Dr. Bruce Augustine expains tensiometers, resistance- and electronic-type water monitoring systems.

Using soil water monitoring sensors to control irrigation

By Ron Morris

This micro-switching tensiometer is made by Irrometer Company of Riverside, California. All photos courtesy of Dr. Augustine.

The most basic description of the water cycle of a turfgrass environment would list input, storage and output. Input is in the form of precipitation or irrigation. Output occurs as evaporation, transpiration, drainage and runoff. Judicious water management would dictate that, to make the most of input, output be limited to that which the turfgrass plant uses for survival.

Once water enters the soil profile, however, visual assurances of conservation are no longer possible. How do you know when you have wet just the rootzone with an amount of water that makes it available to the plant? Obviously more that that is wasteful. If you've got water and money to burn, you might care less, except for the fact that the wetter a soil is, the more prone it is to compaction. In fact, a graph would show that a soil is most prone to compaction when it is at field capacity, that point just before excess collects and begins to drain. There would be an abrupt rise in the curve between moist and field capacity.

What determines moist versus field capacity? The tension with which the water is held by the soil particles does. Storage of water available for plant uptake occurs between the wilting point, a tension where water is bound too tightly to soil particles for the plant to use, and field capacity. This is a most rudimentary explanation, however, if you understand soil moisture holding characteristics, according to Dr. Bruce Augustine, Extension Turf and Water Specialist with the University of Florida, then you will be able to water with some effectiveness.

Why moisture sensing equipment? "What the moisture controlling equipment attempts to do", explains Dr. Augustine, "is alleviate the golf superintendent from having to understand a lot of soil physics situations. The equipment will activate the irrigation system when the soil gets dry enough and will prevent it from coming on when the soil is adequately moist." The following is a description of moisture controlling equipment by Dr. Augustine and his comments about them to Golf Business.

"The standard in the industry is the tensiometer. Basically, it is a ceramic cup connected to a vacuum gauge. This gauge monitors the soil suction and gives a good reading of what the availability or lack of water may be. As the soil dries, it creates more soil suction. A micro-switch can be hooked to a solenoid and the system will go on and off at predetermined points on the gauge. The micro-switches are generally hooked to the 24-volt system of the irrigation system.

"The tensiometer, as a standard to the industry, has been the most successful in monitoring soil moisture levels. There are, however, three drawbacks to overcome. Tensiometers do not work well in coarse sand. The pore size of the ceramic cup must be closely mated to that of the soil. If there is a big difference, the tensiometer will not work as well.

"To illustrate, in Florida we have to run our tensiometer at a setting of about 10 centibars in our coarse sandy soils to prevent major wilting. In California, where tensiometers have been used extensively, they are typically set at 40 centibars and above.

"Another problem is servicing. Tensiometers need to be checked periodically to make sure that there are no air bubbles in the vacuum gauge or pump. This is not a major problem, however, unless you have many of them in a given area.

"When you get into a putting green situation, where the root system may be only two inches deep, you begin to run into problems because the tensiometer itself is almost an inch in diameter. If it is installed too close to the soil surface, there are problems with accuracy.

"The biggest use would be a fairway setting. The important thing to remember during installation, is to get them in the root zone. Irrometer Company, one manufacturer, recom-

mends that you install two, one near the top of the rootzone and one near the bottom. If you get a light rain shower, the top layer may be effectively wetted, but perhaps not deep enough into the rootzone to do any good. The bottom tensiometer will turn the irrigation system on. If you haven't had rain for a number of days, the profile will typically dry from the top down, and the top tensiometer will turn the system on. Installation of two provides a safeguard to make sure that everything is adequate."

Controlled irrigation turfgrass plots at the AREC Ft. Lauderdale experiment station, University of Florida. Half the plots are irrigated daily and the other half are irrigated only when moisture sensing probes indicate the soil is dry. In the controlled irrigation plots, tensiometers or impedance electronic type systems are used. The plots are being expanded to include the interaction of irrigation practices and nitrogen sources on turfgrass quality and growth.

A tensiometer is shown, installed in St. Augustinegrass turf. The tip is located four inches below the turf surface. The tensiometer is wired in series to the solenoid.

Resistance-type soil water monitoring systems

"Soil type definitely affects the resistance reading and you have to essentially calibrate the system for each different soil type that you're involved with. On a putting green, this would not be too much of a problem, but a fairway with several different soil types and several resistance-type devices, you have to be aware that they will trip at different points, different moisture levels.

"Applied salts from fertilizers, or other materials, will affect the ratings and influence when the system will turn on or off. There is also a replacement period of every three to five years, depending on soil conditions."

Electronic types

"There are several new, electronic-type soil water monitoring systems coming out on the market. Most are still in developmental stages, but I'm currently involved with one of them, the impedance system."

