Tensiometers

A tensiometer is a device for measuring soil water tension. It consists of a cylindrical pipe about one inch in diameter with a porous ceramic cup attached to one end and vacuum gauge attached to the other (see Figure 1, below).

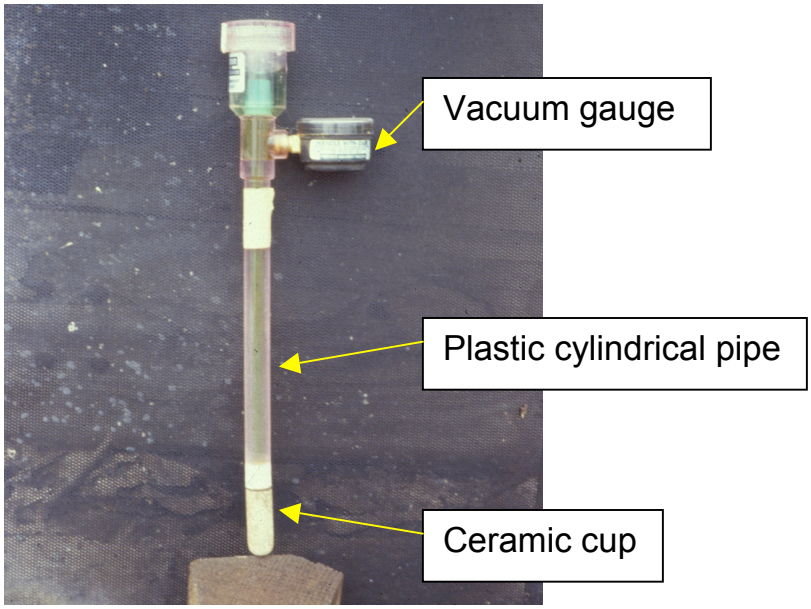

Figure 1. Tensiometer.

Tensiometers indirectly measure soil moisture tension. Since tensiometers are installed for the entire season or longer, they provide readings at the same location over an extended period of time. Tensiometer readings are easily interpreted and indicate the soil water conditions experienced by the trees' roots. Soil salinity does not affect the readings.

Although tensiometers are used most frequently for monitoring soil moisture, they can also be incorporated into automated irrigation systems. Tensiometers with solenoids can be used to control an irrigation system and tensiometers equipped with transducers can be used with computerized irrigation systems.

Installation

To measure soil water tension, the end of the tensiometer having the porous cup is inserted at the depth desired through a pilot hole, made with a soil probe, in the soil. The porous cup should be soaked in water for several hours before installation. After installation, the tensiometer is filled with water and allowed to equilibrate with the soil water for about twenty-four hours. A tensiometer should be installed in the zone of greatest root density, at about one-quarter to one-third of the maximum root depth. A tensiometer at this depth can be used to schedule irrigations. A tensiometer reading of

approximately 60 centibars indicates a need for irrigation in the near future. Refinements based on soil sampling will be required to adjust for site-specific conditions.

It is recommended that a second tensiometer also be installed in the bottom one-third of the root depth, to assure that the moisture extends to an adequate depth. Frequently, the shallower tensiometer will begin to show an increased reading (indicating drier soil) prior to the deeper tensiometer beginning to change. Trees tend to take up water from the shallower depths first. Some water managers utilizing tensiometers use the beginning of moisture extraction from the deeper depths, indicated by a change in the lower tensiometer's readings, as an indicator of when to irrigate. This practice seems to work well as long as irrigation water can penetrate to the lower depths to replace the soil moisture used. If the tensiometer reading at the lower root depth remains unchanged following an irrigation or continues to rise during the growing season, irrigation applications may be insufficient.

The number of tensiometer stations required depends on the irrigation system and on soil uniformity and management. For areas up to forty acres, at least two stations should be established. Stations should be located in areas representative of overall moisture status, with separate stations for problem areas or for areas having different soil conditions.

What do the readings mean?

In an unsaturated soil, soil water tension—frequently called the "suction" — falls below atmospheric pressure. As wet soil dries, the soil-water suction increases, causing water to flow out of the tensiometer through the porous cup. The small pores of the saturated cup prevent air from entering the tensiometer. This outflow of water creates a vacuum inside the tensiometer and increases the reading on the vacuum gauge. If the soil is re-wetted by irrigation, water will be drawn back into the tensiometer, reducing the vacuum inside, and the reading on the tensiometer gauge will decrease. The vacuum gauge measures the suction in centibars (100 centibars = 1 Bar = 1 Atm), with a range of 0 to 100. A reading of zero indicates a saturated soil in which plant roots will probably suffer from poor aeration. A reading of 10 to 25 centibars reflects a soil at field capacity. The lower reading is for sandy soils at field capacity, and the higher reading is for finer-textured soils. Readings of 70 to 80 indicate a dry soil. Tensiometers will not read above 85 centibars.

Tensiometers do not provide information on the amount of water depleted from the soil unless they have been calibrated for the particular soil type. They therefore indicate *when* to irrigate, but not *how much* to irrigate.

Maintenance

Tensiometers must be properly maintained. This requires periodically filling the pipe with water and replacing porous cups. If the soil becomes too dry (tensiometer readings greater than 85 centibars), the porous cup will break tension and air will enter the tensiometer. A cracked cup will also prevent a vacuum from developing in the tensiometer and cause the instrument to always read zero. In locations where temperatures fall below freezing, the tensiometers should be protected or removed from

the field. Finally, the porous cup of a tensiometer filled with water should not be exposed to the atmosphere for long periods of time. Such exposure causes evaporation of water from the cup's surface, which in turn causes salt buildup and clogging of the cup.

References

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