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Lysimetery Evaluation of Nitrate Leaching under Wheat Production with Using of Municipal Treated Wastewater

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ABSTRACT
Using fertilizers in agriculture is known as a source of groundwater and soil resources contamination. Nitrate is one of the most important ingredients of fertilizers. Deficient or excessive presence of this element is both problematic for plants. Soil nitrate leaching can contaminate underground aquifer layers. In order to evaluate nitrate leaching and municipal treated wastewater use in wheat plantation, a completely randomized design with three replications and under lysimetery condition was used. Water treatments include: common irrigation water, municipal treated wastewater with nitrogen concentration of 25mg/L and 50mg/L. After the each irrigation a sample of ever water treatments was collected in order to measure the amount of transferred nitrate. The results showed that the effect of irrigation water type on the amount of nitrate transfer of output lysimeters is significantly different.
Keywords: Nitrate, Municipal treated wastewater, Lysimeter

INTRODUCTION

Nitrate fertilizers depending on chemical composition, amount and time of application and also soil, water and weather conditions, may lead to different results. Usually some portions of nitrate fertilizers evaporate in form of ammonia, nitrogen and nitrogen oxides and also some others firstly turn into nitrite and then nitrate and the resultant nitrate, depending on conditions, may also lead to different results. Due to nitrate destruction, some portions may escape as gas and some absorbed by plant and also some parts may exit from around root zone by drainpipe water and join groundwater or drain water. Therefore the concentration of nitrogen in the water-soil-plant system is remarkable, not only due to using in biological systems but also due to groundwater pollution.

Solhi [1] studied the effects of different sources on nitrate washing. Results suggest that nitrate leaching in all treatments was significant and resulted in groundwater contamination. Afrous et al. [2] compared nitrate leaching in three different irrigation designs. The results indicated that nitrate concentration rate in drainage seeped into root zone was descending. Hosein poor et al. [3] evaluated the transfer of some elements into soil after raw sewage and sullage irrigation and concluded that nitrate nitrogen transfer percent from soil increases over time. Obeidat et al. [4] collected 248 groundwater samples from 16 wells in different areas of Al-Hashimiya, Jordan, and analyzed their nitrate concentration in order to evaluate nitrate levels in groundwater and to determine the potential sources of nitrate. The results showed that nitrate concentration has increased. This study shows a strong correlation between nitrate concentration and sewage as a pollution source. Parkin and lauzon [5] evaluated nitrate leaching for two different hydrogical soil groups using a conserve active tracer Nitrate leaching for the three months of winter was investigated. The farm data shows that leaching damage during these months was approximately %72.

Zhu et al. [6] evaluated nitrate leaching and soil water balance for spring corn and fall wheat. The total sum of nitrogen at a depth of 170cm and application of 220 and 250kg of nitrogen per hectare for corn and wheat were 6.28 and 8.81kg of nitrogen per hectare, respectively. Regarding nitrogen concentration in the water-soil-plant system and particularly because of groundwater pollution, investigating nitrate transfer to groundwater is necessary.

MATERIALS AND METHODS

In order to estimate the nitrate nitrogen leaching at the root zone, wheat nitrate leaching was conducted in 9 lysimeter with 90cm high and 30cm in diameter at Islamic Azad University, Dezful branch farmland, with a completely randomized design and three replications, in agricultural year 2011-2012. Treatments include three types of irrigation water: Common irrigation water as normal irrigation or control treatment municipal treated wastewater with nitrogen concentration of 50mg/L municipal treated wastewater with nitrogen concentration of 25mg/L. In lysimeters which were under normal irrigation, Potassium Nitrate was added to soil as a basic fertilizer before plantation, and nitrogen fertilizer in two phases, after plantation.

Containers were placed under lysimeters' outlet in order to measure nitrate content of drainage after irrigation. Every ten days a sample of drainage collected after irrigation. After each sampling and immediate transfer to laboratory, nitrate content of drainage outlets were measured. Nitrate content of drainage was measured using spectrophotometer at a wavelength of 420nm and according to phenol disulfonic method. You can find soil and sewage properties in tables 1 and 2.

