Soil moisture sensors for irrigation management of vegetable crops – experiences in Almeria greenhouses

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Research lines undertaken with soil moisture sensors

***Blue text**: will not be presented here*

Volumetric soil water content (VSWC) sensors and soil matric potential (SMP) sensors

- Determination of lower limit using plant water status

Volumetric soil water content sensors

- Determination of lower limit using dynamic protocols
- Determination of upper limit in compacted soil with drip irrigation
- Salinity effects

Watermark sensor

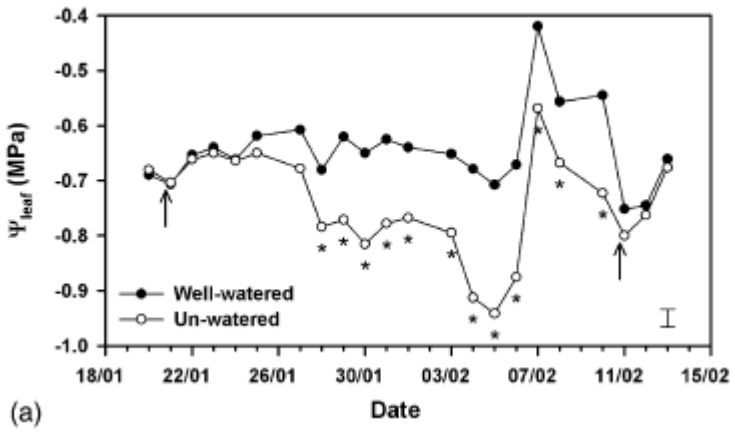
- Effect of different calibration on SMP values
- Performance of *in-situ* calibration
- Performance in very moist conditions
- Performance in rapidly drying conditions

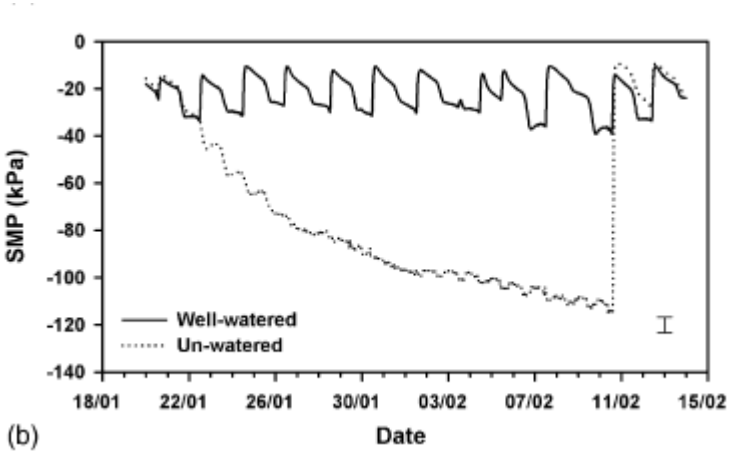
Volumetric soil water content (VSWC) sensors; soil matric potential (SMP) sensors

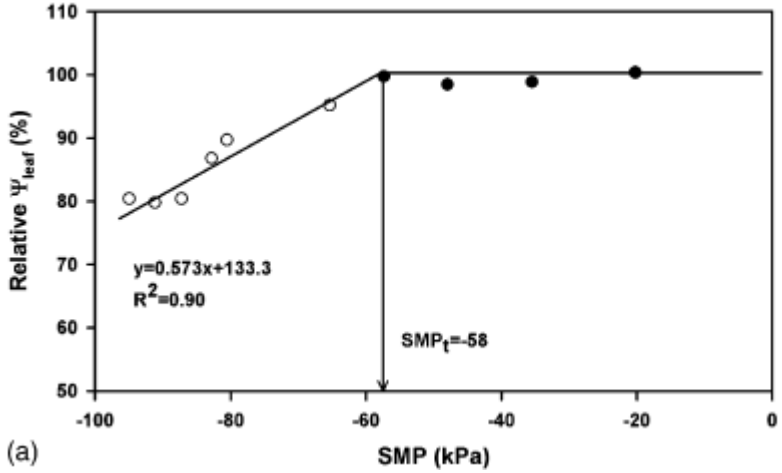
- Determination of lower limit using plant water status

