Evaluation of Infiltration Equations Considering Irrigation Water Quality, Initial Soil Moisture, and Constant Water Head

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Abstract

In order to design or evaluate an irrigation system, the infiltration phenomenon and its variations should be determined accurately. In saline and sodic soil and water conditions, the importance of this issue will become greater. The main objective of this study was to estimate the coefficients of different infiltration equations (Kostiakov, Kostiakov-Lewis, Horton, Philip, and U. S. Soil Conservation) and to evaluate the performance of these equations under different qualities of irrigation water, initial soil moistures, and constant water head. Using a laboratory method, infiltrations were measured in soil columns for constant water head. Then, by applying the cumulative infiltration and drainage outflow data to HYDRUS-1D model, soil hydraulic parameters were determined by the inverse solution. To determine the coefficients of infiltration equations, the outputs of the HYDRUS-1D model including cumulative infiltration verses time were corrolated. The values of root mean square error (RMSE), standard deviation root mean square error (SDRMSE), normalized root mean square error (NRMSE), percent relative absolute error (AE) and percent relative error (RE), were used to evaluate the performance of each infiltration equation and to rank the equations. The equation that had the highest rank was considered as the best and more stable equation. The Horton equation with RMSE, SDRMSE, NRMSE and AE of 0.043, 0.018, 0.006 and 1 and the Kostiakov equation with the values of 0.234, 0.175, 0.025 and 4, were the most and the least suitable eqations, respectively. The evaluation of the performance of infiltration equations using statistical indicators showed that the Kostiakov-Lewis and the Kostiakov infiltration equations were the best and the worst equations, respectively. Comparison of NRMSE values showed that in most cases, under deficit irrigation, infiltration equations estimate infiltration more accurately. For a given treatment, the errors of Kostiakov-Lewis and Philip infiltration equations increased as the amount of irrigation water increased, and as the end of the season approached. The rest of the equations did not show any especial trends. To measure infiltration, it is necessary to consider the effects of irrigation water quality, initial soil moisture, and water heads, because these parameters influence the coefficients of infiltration equations and, consequently, the irrigation efficiency.

Keywords: Infiltration Coefficients, Hydraulic parameters, Kostiakov-Lewis, HYDRUS-1D Model.

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* - Received: November 2016, and Accepted: July 2017