



## Tensiometers – preparation and installation

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### Summary

A tensiometer is a valuable tool for irrigation management on your property. It can help you to apply the correct amount of water at the appropriate time. This can increase yield and quality, and in many cases the amount of irrigation applied can be reduced.

Tensiometers provide a measure of the availability of water to the crop. They behave like an artificial plant root and consist of a tube with a porous ceramic cup at one end, and a gauge at the other. The tube between the gauge and the cup is filled with water and sealed with a cap — see Figure 1: *Tensiometer, with magnified cross-section of porous cup.*

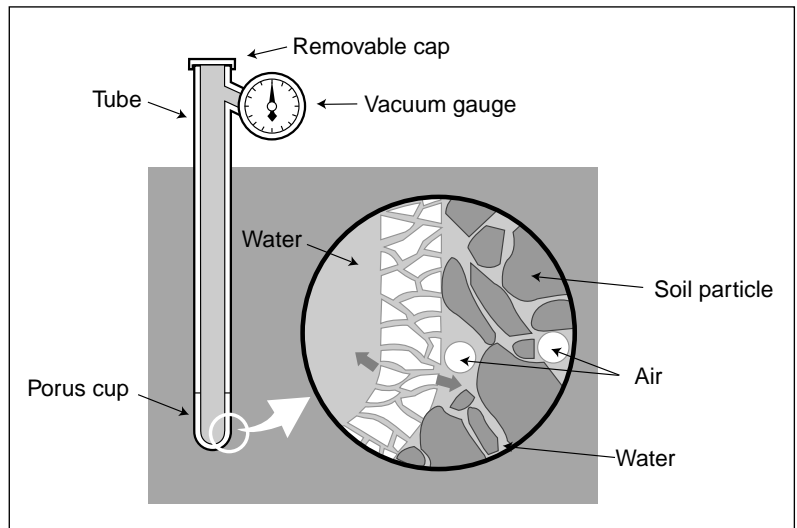


Figure 1. Tensiometer, with magnified cross-section of porous cup.

Tensiometers are used in groups, with two or three instruments installed at different depths making up a 'station' or 'nest'. At each station or nest the tensiometers are installed at the top, middle and bottom of the root zone. For vines and tree crops this is commonly at 30, 60 and 90 cm respectively. For vegetable crops tensiometers are commonly installed at 15 cm, 30 and/or 45 cm.

The two most common tensiometers used in Western Australia are the Irrrometer® and Jet-Fill® brands. Most tensiometers read from 0 to 100 centibars, with 0 centibars being saturated and 100 centibars being dry (one centibar equals one kilopascal). However, tensiometers only read accurately up to about 80 centibars, as once the soil moisture suction increases above about 80 centibars air enters the tensiometer tube via the ceramic cup and the tensiometer's gauge reads incorrectly. Tensiometers are not suitable for crops when deficit irrigation is practiced, as the soil moisture tension will increase to that above the range of the gauge. The Irrrometer® Company has a low-tension tensiometer that is more suitable for sandy soils. In this tensiometer the gauge measures accurately in the range from 0 to 40 centibars.

It is important not to rely solely on the tensiometer readings to schedule irrigation. Soil variation, poor irrigation system uniformity and the location of plant roots greatly influence the distribution of soil moisture. Use your own experience and visual symptoms of moisture stress as well as tensiometer readings to determine

when and how much to water. Initially you will need to spend extra time checking the tensiometers and recording measurements. With a season or two of familiarity you will not need to check the tensiometers as frequently. It is better to have two or more nests of tensiometers in each irrigation block to give a better indication of the range of soil moisture over the block.

### How it works

Water moves freely in and out of the porous cup. As the soil dries, the water moves from the cup into the soil, creating a vacuum in the tube. This is registered on the gauge. The drier the soil becomes, the higher the reading on the gauge, indicating that it is more difficult for the plant to extract water from the soil. After irrigation, water moves back into the cup, and the gauge reading falls.

