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Comparative Evaluation of Root Uptake Models for Developing Moisture Uptake Based Irrigation Schedules for Crops

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Abstract : In the era of water scarcity, effective use of water via irrigation requires good methods for determining crop water needs. Implementation of irrigation scheduling programs requires an accurate estimate of water use by the crop. Moisture depletion from the root zone represents the consequent crop evapotranspiration (ET). A numerical model for simulating soil water depletion in the root zone has been developed by taking into consideration soil physical properties, crop and climatic parameters. The governing differential equation for unsaturated flow of water in the soil is solved numerically using the fully implicit finite difference technique. The water uptake by plants is simulated by using three different sink functions. The non-linear model predictions are in good agreement with field data and thus it is possible to schedule irrigations more effectively. The present paper describes irrigation scheduling based on moisture depletion from the different layers of the root zone, obtained using different sink functions for three cash, oil and forage crops: cotton, safflower and barley, respectively. The soil is considered at a moisture level equal to field capacity prior to planting. Two soil moisture regimes are then imposed for irrigated treatment, one wherein irrigation is applied whenever soil moisture content is reduced to 50% of available soil water; and other wherein irrigation is applied whenever soil moisture content is reduced to 75% of available soil water. For both the soil moisture regimes it has been found that the model incorporating a non-linear sink function which provides best agreement of computed root zone moisture depletion with field data, is most effective in scheduling irrigations. Simulation runs with this moisture uptake function result in saving 27.3 to 45.5% & 18.7 to 37.5%, 12.5 to 25% % &16.7 to 33.3% and 16.7 to 33.3% & 20 to 40% irrigation water for cotton, safflower and barley respectively, under 50 & 75% moisture depletion regimes over other moisture uptake functions considered in the study. Simulation developed can be used for an optimized irrigation planning for different crops, choosing a suitable soil moisture regime depending upon the irrigation water availability and crop requirements.

Keywords : irrigation water, evapotranspiration, root uptake models, water scarcity
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