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Determining the Most Compatible Method for Estimating Infiltration Parameters in Mathematical Furrow Irrigation Models

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Introduction: Surface irrigation is still the most used method. For accessing to high efficiency, irrigation requires careful design and correct implementation. In addition, the design and evaluation of these systems require the identification of the advance, recession, and infiltration curves. Infiltration is the most important and difficult parameter to evaluate surface irrigation systems. The objective of this study was to evaluate five different methods to estimate infiltration parameters (two-point method of Elliott and Walker, recycling furrow infiltrometer, Singh and Yu method, Shepard one-point method and modified Shepard et al. two-point method) and to determine the most compatible method with design and evaluation models of furrow irrigation (hydrodynamic, kinematic wave and zero inertia) by applying SIRMOD software.

Materials and Methods: For the simulation of the surface irrigation, the continuity and momentum equations (Sant-Venant equations) used. SIRMOD simulation model is one of the models for the management and design of surface irrigation systems. The software package, hydraulic hydrodynamic models, zero inertia and kinetic wave have been placed. These models are resolvent of the Sant-Venant equations based on various assumptions. In this study, two-point method of Elliott and Walker, recycling furrow infiltrometer, Singh and Yu method (to calculate the coefficients of Kostiakov-Louis equation), Shepard one-point method and modified Shepard et al. two-point method (to calculate the coefficients of Philip equation), were used for estimating infiltration parameters. For this purpose, three field data sets were used. The total infiltrated water volume and advance time were predicted in each infiltration method and irrigation simulation model. In order to compare and evaluate the mentioned methods, the relative and standard errors were calculated.

Results and Discussion: According to the five methods (two-point method of Elliott and Walker, recycling furrow infiltrometer, Singh and Yu method, Shepard one-point method and modified Shepard et al. two-point method) Kostyakof- Louis and Philippe equations coefficients were determined. To evaluate the different methods for estimating infiltration parameters, the volume of water penetration in the furrow length was estimated using five named methods and the findings were compared with the actual volume of infiltrated water in the furrows (was estimated using the input-output hydrograph). Values of relative error in estimating the infiltrated volume in the furrows show the two-point Elliott and Walker method with 9.2 percent relative error is the lowest error than other methods. Then recycling furrow infiltrometer (back water) method is with 21.4 percent relative error. The standard error in the simulation and predict the advance stage in furrows based on different estimated parameters showed that hydrodynamic model by two-point Elliott and Walker method will give the best results (with 12.86 percent standard error). Also in Kinetic Wave model, recycling furrow infiltrometer method has the lowest standard error (10.04 percent) and zero inertia models with two-point Elliott and Walker method have lowest standard error (12.81 percent). In Hydrodynamic and zero inertia models, recycling furrow infiltrometer and two-point method of Elliott and Walker and Singh and Yu method have estimated advance figures in furrow less than its actual value. Shepard et al. one-point method underestimated about 100 meters of furrow length and overestimated from this point to the end of the furrow. Modified Shepard et al. two-point method is generally overestimated. In the kinetic wave model, two-point Elliott and Walker and recycling furrow infiltrometer methods numbers have been estimated to be completed in accordance with the numbers seen in a distance of about 40 meters along the furrow and the low estimate since the end of the furrow. Singh and Yu method overestimated. Shepard et al. one-point and Modified Shepard et al. two-point method were like the other two models.

Conclusions: Elliott and Walker two-point method is generally the least error in the calculation of the total volume of infiltrated water through the grooves, compared to other methods and then using rotating penetrometer (back water) is located. In general it can be said that both recycling furrow infiltrometer and two-point Elliott and Walker, the most appropriate methods to determine the infiltration equation parameters than

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other methods under study and using them in all three hydrodynamic, kinematic wave and zero inertia models, the results of the simulation irrigation, have created the smallest error. In general, the kinetic wave model than hydrodynamic and zero inertia models, was estimated more accurately the data in water advance stage and this trend can be seen in every five methods for estimating the infiltrated parameters. However, calculated errors in both hydrodynamic and zero inertia models in predicting this stage of irrigation are almost equal.

Keywords: Infiltration Equation, SIRMOD, Surface Irrigation, Surface Irrigation Models