Effect of Parallel Strip Water Source Spacing on Lateral Infiltration Flux

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Abstract

This analysis evaluates the importance of the lateral component of flow on the infiltration of water from parallel strip sources of water on the soil surface. Infiltration from such sources will be two-dimensional, having both a vertical and a lateral component. Historically this infiltration process can be approximated by a one-dimensional infiltration equation with one or more terms added to account for the accompanying lateral flow component. Warrick et al. (2007) developed a method to calculate two-dimensional infiltration from a single strip source by adding an "edge effect" (a single term) to the one-dimensional calculations. They quantified the edge effect by numerical solution of the Richards equation. Since their analysis was for a single strip source they did not account for the impact of parallel strip sources on this edge effect. In our research COMSOL Multiphysics® software with the Subsurface Flow Module has been used to simulate the reduction of lateral infiltration (and therefore the edge effect) of a strip water source due to the influence of adjacent strips. The infiltration from strip water sources was modeled using various strip spacings and soil textural classes. The moisture profile for the case of a single strip source is shown in Figure 1, and for the case of three parallel strip sources in Figure 2. It is observed that for the multiple strip source case the flow from each of the parallel strips interacts with the adjacent strips. This interaction effectively reduces the lateral infiltration from the individual strips. The relation between strip spacing and the edge effect is illustrated in Figure 3. The plot shows that as the strip spacing increases the edge effect also increases. It is also observed from this figure that as the soil become more coarse-textured (more sandy that is) the influence of spacing on the edge effect is reduced. The results show that there is a specific separation between strips, different for each soil texture class (0.28 m for loamy sand versus 0.5 m for silty loam), where there is no effective interaction between them with respect to the edge effect. Based on the numerical simulation results a relationship was established that relates strip spacing with the magnitude of the edge effect. This research facilitates the calculation of infiltration from parallel strip sources using a one-dimensional approximation with a factor to account for the actual two-dimensional flow with strip interaction.

Reference

Warrick, A. W. et al., 2007. Explicit infiltration function for furrows, J. Irrig. Drain. Eng., 10.1061/(ASCE)0733-9437(2007)133:4(307), 307–313.

Figures used in the abstract

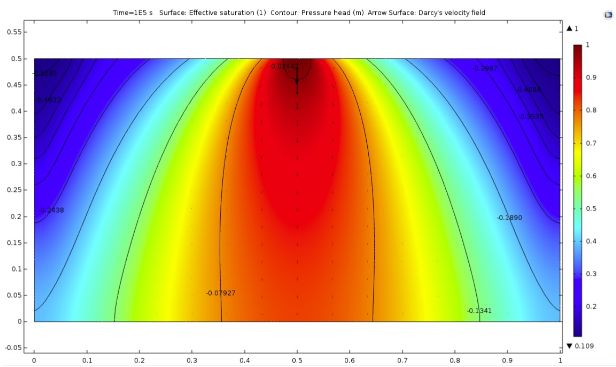

Figure 1: Soil moisture pattern beneath a single strip source of water.

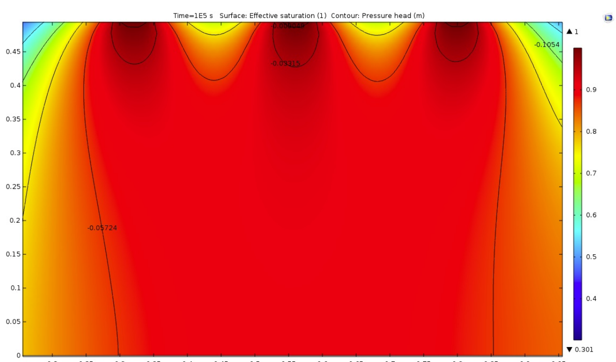

Figure 2: Soil moisture pattern beneath three parallel strip sources of water spaced 0.21 m apart.

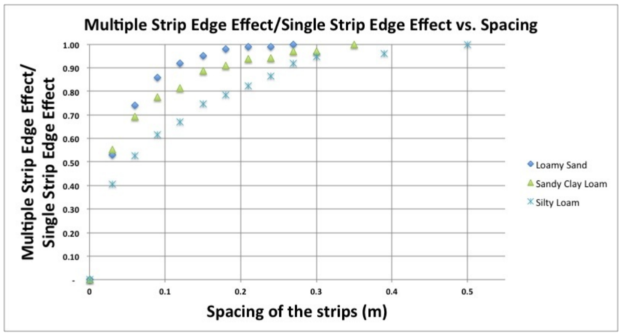

Figure 3: The influence of strip source spacing on the lateral flow (edge effect) as impacted by soil texture.

Figure 4