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Impact of soil hydraulic properties on water fluxes for a typical cropping system of Southern Italy: a sensitivity analysis using SWAP model

D. Ventrella, L. Giglio, M. Castellini, N. Losavio, R. Leogrande

C.R.A.-Istituto Sperimentale Agronomico, Bari, Italy (domenico.ventrella@entecra.it / Phone: +39-080-5475011)

The modelling of soil water fluxes is a fundamental task for evaluating the agricultural cropping systems from environmental and economic points of view. The soil water fluxes as drainage and evaporation are difficult to measure. Indeed it is possible to measure the plant transpiration, but the measurements are expensive and time-consuming. For these reasons the model applications are become very useful for evaluating different irrigation management strategies with the objective to increase the water use efficiency (WUE). It is evident that this issue is particularly important for the regions where the scarce water resources are often the limitant factor for agricultural productivity. SWAP (Soil-Water-Atmosphere-Plant) is a physically-based model that simulates transport of water, solutes and heat in variably saturated soils. The program is designed to simulate the transport processes at field scale level and during whole growing seasons. In this paper we present the results of a sensitivity analysis (SA) carried out for a "real" lettuce cropping system typical in the Southern Italy during the winter season. The SA was performed by using SWAP with the main objective to evaluate the sensitivity of the main soil/plant/atmosphere fluxes (transpiration, evaporation and drainage) to the hydraulic parameters included in the of Mualem-van Genuchten soil hydraulic functions: saturated hydraulic conductivity (Ks), saturated and residual soil water content (thetas and thetar, respectively) and the fitting parameters (a and n). Numerical runs were generated for three climatic data sets - wet (W), normal (N) and dry (D) crop seasons - based on data recorded by a meteorological station located in Metaponto which is situated in the coastal area of the Basilicata region in Southern Italy (lat. 40° 24' N and long. 16° 48' E). The simulations were generated for a 70-cm-depth profile considered homogeneous for hydraulic properties. All the

crop parameters and the hydraulic properties were derived and/or measured from a farm field concerning a lettuce crop cultivated on a sandy soil from November 2004 to February 2005. For the SA we have generated a reference run for the three different climatic conditions using soil hydraulic parameter averaged for 20 sampling location. For each location, undisturbed soil cores (5 cm in height Œ 8 cm in diameter) were collected and the drying part of water retention function and the Ks were determined by means a hanging water column apparatus and the constant head method, respectively. Successively for the SA, the averaged soil parameters (Ks, thetas, a and n) were perturbed by 5% of the nominal values between -25 and +25% in order to test the linearity of cumulated outputs (actual evaporation and transpiration and drainage water flux at the bottom boundary) to the changed hydraulic parameters. In general the water fluxes were found to be most sensitive to thetas and n changes while the effect of Ks and a was rather weak. Regarding the climatic variability, the impact of the hydraulic parameters was generally highest in dry climatic conditions with the model responses linear for some parameters and non-linear for others.