Accuracy of FieldScout TDR 300 Soil Moisture Meter in Saline Soils

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Objectives:

1. To evaluate the accuracy of a FieldScout TDR 300 hand held soil moisture sensor in a USGA sand at salinity levels ranging from 0.46 to 20 dS m^{-1}
2. To compare the accuracy of a TDR 300 to a permanently installed Decagon 5TE soil sensor

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Project Duration: 2 years
Total funding: $6,000

Measuring soil moisture with Time Domain Reflectometry (TDR) sensors can aid in turfgrass water conservation efforts, help improve playing conditions, green speed, and irrigation efficiency, and can assist in rootzone salinity management. However, information is lacking on the accuracy and reliability of newly introduced hand-held electromagnetic moisture sensors in saline soils. A laboratory study was conducted at New Mexico State University during 2015 to investigate the accuracy and reliability of a FieldScout TDR soil moisture sensor and a Decagon 5TE soil sensor at different salinity levels (expressed as electrical conductivity of the saturated soil paste extract ECe).

Columns measuring 14 cm in height and 20 cm in diameter were filled with a sand meeting USGA specifications for particle size distribution. Columns were subsequently saturated for 24 hours with either distilled (ECw = 0 dS m^{-1}), tap (ECw = 0.7 dS m^{-1}), or saline water (ECw = 2, 4, 6, 8, 10, and 15.5 dS m^{-1}) which resulted in ECe of 0.46 (distilled water), 1.08 (tap water), and 3.68, 5.40, 5.78, 7.68, 9.38, and 19.84 dS m^{-1}, respectively. Two FieldScout TDR 100 (Spectrum Technologies, Inc. Aurora, IL) (rod length 7.6 cm) and two Decagon 5TE (Decagon Devices Inc., Pullman, WA) (rod length 5 cm) sensors were used in this study. The soil sensors were inserted into the columns and subsequently placed onto a pressure plate inside a pressure chamber to record sensor readings at different soil moisture levels. For the purpose of this study we used the Spectrum Technologies' TDR 100 sensor instead of the TDR 300 as it uses the same measurement technology as the TDR 300 (Spectrum Technologies, pers. communication) but does not have a long handle attached to the body that holds the rods. Columns and sensors were then exposed to increasing air pressures which initiated soil drying by removing water from the soil. At the end of the dry-down period, columns were dried at 105 °C. Volumetric soil moisture was subsequently determined for each moisture level and data comparisons were based on either fitting linear regressions or quadratic polynomials to all salinities. Results are presented for the TDR 300 only.

There were no differences between values from the two sensor replicates therefore data were pooled over both sensors. Overall, sensor values increased with increasing soil moisture as slopes differ significantly from 0 for every soil salinity. Slopes for ECe $\geq$ 5 dS m^{-1} were greater than for salinities of ECe < 4 dS m^{-1}. The slope at ECe = 19.8 dS m^{-1} was 4 times higher than the slope at ECe = 0.5 dS m^{-1}. These results suggest that different salinity levels need separate calibration if the absolute soil moisture value is of interest. When separate quadratic polynomials were fit for each salinity the models differed significantly from 0 for salinities of ECe =3.7 and greater. Only for the salinities of ECe = 0.5 and 1.1 dS m^{-1} data did not suggest to fit a quadratic term. However, caution needs to be used when fitting a quadratic polynomial as some of the moisture ranges included only 4 data points.

Table: Intercept and slope for the linear regression models to measure soil moisture with a Spectrum TDR 300 at different soil salinities compared to moisture determined gravimetrically (SE = Standard Error).

