ABSTRACT

Analytical solutions are worked out for the general one-dimensional steady state infiltration equation for a heterogeneous soil column with the sink term of the equation being treated as any valid root-water uptake function along the length of an infiltrating space. Solutions are being obtained for the governing equation (Richards's equation) considering both the Gardner as well as van-Genuchten conductivity functions. The validity of the developed solutions is being checked by comparing with the analytical works of others for a few simplified infiltration situations; also, a few numerical checks and experimental comparisons on them have also been carried out. These solutions can predict infiltration behavior through any arbitrarily inclined soil column and can also accommodate any valid spatial variations of the root-water extraction function and the soil hydraulic parameters of the infiltration equation, along the length of an infiltrating column. The study shows that infiltration on a heterogeneous Gardner or van-Genuchten soil is a highly complex process involving many variables and the spatial variations of these variables in such a soil may greatly influence the infiltration mechanics associated with it; this is true both when a root-water function is present in an infiltrating space and when it is absent. It has also come out of the study that infiltration hydraulics related to a heterogeneous Gardner or van-Genuchten soil is mostly due to the combined effect of all the players of the system and is not due to one or two infiltration variables of the system alone. As there is currently no analytical solution to either the Gardner or van-Genuchten-based infiltration equation for a heterogeneous soil with or without the sink term, it is hoped that the proposed solutions will be worthwhile additions to the collection of analytical solutions on the subject.

Keywords: Analytical solution; Gardner's conductivity function; van Genuchten's conductivity function; Root-water extraction function; Soil heterogeneity.