Methodology

- Pepper, tomato and melon, grown in soil, in greenhouse
- Plants subjected to drying cycles which compared with well-watered plants (-10 to -30 kPa)
- Leaf water potential determined
- Relative leaf water potential (ψ_{leaf}) calculated (ψ_{leaf} un-watered divided by ψ_{leaf} well-watered)
- Relative ψ_{leaf} related to SMP and VSWC







Source: Thompson et al. 2007. Using plant water status to define soil water thresholds for irrigation management of vegetable crops using soil moisture sensors. Agricultural Water Management, 88: 147–158

Volumetric soil water content (VSWC) sensors; soil matric potential (SMP) sensors

- Determination of lower limit using plant water status

Results - SMP

- SMP Limit for pepper: -58 kPa
- SMP Limit for tomato: -35 to -58 kPa
- SMP Limit for melon: -35 kPa

Source: Thompson et al. 2007. Using plant water status to define soil water thresholds for irrigation management of vegetable crops using soil moisture sensors. Agricultural Water Management, 88: 147–158

Results - VSWC

- Evaluated as Available Water Content (AWC)
- AWC threshold values influenced by calibration, depth of soil considered, values used for FC and PWP
- Therefore, appreciable uncertainty regarding AWC threshold values
- SMP thresholds are much more reliable than AWC thresholds for greenhouse-grown vegetable crops
- Plants subjected to drying cycles compared with well-watered plants (-20 to -30 kPa)

Salinity effects on a VSWC sensor

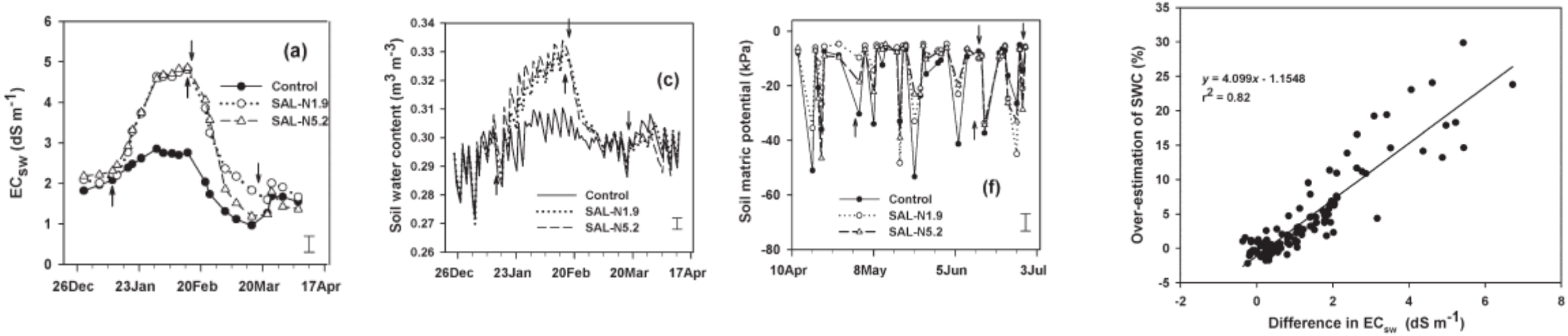
Methodology

- EnviroScan and tensiometers used
- Fertigated crop tomato crop grown in soil
- EC of nutrient solution initially was 1.9 dS m^{-1}
- 5.0 dS m^{-1} nutrient solution then applied for one month, then leaching applications water (EC 0.4 dS m^{-1})
- Two salinity treatments: sensors "normalised" at 5.0 dS m^{-1} or 1.9 dS m^{-1}
- Control received 1.9 dS m^{-1} and then water
- EC of soil solution measured (EC_{SW})

Source: Thompson, R.B., Gallardo, M., Fernández, M.D., Valdez, L.C., Martínez-Gaitán, C. 2007. Effect of salinity on soil moisture measurements made with a capacitance sensor under vegetable production conditions. Soil Science Society of America Journal, 71: 1647–1657

