# کارگاه‌های آموزشی مرکز اطلاعات علمی


## آموزش نرم‌افزار Word برای پژوهشگران


## روش تحقیق کمی


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# Evaluation of Nitrate Leaching and Nitrogen Uptake by Maize Under Irrigation with Raw and Treated Wastewater

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**Introduction:** Water scarcity is an important challenge worldwide, especially in arid and semi-arid regions. Water-scarce countries will have to rely more on the use of non-conventional water resources to partly alleviate water scarcity. The reuse of wastewater for irrigation is considered to be beneficial for crop production, and due to its nitrogen and phosphorus content, it can help to reduce the requirements for commercial fertilizers. However, under certain conditions, this type of water if not well managed, can have negative impacts on cultivated crops and soils, particularly on soil salinity and sodicity, and may pollute groundwater, as a result of high nitrogen concentration of most treated wastewater. Besides nitrogen (N) contamination of surface and ground waters has become a serious and global environmental problem. The risk of groundwater contamination by N depends largely on the N input to agricultural fields in the form of inorganic fertilizers and on its effective use of agricultural crops. Improvement of irrigation and nitrogen application management during the growing period can be achieved using mathematical models. The goal of this study was to assess the effects of irrigation with raw and treated wastewater by using the HYDRUS-1D model for simulation of water and nitrate transport in a maize field.

**Materials and Methods:** The experimental station of the College of Agriculture and Natural Resources, University of Tehran, was considered as a case study. The information of maize growing season in 2010, as well as raw and treated wastewater of *Ekbatan* housing complex was considered as a source of irrigation water for simulation of water and nutrient movements in the soil by HYDRUS-1D software package. HYDRUS-1D numerically solved the Richards equation for describing the variably-saturated water flow in a radially symmetric domain and the convection-dispersion equation for solute transport. The soil hydraulic properties were described using the *van Genuchten-Mualem* model. Since the direct measurement of soil hydraulic parameters in the field or laboratory is time consuming and costly, they were estimated using the ROSETTA model, using particle size and bulk density data determined on soil samples taken from depths of 0-20, 20-40, 40-60 cm.

**Results and Discussion:** The results showed that water contents increased after any irrigation event, and then decreased gradually during the following hours and days, until the next irrigation took place. Deeper depths showed smaller water content variations since root water uptake and soil evaporation were more pronounced at shallower depths. Simulated plant water uptake was estimated to be 80% of the water application, indicating the high irrigation efficiency of the system. Cumulative deep percolation (DP) values increased rapidly at around 43 days after planting. This is obtained due to higher irrigation water depth applied at irrigation events after this time because of rapid growth of maize crop that is occurring due to increase air temperature at this time. Simulated deep percolation reached 6.98 cm which is 13% of the total amount of water applied during the growing season. Simulation results showed that N leaching at 60 cm depth for about 7.61 and 2.64 kg N $ha^{-1}$ for raw and treated wastewater, respectively. Nitrogen concentration for raw and treated wastewater decreased due to root nutrient uptake. The results also showed that the crop N uptake was 76.2% and 81.9% of total N input (TNI) during the growing season, while 19.4% and 14.5% of TNI was retained in the soil at the end of the season for raw and treated wastewater, respectively.

**Conclusion:** The HYDRUS-1D model was used to simulate the transport of $N\text{-}NO_3^-$ under the raw and treated wastewater application in the soil. Simulation results provided detailed moisture and N regime, as well as bottom boundary flux for percolation and N leaching estimation. N leaching is closely correlated with vertical water flow. The N leaching distributions at the bottom of the soil profile (60 cm) are similar to the corresponding water flux distributions. The results also showed that the crop N uptake was 130 and 60 kg N $ha^{-1}$ during the

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growing season for raw and treated wastewater, respectively. As the results showed wastewater can use as a source of N for crops and it can help to reduce the requirements for commercial fertilizers, and decrease their negative environmental impacts. It is suggested that the model parameters can be measured practically, in order to be used for model calibration and validation. Besides, the simulation can be done for a longer period of time to evaluate the effect of rainfall and different cultivations on solute transport.

**Keywords:** Deep percolation, HYDRUS, Nitrate-nitrogen, Non-conventional water, Wastewater

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