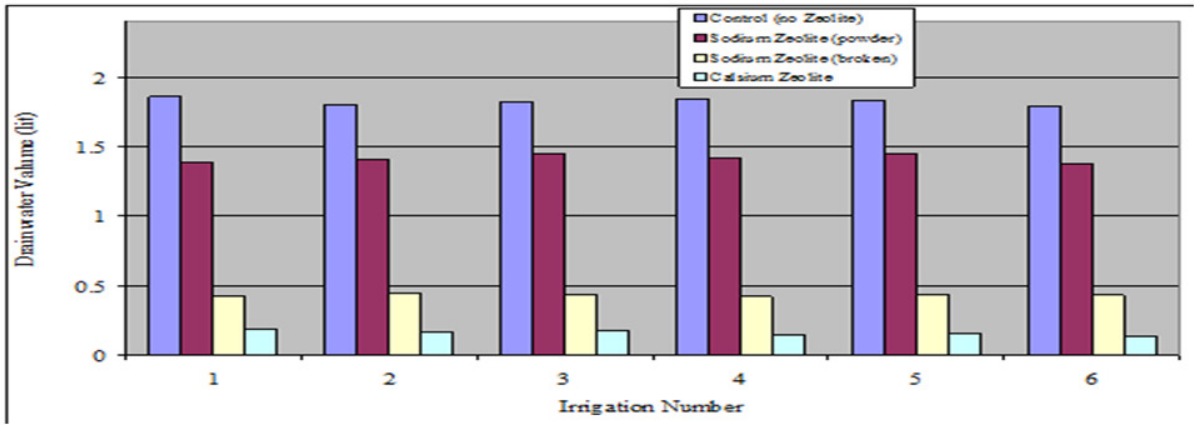

Fig 1. Changes of drain water volume in zeolite treatments after 6 irrigation numbers

Table 1 shows the mean of nitrate concentration in five irrigations. As it is observed, in calcium zeolite treatment due to little amount of extracted drainage, it has not been possible to measure its nitrate. Of course, due to reduction of drainage volume, its nitrate losses will be negligible, as well. Therefore, in this treatment the efficiency of nitrogen fertilizer consumption by plant will be more, too.

Table 1: Average of nitrate concentration in the 6 irrigation numbers

Treatments	Control (no zeolite)	Calsium Zeolite	Sodium Zeolite (Granole)	Sodium Zeolite (powder)
Nitrate concentration (mg/l)	83	5	43	27

In control treatment, the highest rate of nitrate concentration was 83 mg/lit in average and in powdered sodium zeolite and broken sodium zeolite it was 43 and 27 mg/lit respectively, lowest nitrate concentration is belong to Calsium Zeolite with 5 mg/l.

4. Conclusion

This research which was conducted in lysimetric scale could be a good introduction to the use of zeolite in agricultural lands in the studied area which is an agricultural pole. According to the results the use of such materials can contribute to more efficient use of chemical fertilizers and water in growth environment, and thus the output drainage of agricultural lands will have better quality for discharge into the environment.

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