Closure to "New Results for an Approximate Method for Calculating Two-Dimensional Furrow Infiltration" by E. Bautista, A. W. Warrick, and T. S. Strelkoff

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The authors thank the discussers for their interest in the paper. The authors will attempt to clarify the issues raised by the discussers.

1. If measured soil water content versus tension data are fitted to the van Genuchten (vG) and Brooks-Corey (BC) models, and those models are then used to simulate infiltration with the Richards equation, infiltration predictions will differ for the same initial and boundary conditions. The difference is explained by the fact that the water content θ remains constant for pressures greater than the bubbling pressure with the BC model, whereas water content changes very rapidly with small pressure changes when the soil is near saturation with the vG model. This is the subject of the Ma et al. (1999) paper and the reason why the Tifton loam sand soil data were included in the analysis. For cases where soil water retention data has been fitted to a particular soil hydraulic model, conversion formulas can be used to derive the parameters of another model (vG to BC or vice versa). The conversion formulas suggested by Lenhard et al. (1989) yield water retention and hydraulic conductivity curves that match closely over a wide range of water contents, but not near saturation for the above explained reasons. As a result, the infiltration curves can be quite different. The conversion formulas suggested by Morel-Seytoux et al. (1996) make the infiltration predictions more alike, but at the expense of making the water retention and conductivity curves different. Water flow predictions at lower water contents will then be different. It is important to remember that the vG and BC models are empirical. Hence, empirical judgement is needed when selecting an approach for representing water content and hydraulic conductivity for a particular soil. Considering that same hydraulic behavior cannot be represented for a given soil with different hydraulic models, comparisons of calibration results based on soils that are not identical, but that are textually similar, still seems useful.
2. In the article under discussion, simulation time refers to the duration of the simulated infiltration event. The comment confuses simulation time with computational (execution) time. In the analysis, one-dimensional (1D) infiltration was calculated for the same simulation time as two-dimensional (2D) infiltration.
3. A constant pressure head boundary condition can be imposed in HYDRUS with the variable pressure head option, by using a single variable head record.
4. The authors agree, the term flux was inappropriately used. In the paper under discussion it denotes infiltrated volume per unit area.
5. The results of Figs. 3 and 4 were developed from strip infiltration tests, whereas Figs. 12 and 13 were developed for trapezoidal furrows. In the latter figures, the values of γ tend to be larger when infiltration was calculated with the BC model. Hence, the soil hydraulic model is not the only factor affecting the values of γ. Additional tests have been conducted for other vG and BC soils, and furrow geometries, and those results tend to support the findings of Figs. 12 and 13.

   The authors agree with the general concern expressed by the discussers relative to generalizing the results presented just based on a few soils. Thus, additional tests need to be conducted to better understand if results are affected by numerical artifacts. Infiltration predictions can sometimes be surprisingly sensitive to small changes in the values of soil parameters. This sensitivity is partly related, as explained earlier, to large changes in water content with pressure when near saturation. Given these limitations, and considering that the calibration parameters computed for various soils are not very different, the proposed approach still seems very promising.
6. The original methodology of Warrick et al. (2007) required W^* to be calibrated. In this slightly modified approach, $W^* = W$. A remaining problem is characterizing γ as a function of W or h_0. As indicated by the discussers, another concern is characterizing the soil hydraulic properties for practical applications, but that issue is beyond the scope of this paper. The proposed methodology aims only to approximate the solution to the 2D Richards equation under furrow irrigation conditions.

   For practical use, calibration of the proposed method requires being able to run 2D infiltration simulations, and potential users of the proposed methodology may have little interest in performing such calibration, or may not have access to HYDRUS-2D or a similar program. That is why the sensitivity of predictions was examined assuming no calibration in p. 9 of the paper under discussion. From a practical standpoint, there are many other uncertainties associated with modeling infiltration with the Richards equation, including selecting a soil hydraulic mode, defining the parameters of that model, and accounting for water flows through macropores. Infiltration predictions are probably more sensitive to those factors than to the value of the calibration parameter.
7. In fact, all analyses were conducted using the same pressure value for 1D infiltration and sorptivity calculations. For example, the results of Fig. 10 were computed for three different values of that pressure head, but in all cases the same value was used for one-dimensional and sorptivity calculations.

References

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