UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources
Helaine Berris, UCCE, Feb 2025

Soil Moisture Monitoring with Tensiometers

What is a tensiometer?

A tensiometer is a sensor that measures soil water tension (SWT) as a proxy for soil moisture. SWT indicates how tightly water is held in the soil and reflects the amount of force a plant must exert to extract it. As the soil dries, moisture decreases, SWT increases, and plants must use more force to obtain water. Tensiometers are a useful and easily accessible tool for agricultural water management.

The main components of a tensiometer include an airtight, water-filled tube, a porous ceramic cup, and a vacuum gauge. Water moves freely between the tube and the surrounding soil through the porous cup as soil moisture changes. As water enters or leaves the tube, the internal vacuum changes, which is measured by the gauge. For example, when soil dries, water moves from the tensiometer into the soil, increasing the vacuum and resulting in a higher SWT reading.

Most tensiometer gauges range from 0 to 100 kPa (or centibars), where 0 indicates wet, saturated soil and 100 indicates dry soil.

Why is measuring SWT useful?

- Irrigation efficiency – Irrigate at optimal times to prevent overwatering.
- Energy and water use – Cut pumping costs by timing irrigation wisely.
- Runoff and percolation – Align irrigation with soil moisture needs.
- Plant stress monitoring – Track plant stress to ensure water uptake.

Advantages of tensiometers

- Easy to use / install
- Cost efficient
- No calibration
- Practical irrigation scheduling

Disadvantages of tensiometers

- Poor performance in very dry soils or soils with extreme wetting and drying fluctuations
- Slower response time
- Semi frequent maintenance

For questions & more information, reach out to -
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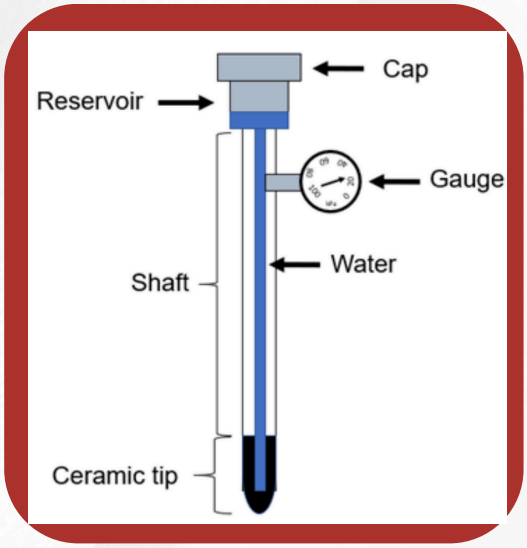

Fig 1: Tensiometer design (RCDMC).

How to read a tensiometer

- SWT represents the force required for plants to suck water from soil.
- Dry soil means the plant has to exert more force to suck up water.
- Wet soil means the plant has to exert less force to suck up water.

↑ SWT = drier soil = more force required by plant

↓ SWT = wetter soil = less force required by plant

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How to use a tensiometer

Prepare the tensiometer:

1. Fill tensiometer with degassed (boiled and cooled) water.
2. Place rubber stopper on end of tensiometer and ensure there are no air leaks.
3. Soak the tensiometer overnight. Porous cup must be saturated for water to move between tensiometer and soil.

Install the tensiometer:

1. Make a hole the same diameter as the tensiometer tube and as deep as the crop's effective rooting depth.
2. Insert the tensiometer into the hole. Fill the hole with a soil-water slurry to ensure good contact.
3. For more accurate monitoring, install multiple tensiometers at different depths, soil textures, crop types, and irrigation systems on your property.

Maintenance of tensiometer:

1. Refill tensiometer with water periodically
2. If tensiometer reads 0 when the soil is dry...
   a. Evaluate water level in tensiometer. Refill if necessary.
   b. Check for air leaks and cracks in the tensiometer.
   c. Replace parts if needed.

Interpret tensiometer readings:

1. Note the SWT reading on the tensiometer at the earliest indication of plant water stress and plan next irrigation before tensiometer reaches that point.
2. Keep record! As tensiometers are monitored over time, SWT trends can be associated with crop observations to aide irrigation management.

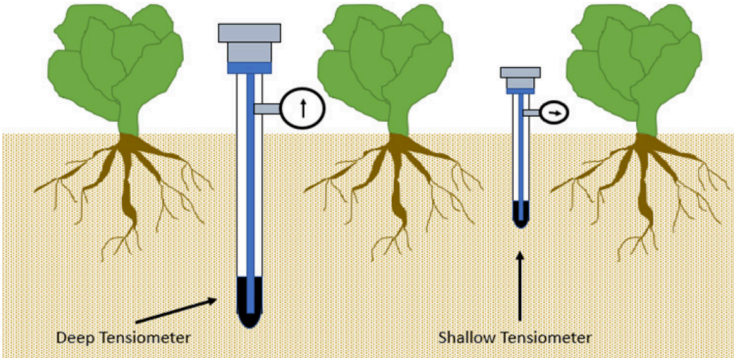

Fig 2: Tensiometer installation (RCDMC).

Tensiometers for irrigation scheduling

Tensiometers tell you when to irrigate, **not** how much to irrigate. While SWT indicates water availability, it does not directly measure volumetric soil moisture. Irrigation thresholds can guide the use of tensiometer readings for irrigation scheduling.

- Soil texture thresholds - Sandy soils have lower thresholds than clay because they hold less water and exert less force to retain it.
- Crop specific thresholds - Most accurate. Different crops have varying tolerance to water stress (eg. lettuce vs grapes).
- Create your own threshold - Keep records and notes to correlate tensiometer readings to observed plant stress.

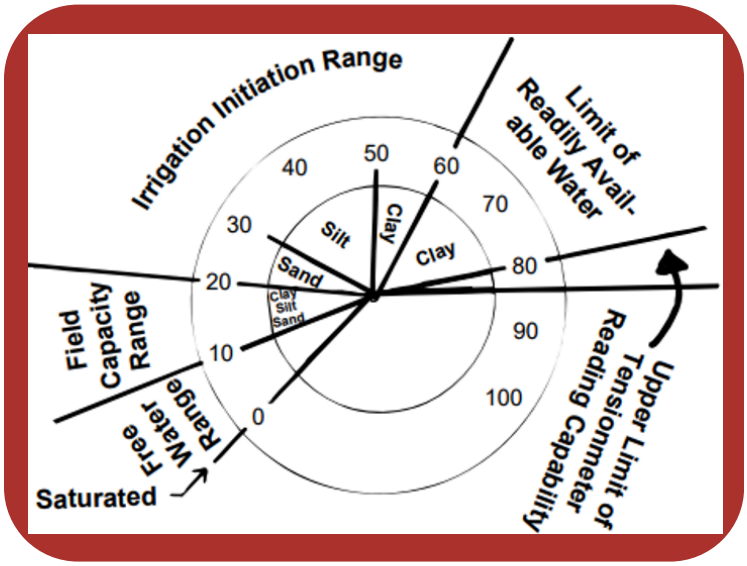

Fig 3: Interpretation of tensiometer readings. Soil texture irrigation thresholds (Alam & Rogers).

Tensiometer Resources

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