### Preparing for installation

To prepare tensiometers for installation:

- Remove the cap and put the tensiometers in a bucket of clean water overnight. This will wet up the ceramic cup.
- Fill the tensiometer reservoir with water. Before filling the tensiometers add dye to the water to make seeing the water level in the tensiometer easier. Air must be removed from the tensiometer tube to allow water to

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enter from the reservoir. Use the suction pump supplied or jiggle a straw or piece of wire up and down in the tensiometer to make water enter the tube. Alternatively, tilt the tensiometer on its side and pour the water in slowly so air can escape as the water enters the tensiometer tube. After water has filled the tube add more water to top up the reservoir.

- If you have a suction pump that is supplied with the service kit, pump the tensiometer up to approximately 70 centibars and tap it to release any air bubbles trapped in the instrument. Slowly release the vacuum in the pump by opening the release valve on the side of the rubber suction cup. If the suction pump is not used check the top of the tensiometer for any air that has collected and remove it.

- Replace the cap by tightening it until the rubber is seated. Then turn the cap a further quarter turn only.
- Tensiometers need to be calibrated before installation in the field. The length of the water column in the tensiometer tube results in the gauge registering even when the ceramic tip is in water. The gauge will read approximately 1 centibar for each 10 cm of tube length. Place the tip of the tensiometer in a cup of water and read the gauge. If the gauge reads 5 centibars then this should be marked on the cap, and subtracted from all future readings. That is, if the gauge shows 45 centibars while in use, the actual reading is 45 *minus* 5, equalling 40 centibars.

**Table 1.** Approximate amounts to subtract from the gauge to calibrate different length tensiometers

| Length of tensiometer shaft | Amount to subtract off gauge to get the correct reading |
|-----------------------------|---|
| 15 cm                       | 1.5 centibars   |
| 30 cm                       | 3 centibars   |
| 45 cm                       | 4.5 centibars   |
| 60 cm                       | 6 centibars   |
| 90 cm                       | 9 centibars   |

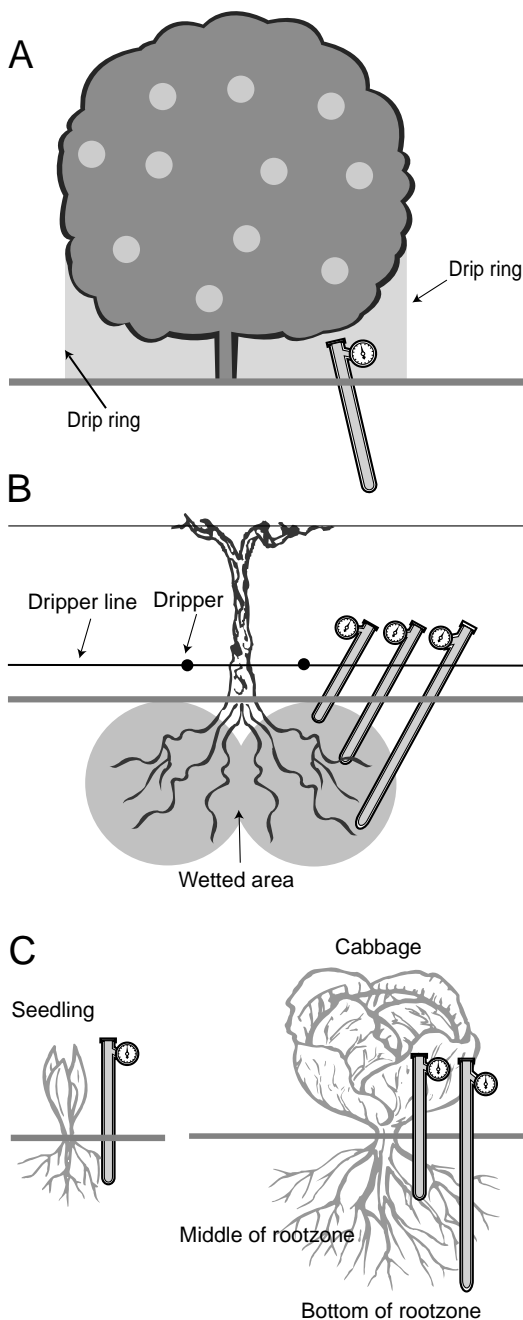
Jet-Fill tensiometers® come equipped with a zeroing adjustment. While the ceramic tip is in a cup of water the adjustment screw can be turned so that the gauge reads zero. This removes the need for continual correction of the gauge reading.

