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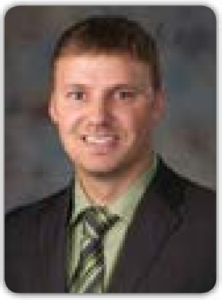

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Quantifying and correcting for clay content effects on soil water measurement by reflectometers

Clay content could affect the calibration of electromagnetic soil water sensors including reflectometers. To investigate this effect further, three TDR315 and three CS655 reflectometers were installed in each of five soils with clay content ranging from 5 to 49%. As the soils were dried in a temperature-controlled room, sensor reported soil volumetric water content (θ_v) according to factory calibration was compared against reference θv determined by weighing the soils. Sensor-reported θ_v was similar to reference θ_v in the sand (root mean square difference (RMSD) <0.02 m^3 m^{-3}), but the discrepancy was larger for the clayey soils. An increase in clay content tended to cause TDR315 to underestimate low θ_v and tended to cause CS655 to overestimate θ_v curvilinearly. At the levels evaluated in this experiment, differences in clay content produced a larger effect than temperature (24 versus 35°C) and salinity (0 versus 3.09 g/L $CaCl_2$) on the accuracy of the factory calibration for both sensors. Soil-specific empirical calibrations developed using quadratic regression fitted the experimental data very closely (R^2>0.93) for both sensors. By estimating calibration coefficients based on clay content alone and then adjusting sensor-reported θ_v accordingly, RMSD from reference θ_v was approximately halved for both sensors. Applying the same procedure to independent literature data resulted in improvements in a soil with 39% clay content but deterioration in a soil with 17-18% clay content. A clay content correction can enhance the accuracy of some reflectometers and electromagnetic sensors for soil water measurement.

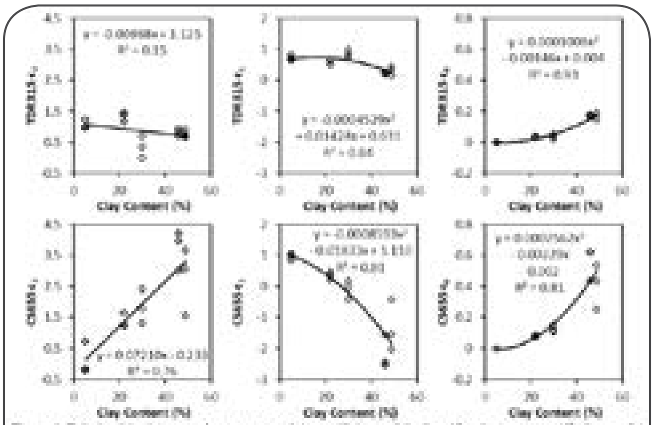

Figure 1. Relationships between clay content and the coefficients of the θ_v calibration equation ((Reference θ_v) = c_2 × (Sensor $\theta_v)^2$ + c_1 × (Sensor θ_v) + c_0) for TDR315 and CS655 in the 15 soil columns during the drying cycle with constant temperature and no added salinity.

Recent Publications

1. Barker B J et al. (2018) Evaluation of variable rate irrigation using a remote-sensing based model. Agricultural Water Management. 203:63-74. Doi:10.1016/j.agwat.2018.02.022.

2. Singh J T et al. (2018) Performance assessment of factory and field calibrations for electromagnetic sensors in a loam soil. Agricultural Water Management. 196(C):87-98. Doi:10.1016/ j.agwat.2017.10.020.
3. Djaman K K et al. (2017) Performance of twelve mass transfer based reference evapotranspiration models under humid climate. Journal of Water Resource and Protection. 9(12):1347-1363. Doi:10.4236/jwarp.2017.912086.
4. Rudnick D R et al. (2017) Impact of irrigation and nitrogen fertilizer rate on soil water trends and maize evapotranspiration during the vegetative and reproductive periods. Agricultural Water Management. 191:77-84. Doi:10.1016/j.agwat.2017.06.007.

Biography

Daran Rudnick obtained his BS, MS and PhD Degrees from the University of Nebraska Lincoln, USA. He is currently an Assistant Professor and Irrigation Management Specialist in the Department of Biological Systems Engineering at the same university. His research focuses on improving irrigation management strategies for commonly grown crops and rotations found in the semi-arid climate of west central Nebraska. His research projects include the evaluation of deficit irrigation strategies for maize and soybean under center pivot and subsurface drip irrigation systems, integration of variable rate irrigation and nitrogen fertilizer management, assessment of residue removal effects on maize yield and crop water use and field and laboratory evaluation of soil water monitoring equipment.

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