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Soil Water Content Monitoring with Capacitance Probes operating in access-tubes: Laboratory Calibration and Type Comparison

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Capacitance probes have proved to be an alternative to TDR-sensors for real-time and quasi-continuous water content measurements in a soil profile in the field, especially for irrigation management. However, a careful calibration improves the quality of their information from relative levels to absolute values, which broadens their area of application considerably. Unlike for multisensor capacitance probes, published experience with portable single-sensor probes is scant. The portable probe is cheaper than the permanently installed multisensor probe, but requires manual readings. It acquires profile distribution of soil water content in 10-cm steps by down- and up movement of the sensor in the access tube. The objective of our study was a calibration of the portable type against a silt loam in the lab, a comparison among three sensors of the same portable probe type and of two multisensor probes. Container was constructed from a PVC-pipe with a diameter of 0.39 m and 1.0 m length. As bottom for the soil column a wooden plate was attached in half of the pipe's height. The access tube was inserted in a hole of the plate prior to insertion of the soil. The initially air dry soil was manually packed in small uniform increments up to a filling height of 0.49 m. After sensor readings undisturbed soil cores were taken in the three measurement horizons for checking of uniformity of packing and volumetric water content. The desired amount of water was added to the soil and the procedure repeated three times (giving 4 distinct volumetric water contents from 2 % to 41 %). Whereas deviations among portable probes in frequencies proved to be small, considerable deviations in scaled frequencies occurred. Measurements in air and in water showed that this was due to an incorrect

normalization procedure of one sensor. In order to assure not to have been evoked by distinct temperatures during prior normalization and the calibration experiment, frequencies in water were measured at three temperatures. Erroneous data were exported and corrected by numerical re-normalization, normalization parameters in the logger and display unit were not changed. Volumetric water contents calculated with an exponential calibration function and standard parameters provided by the manufacturer gave absolute errors up to 10 %. Calculation with consistent fitting parameters for all three portable probes resulted in satisfying small discrepancies. The two multisensor probes showed a good agreement regarding scaled frequencies and poor results for the water content calculated with the standard procedure. Our study indicates that achievable accuracy of the portable probe is similar to that of the portable probe - careful normalization and calibration provided.