Tensiometers: Useful Tools in Scheduling Irrigation

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Water suitable for irrigation purposes is a limited resource that is becoming more costly as time progresses. Sound irrigation practices that reduce the quantity of water used should be implemented. The use of tensiometers by the turfgrass manager can help in scheduling when irrigations should occur, and how much water should be applied. The results are a reduction in the quantity of water used (resulting in a dollar savings), while providing a more suitable soil moisture environment for turfgrass growth.

Unlike normal visual methods of evaluating soil moisture conditions such as by color and feel of the soil, the tensiometer can tell us the energy status of water present in the soil. This energy status is termed the soil water potential, soil moisture tension, or soil suction. Knowing the energy status of the soil water is very important because the amount of water available for plant growth is directly related to the energy status of the water present in the soil. It is for this reason that tensiometers are useful in scheduling irrigations.

The dial or gauge-type tensiometer consists of a water filled tube, sealed to a porous ceramic cup on one end, and a vacuum gauge on the other. A removable air tight cap is located near the end of the tube bearing the gauge. Photo 1 shows a typical guage-type tensiometer having a gauge incremented into units of centibars (hundredths of a bar). One bar of 100 centibars of soil suction is equal to a negative pressure of 14.69 psi. The water in the soil is under negative pressure (suction) due to the adhesion of water to the soil particles.

When the tensiometer's cup is placed in direct contact with the soil, water moves into or out of the tensiometer through the cup, coming into equilibrium with the water in the soil. The soil suction can then be read on the gauge. Saturated soil will have a reading of 0 centibars, while a drier soil wil have some value greater than 0. As the soil continues to dry out (less water available for plants), the value in centibars of soil suction increases. When irrigation or rain moistens the soil, the value on the gauge will decrease, returning to zero if the soil is saturated.

A subsurface monitoring station like that shown in photo 2 can be constructed in 40 to 60 minutes time. The site of the station should be one of level to gently sloping terrain, as the reading taken from tensiometers in these areas are the most indicative of the true soil moisture conditions. A 12 inch tensiometer will be the adequate length in most sites. When properly placed, the tensiometer cup will be located slightly below the cutoff point in rooting density (see photo 1). An insertion tool or pipe is used to make the horizontal opening in which the tensiometer is inserted. The entire monitoring station is made narrow enough that the lid of the station can support the weight of mower traffic. After initially being installed, a 24-48 hour period is required before accurate readings can be taken. The tensiometers can remain in their monitoring station until freezing weather arrives.

Soil suction values can be obtained from tensiometers as often as is desired. It is suggested that readings be taken at least once every 24 hours. Before taking a reading, the gauge should always be tapped slightly, to ensure that the needle assumes the true soil suction value.

Maintenance of tensiometers should be performed on a once-a-week basis. This involves loosening of the cap to remove air bubbles, and refilling of the tensiometer. The device stays in place, and the entire procedure takes 3-5 minutes per tensiometer. Tensiometers should be removed from their stations and drained of all water before freezing temperatures occur.

Tensiometers are being used to monitor the soil water potential in an annual bluegrass heat tolerance monitoring study at the University of Illinois at Urbana-Champaign. The study is being maintained under fairway-type conditions. Four subsurface tensiometer stations are monitoring an area 20x20 feet. After being installed, the study was allowed to dry down until visual signs of water stress occurred. "Footprinting" (where blades of grass fail to return to their normal habit after light foot traffic) was used as the visual sign of waterstress. The readings in centibars at the 4 inch depth was recorded from each station, and the mean value was determined to be 18 centibars. The value of 16 centibars was then chosen as the value at which to irrigate so that waterstress would be avoided. After several irrigations, the minimum quantity (20mm or 8/10 inch) of irrigation water necessary to bring the soil to saturation at the 4 in depth was determined. These practices were in keeping with the "deep and infrequent" rule of thumb, designed to discourage shallow rooting of the turf. Readings from the four stations were recorded on a daily basis, and plotted with the readings in centibars being the vertical axis, while days elapsed was recorded on the horizontal axis. The graph showed that in general, irrigation from the beginning of June through the second week of July was necessary once every 5 days. Slight variations in frequency of irrigation occurred due to natural rainfall, and changes in temperature and relative humidity.