Salinity effects on a VSWC sensor

Results

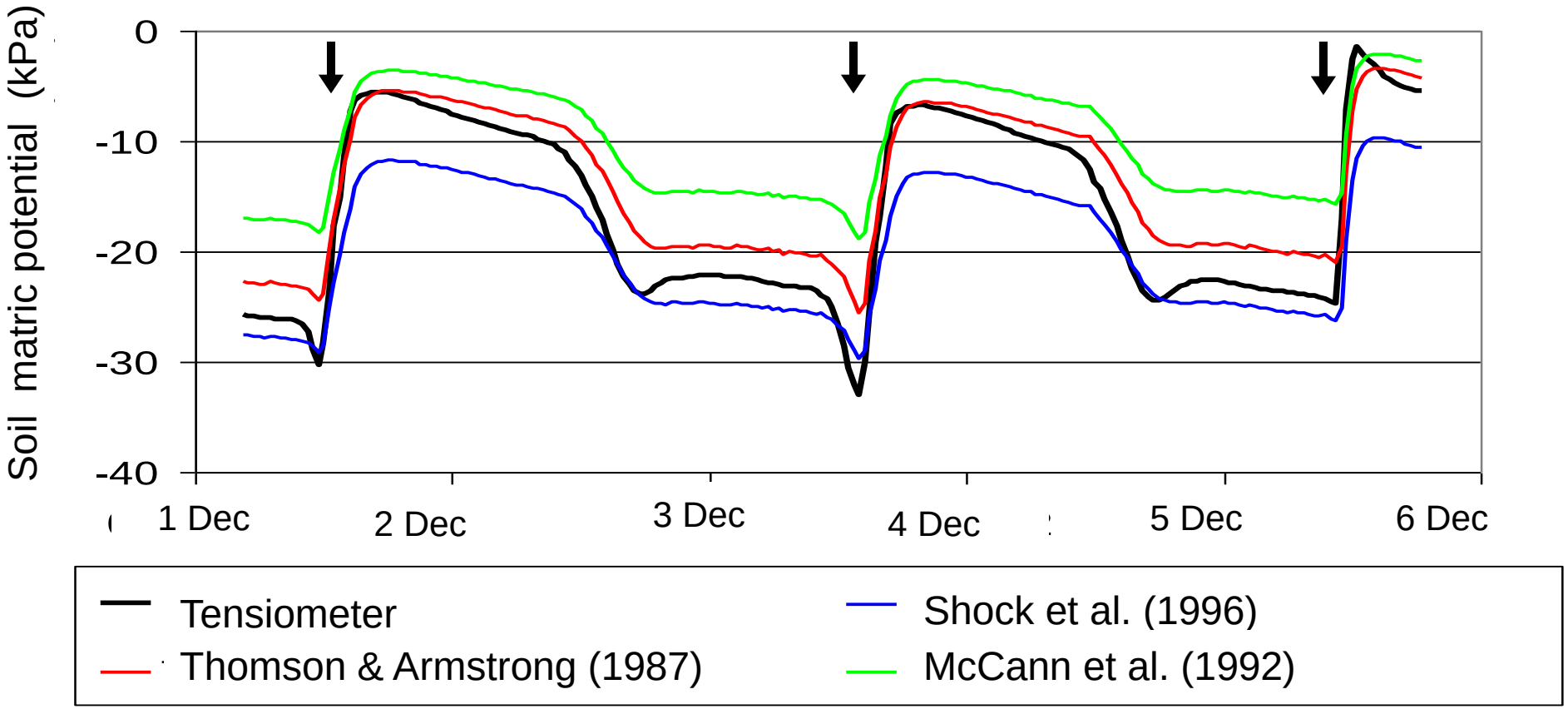


- SMP not affected by salinity
- VSWC data strongly affected
- 4% increase in VSWC value for each additional 1.0 dS m^{-1} of EC_{SW}
- “Normalising” the sensors in higher EC water did not reduce the “salinity effect”

Source: Thompson, R.B., Gallardo, M., Fernández, M.D., Valdez, L.C., Martínez-Gaitán, C. 2007. Effect of salinity on soil moisture measurements made with a capacitance sensor under vegetable production conditions. Soil Science Society of America Journal, 71: 1647–1657