Table 1- Some properties of the soil

Soil texture	Ec	Soil total nitrogen	Phosphorus	Potassium	pH	Organic matter
Clay loam	1.4	16	35	245	7.9	6

Table 2- Some chemical properties of the municipal treated wastewater

Organic matter	pH	Potassium	Phosphor	Total nitrogen	EC
1.1	7.9	26.2	11.5	25	3.1

RESULTS AND DISCUSSION

Considering the figures resulted from samplings and regarding Figure (1), it was concluded that nitrate content of drainages at the beginning of each season and in the first samples obtained from lysimeters' drainpipes, with the continued irrigation operation, nitrate content of drainage gradually decreased, slightly. The reason for this decline may be due to plant growth in lysimeters and expansion of roots and shoots because due to chlorophyll growth, plants can consume more nitrate form soil and irrigation water and consequently less nitrate was present in drainpipe water. Consolidation and settlement of soil in lysimeters, over time, can be also an effective factor in this decline. These results are in accord with Afrous et al. (2010) findings and also with Rahbari et al. 7(2006) reports.

Using SPSS and the completely randomized design, data analysis was conducted for all nitrate amounts measured during experimentation period. The results are summarized in Table (3).

Table 3- The results of analysis of nitrate content of lysimeters' outlet

Sources of Difference	Sum of the squares	Degrees of freedom	Mean squares	F	P-value
Treatment	275937.99	2	137968.99	11.58	0.000
Experimental error	321582.41	27	11910.46		
Total	597520.41	29			

According to Duncan test which is presented in table (4) it can be argued that the average of nitrate content of lysimeters drainage, irrigated by sewage with nitrogen concentration of 25mg/L was greater than the average of nitrate content of lysimeters irrigated by common irrigation water and both of them was greater than the average of nitrate content of lysimeters drainage, irrigated by sewage with nitrogen concentration of 50mg/L. The results suggest that there is a significant

difference between irrigation water in terms of the amount of nitrate transferred into drainpipes depth.

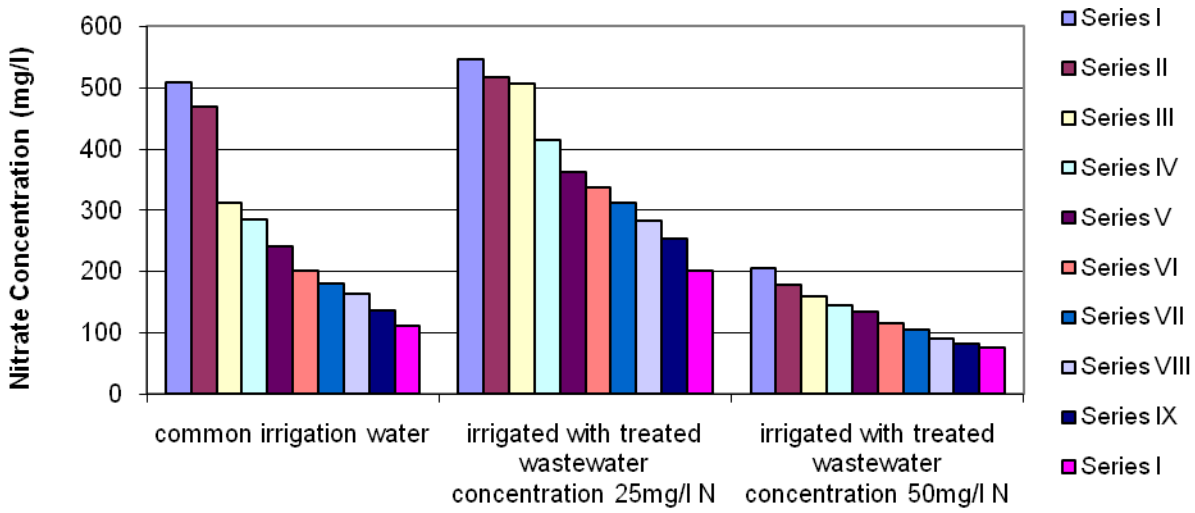

Figure (1) the effect of different treatments on nitrate leaching in drainage outlet

Table 4- Results of Duncan test of nitrate content of lysimeters' outlet drainage

Irrigation type			Duncan classification
Mean	Water treatment	Total number of samplings	
362.83	2	10	A
260.03	1	10	B
128.50	3	10	C

CONCLUSION

With respect to nitrate seepage into soil, the nitrate content of lysimeters drainage which was irrigated by municipal treated wastewater with nitrogen concentration of 25mg/L was greater than other lysimeters. During the season, the changes in nitrate content of lysimeters drainage were descending. In all three treatments, the amount of nitrate leaching was significant and caused groundwater and flowing water contamination and at last the risk of nitrate concentration growth, especially in crops irrigated by nitrate rich water, is serious. Nitrate ion, due to its negative charge, is very mobile and its movement is like the movement of water in soil and if it is not absorbed by plants and micro-organisms, it would immediately enter into water and may lead to health problems.

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