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Can the temporal dynamics of soil water retention on agricultural land be predicted from the simple time-dependent parameters bulk density or macroporosity?

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Agricultural soil structure can vary markedly over a growing season, whether it be from the slumping of seedbeds in cultivated soils or the action of plants and weather under zero-tillage. Water retention and transport properties therefore also vary over the growing season, with implications to hydrological processes, crop water availability and ecosystem processes such as carbon cycling. Collecting water retention data is time-consuming and expensive, with most studies relying on one time point. To overcome this constraint, we explored whether the simpler to obtain measurements of bulk density or macroporosity could predict the temporal dynamics of the soil water retention curve (SWRC) in field soils. Using soil samples compacted in the laboratory, Assouline (2006) developed a model to predict the soil water retention curves of compacted soils using only bulk density of the compacted soil and the parameters of the SWRC of a previous compacted state. In this work, we tested the workability of Assouline (2006) model for field conditions using data obtained from two tillage experiments on contrasting soil textures (loamy sand and clay loam) in the UK. We also developed a new model using macroporosity to predict the temporal dynamics of the SWRC. Data obtained for the sandy loam (SL) soils were for the following tillage treatments: Zero Tillage (ZT-SL), non-inversion Shallow Tillage (ST-SL), Plough (P-SL) and Compacted (C-L) while those of the clay loam soils were non-inversion Shallow Tillage (ST-CL) and Deep Tillage (DT-CL), and Plough (P-CL) with 9 replications for each treatment. For the sandy loam soils, SWRCs at Timepoint 2 (August - post harvest) were predicted from the parameters of SWRCs at Timepoint 1 (May – 1 month post cultivation). SWRCs predictions for the clay loam soils at Timepoints 2 (August – post harvest) and 3 (September – post cultivation) were achieved using the parameters of Timepoint 1 (April – post winter) while those of Timepoint 3 were obtained with the parameters of Timepoint 2. For the sandy loam soils, very good fits of the SWRC were obtained with either the bulk density or macroposity model. The bulk density model had R^2 ranging from 0.907 to 0.950 and RMSE ranging from 0.052 and 0.092. The macroporosity model performed slightly better, with R^2 ranging from 0.914 to 0.953 and RMSE ranging from 0.049 to 0.054. For the clay loam soil, the bulk density model had R^2 ranging from 0.824 to 0.876 and RMSE ranging from

0.105 to 0.077, while the macroporosity model had R^2 ranging from 0.821 to 0.881 and RMSE ranging from 0.086 to 0.065. Both models worked better for sandy loam than clay loam soil. The macroporsity based model provided a more accurate prediction than the bulk density model, particularly at predicting time-dependency at the wet end of the SWRC. This is very early research that will continue to explore whether simple parameters that are practical to collect in the field can aid predictions of the SWRC over time.