Watermark - Calibration

Evaluation of published calibration equations

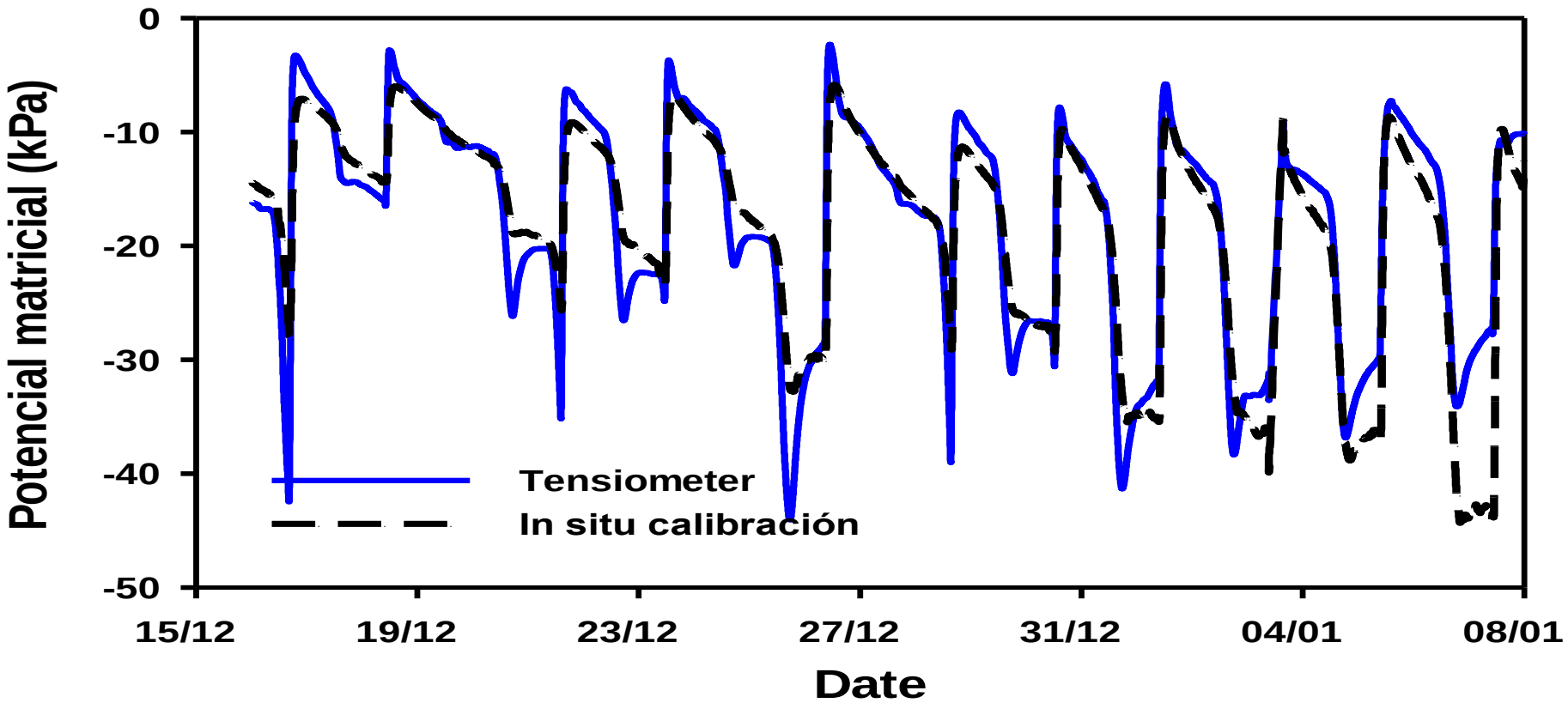


Calibration used has an appreciable effect on the values that are actually measured

Source: Thompson, R.B., Gallardo, M., Agüera, T., Valdez, L.C., Fernández, M.D. 2006. Evaluation of the Watermark sensor for use with drip irrigated vegetable crops. Irrigation Science, 24: 185–202