In mid-July the "Footprinting point" was found to occur at a mean reading of 14 centibars at the 4 inch level. Examination of the root zone showed both a decline in density and depth of rooting of the annual bluegrass. The irrigation schedule was adjusted accordingly, with 12 centibars being the new mean value at which irrigation water was applied. When "centibars of soil suction vs. days elapsed" was graphed, irrigation appeared to be necessary on approximately a 3 and one half day basis. As expected, some variation occurred from week to week due to rainfall and varying atmospheric conditions. As we move out of the mid-summer stress period, a deeper and denser root system will be expected, leading to a decrease in the necessary frequency of irrigation.

Information from the previous study was given to illustrate how tensiometers are being used in one specific situation. In most instances a single monitoring station would have easily handled the small area involved in the study. Species other than annual bluegrass will no doubt exhibit different seasonal tendencies. Soil type as well as many other conditions will affect the necessary frequency and duration of irrigation from location to location.

Although the turfgrass manager will "fine tune" the irrigation program to his individual site, the basics in establishing an irrigation program based on tensiometers involves:

1) Establishing the soil suction value at which waterstress occurs.
2) Choosing a soil suction value lower than the value at which stress occurs, and irrigation at this value.

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3) Establishing the minimum duration of irrigation or quantity of water necessary to replenish water in the root zone.
4) Being aware of seasonal and daily changes that may affect when and how much water should be applied, and making the proper adjustments.

The approximate cost of a 12 inch tensiometer is $60, with a $3 increase for each additional 6 inches in length. The estimated useful life of a tensiometer is 4 years or more. When purchasing tensiometers it is recommended that a service kit be purchased also. Surplus pipe can often be substituted for the commercially available insertion tool.

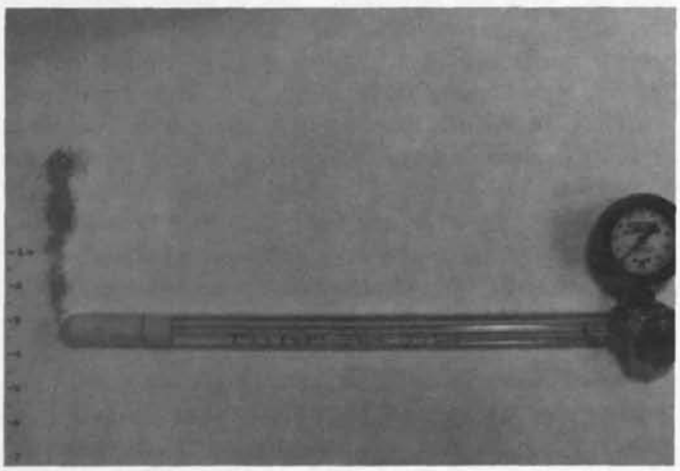
A short list of tensiometer vendors follows. No endorsement or discrimination is intended.

Brinkmann Instruments, Cantiague Rd., Westbury, NY 11590, (516-334-7500)

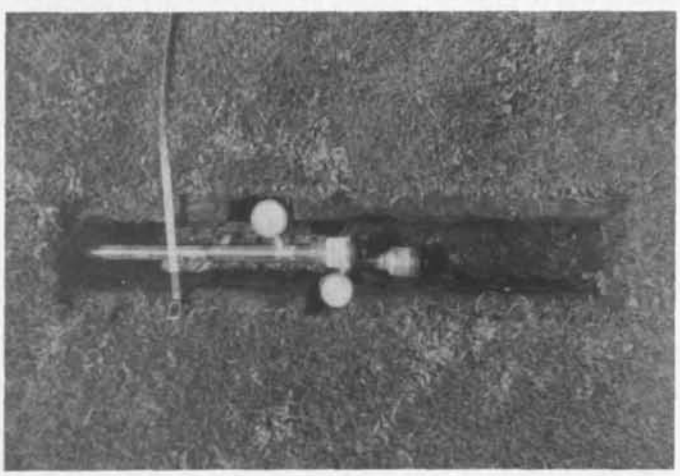
Fisher Scientific, 711 Forbes Ave., Pittsburgh, PA 15219, (412-562-8300)

Tensitron, 126-128 Harvard Depot Rd., Harvard, MA 01451, (617-456-3511)

Soiltest, Inc., 2205 Lee St., Evanston, IL 60202 (312-869-5500)



A typical gauge-type tensiometer, and its depth of placement in relation to the creeping bentgrass root system at left.



A subsurface monitoring station with tensiometers at the 2 and 4 inch depths. Lid to the station is not shown.