Take the tensiometers to the installation site with their porous tips in a bucket of water or bucket of saturated sand.

## Where to install

If a tensiometer is to give useful information about the availability of water in the soil, it must be put in a representative position and installed properly. Use the following guide to select the right site. Install the tensiometer in an area of soil that is most representative of the irrigation block. Select an area where the plants have average vigour. A second station should be placed elsewhere in the planting as a check.

- Choose a place to install the station — see Figures 2a, b and c. For sprinkler irrigated tree crops, the tensiometer stations should be placed two-thirds of the distance from the sprinkler to the edge of the wetted area — see Figure 2a. *Where to position tensiometers. Tree crops, sprinkler irrigated.* For dripper-irrigated trees and vines, the tensiometer station should be within the wetted zone. — see Figure 2b. *Where to position tensiometers. Vines, dripper irrigated.* For shallow-rooted vegetable crops the tensiometer station should be placed in the active root zone of the plant — see Figure 2c. *Where to position tensiometers. Shallow-rooted vegetables.* When the crop is young, one shallow tensiometer is adequate; as the plant grows, place a deeper tensiometer at the bottom of the root zone.



**Figure 2.** Where to position tensiometers.  
 A) Tree crops, sprinkler irrigated.  
 B) Vines, dripper irrigated.  
 C) Shallow rooted vegetables.

- Ensure that the positions selected receive an average water application. You must check the operating pressures, water output and water distribution of the sprinklers or drippers to choose the best possible sites. For details on how to do this, see Farmnote No. 35/90 *Evaluating sprinkler and trickle irrigation systems* (Agdex 560).
- Do not place tensiometers in localised hollows or excess water may build up around them.

## Equipment needed for installation

To install tensiometers correctly you will require:

- Sets of tensiometers to give measurements at the top, middle, and bottom of the root zone.
- For sands and loamy soils, a one metre length of 13 mm galvanised or copper water pipe and a hammer or mallet.
- For heavy soils or compacted soils a 13 mm hand auger, made by welding a 13 mm coring bit on to a piece of steel rod may be more useful.
- For very gravelly soils, a 25 mm or 50 mm hand auger may be needed to make the hole for the tensiometer.
- A hand suction pump is useful but not necessary.
- A white painted post to mark the position of the station, so that tractor operators and pickers can see it.

## Installation

Installation should be done after irrigation or rainfall when the soil is moist. On sandy and loamy soils the pipe can be hammered into the ground to make the installation hole. On heavier soils use the 13mm auger. The installation hole should be at a slight angle. To ensure good contact between the ceramic tip and the surrounding soil you can place a small amount of water into the bottom of the hole and allow it to soak in. If water is added to the hole the tensiometers will read wetter than the surrounding soil for a few days.

Insert the tensiometer into the hole with the lid off (to prevent pressure damage to the gauge). Do not wobble or rotate the tensiometer shaft and do not push on the gauge. When the cup of the tensiometer is properly positioned there must be at least 3 cm between the bottom of the gauge and the soil surface. If there is less than 3 cm or if the tensiometer can be easily rotated, the installation should be started again in a fresh hole.

In gravelly soils it may not be possible to make a hole with the pipe or 13 mm auger and a larger hole will need to be dug with a 25 mm or 50 mm auger. Soil from this larger hole should be laid on the plastic sheet in the order in which it is removed. Remove all gravel stones from the soil that will be placed near the ceramic tip. If the stones are not removed, they will jam against the side of the tensiometer, causing air pockets to form. These air pockets can help air to enter the porous cup, or hold more water than the surrounding soil, leading to false readings. If possible, use the pipe or 13 mm auger to excavate the last 7 cm of the hole as this will ensure better soil contact with the tensiometer's ceramic tip (see Figure 3).

Start replacing the soil around the tensiometer using material from the bottom of the hole first. Every few handfuls, tap down the soil with the flat top of the coring tool or some other suitable tool. Continue repacking to the surface, finishing with the topsoil to ensure that the original order of the soil layers is maintained. Ensure a depression is not left on the surface around the base of the tensiometer as water will collect here and influence the tensiometer reading.