Watermark – Calibration

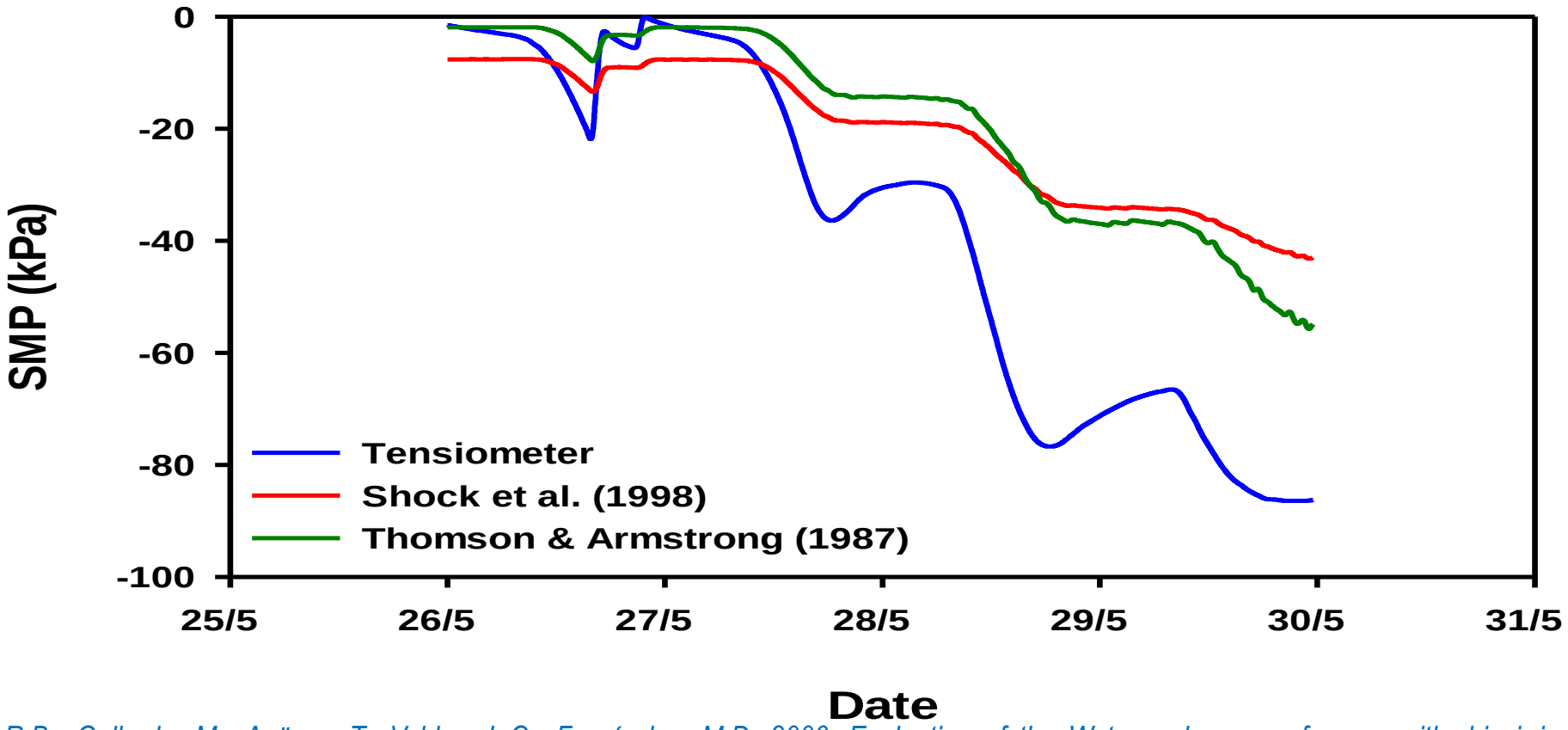
Performance of an *in-situ* calibration in favourable conditions



Source: Thompson, R.B., Gallardo, M., Agüera, T., Valdez, L.C., Fernández, M.D. 2006. Evaluation of the Watermark sensor for use with drip irrigated vegetable crops. Irrigation Science, 24: 185–202

Watermark – Performance

- *Responds slowly to rapid drying of soil-*
- *Can cause significant errors in drier soils*



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THANK YOU FOR YOUR ATTENTION