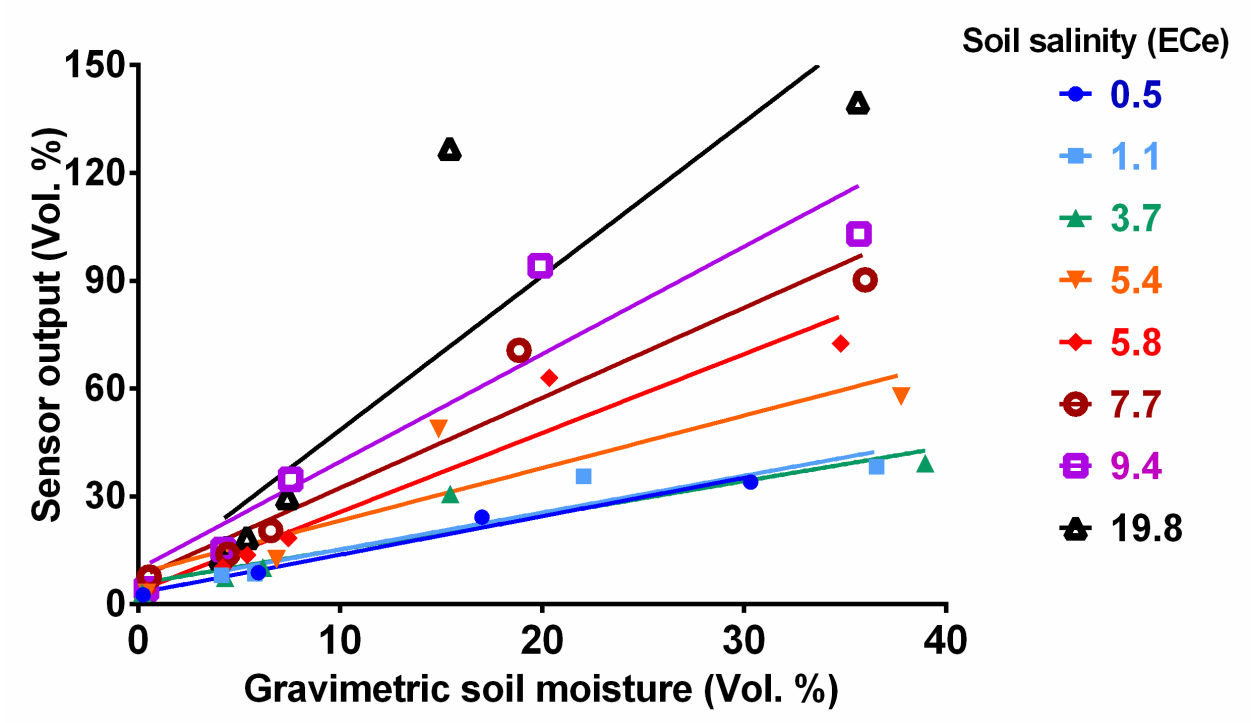
Soil salinity (ECe)	Intercept	SE	Slope	SE
0.5	3.13	7.61	1.07d*	0.43
1.1	5.06	8.11	1.02d	0.37
3.7	5.76	6.07	0.95d	0.32
5.4	8.67	7.22	1.46cd	0.35
5.8	3.74	5.77	2.20bc	0.34
7.7	7.32	6.36	2.51b	0.34
9.4	9.79	6.44	2.99b	0.34
19.8	5.67	5.93	4.28a	0.36

* Values followed by the same letter are not significantly different from one another (Fisher's protected LSD, $\alpha = 0.05$)

Summary Points

- Hand held TDR sensors can help in turfgrass water conservation efforts and in improving playing conditions
- Soil moisture readings between two replicate TDR 300 sensors with a rod length of 7.5 cm (3") did not differ from one another across a wide range of soil salinities.
- Soil sensors estimated moisture in a USGA sand accurately at salinity levels of ECe < 5 dS m^{-1}
- Different salinity levels need separate calibration for ECe > 5 dS m^{-1} if the absolute soil moisture value is of interest rather than the relative difference.


FIELDSCOUT
TDR 100
ON
MODE
Delete Clr Avg
READ
Spectrum
FIELDSCOUT
TDR 100
ON
MODE
Delete Clr Avg
READ
Spectrum
MADE IN USA


Soil salinity (ECe)
0.5
1.1
3.7
5.4
5.8
7.7
9.4
19.8
Sensor output (Vol. %)
150
120
90
60
30
0
0
10
20
30
40
Gravimetric soil moisture (Vol. %)