When the tensiometer is correctly installed remove any air from the tensiometer. Screw the cap down until the rubber stopper just touches the base of the reservoir, then apply another quarter of a turn. Take care not to turn the tensiometer while tightening the cap. Install the white marker post near the tensiometers so that the site is clearly visible.

## Maintenance

Under normal use, air bubbles form in the water column just below the stopper. To remove the bubbles and prevent the gauge giving an incorrect reading service the tensiometers by:

- Removing the cap and stopper by holding the reservoir and gauge in one hand and unscrewing the cap with the other. This procedure stops the tensiometer from rotating in the soil.
- Jet-Fill® tensiometers can be topped up by pushing the plunger on the top of the reservoir.
- Top up the water reservoir with clean water.

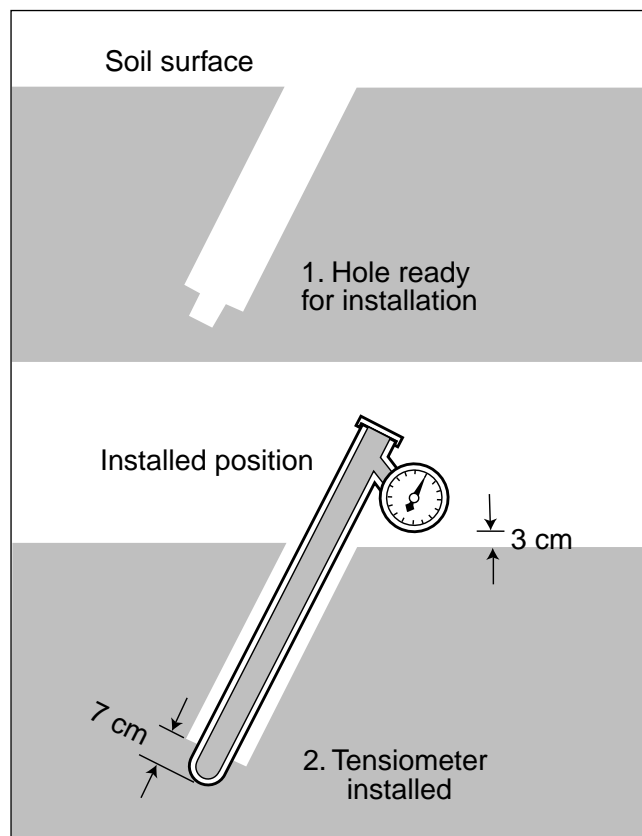


Figure 3. Installation in gravelly soil.

- Before replacing the cap check that its rubber stopper has not become flattened or perished. If it has, replace it.

If the soil dries out beyond about 80 centibars then air will enter via the ceramic tip and the water column in the tensiometer will break. The gauge will not give a true reading and can read either high or low. Subsequent irrigations will not register on the gauge until the air is removed from the tensiometer. The only reliable method for judging whether when a tensiometer has broken tension is to observe the water column near the vacuum gauge and check for a break in the water column. If this has occurred the tensiometer will need servicing as described above. For most crops severe moisture stress will have occurred if the soil is allowed to dry out to 80 centibars.

If the tensiometer reading remains unchanged after irrigation it may be installed in a 'dry' spot, or further irrigation may be needed to wet the soil to the desired depth. Check that the irrigation system is working efficiently.

If the tensiometer does not respond and remains on 0 centibars there may be an air leak. Check the rubber O rings located near the gauge and the ceramic tip.

Place Teflon thread tape on the thread that connects the gauge to the tensiometer body. Do not over tighten the gauge as this can cause the tensiometer body to crack.

The pores in the ceramic tip can become blocked with algae, or by greasy hands or other contaminants, making the tensiometer slow to respond to changes in soil moisture. If this occurs place the ceramic tips in a chloride solution overnight (35 g of 65 per cent calcium hypochlorite in 10 L of water)

Tensiometers should be removed during the winter months, and emptied and cleaned before storage

## Interpreting tensiometer readings

Information on interpreting tensiometer readings for scheduling irrigation can be found in Farmnote No. 24/90 *Interpreting tensiometer readings*.

## Acknowledgment

This Farmnote has been adapted from Primary Industries and Resources, South Australia Fact Sheet 42/86/97/02 *Tensiometers — preparation and installation*.