Impedance system

"The impedance system involves an electronic device which interfaces with an existing control clock. It has a pair of stainless steel probes that go into the ground. One probe is placed just underneath the thatch layer, surrounded by soil. The bottom probe is about three to four inches below the first. This type, very much like the resistance type,

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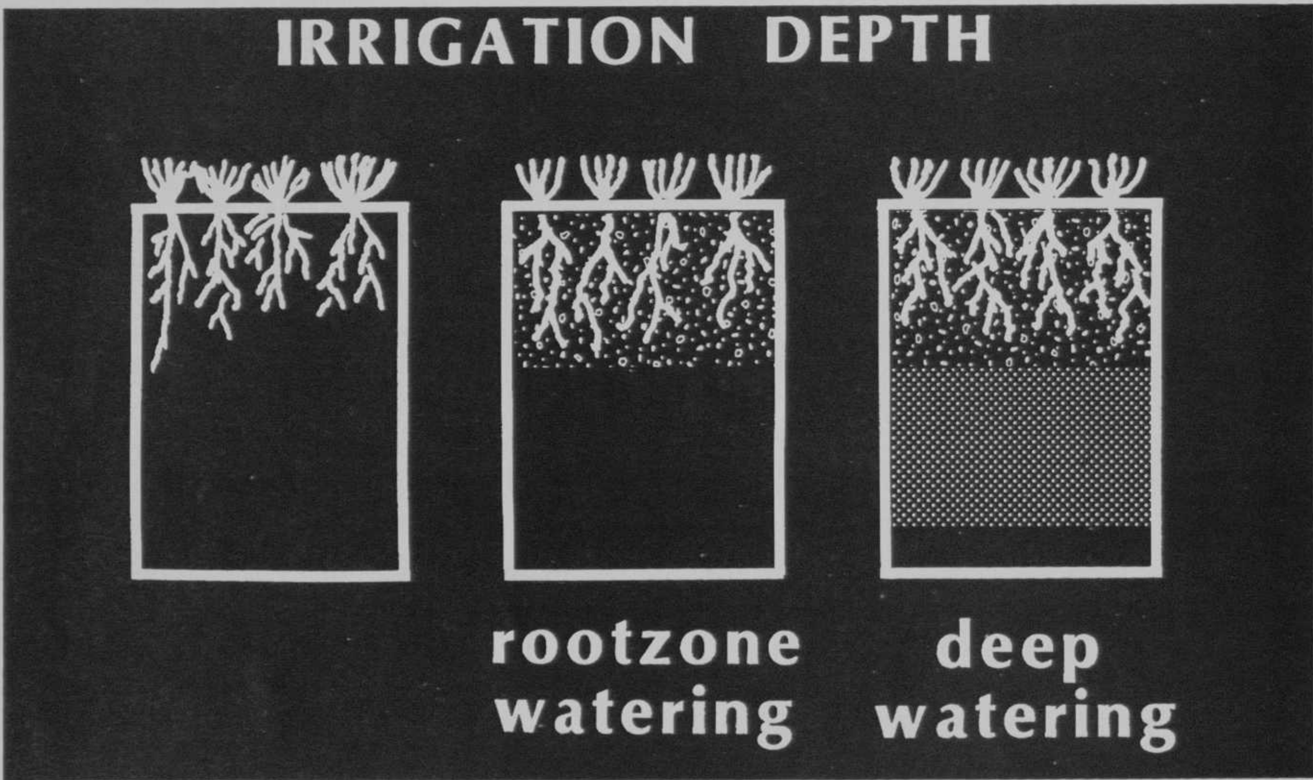

Proper irrigation depth for humid parts of the United States is shown. Saturate the rootzone only, when watering. Deep watering wastes water and causes excessive leaching of fertilizers and pesticides.

relies on electric current to go from one probe to another. The amount of water that is in the soil will influence how both of the systems react.

"This system is less susceptible to salt concentration, which is a big advantage, and soil type seems to be of less importance in the way it reacts. Very careful probe placement is essential, however. If they are too close together, they won't trip properly and if they are too far apart, the system will stay closed for longer periods of time."

RF (radio frequency) Signal System

"This system can be interfaced with an existing time clock or on its own. It has a control box and a probe that goes into the soil. The probe consists of a plate, copper clad on either side. It generates a radio frequency that comes out of one side of the plate, sort of like a magnetic field, that goes around to the bottom side, or vice versa, of the plate. The system can be calibrated to soil type and set to go on or off at a given wetness in the soil."

Background

Dr. Augustine works closely with George Snyder, Professor of Soil Science at the University of Florida, who has developed a computer simulation model of daily irrigation versus the soil budget irrigation (watering when needed, when the soil reaches a certain dryness). Data that Professor Snyder has run through the computer for typical Florida conditions show, conservatively, a 40 percent savings for the soil budget irrigation.

Preliminary data, a year ago last January (during fairly normal weather for Florida), showed an 89 percent savings for tensiometer controlled irrigation versus daily. "Of course," Dr. Augustine emphasizes, "This certainly will vary according to the season and amount of rainfall."

Conclusion

One of the things that Dr. Augustine deems exceedingly important is that if you do not have, or intend to use a moisture sensing system, you should take time to calibrate your sprinkler system and learn how much water is being applied any given time you irrigate. "You can save more water that way, without incurring any cost other than the labor to do it," he says. "Most people cannot tell you more than they turn the sprinklers on for 15 to 30 minutes per zone." **GB**

Dr. Bruce Augustine came to the University of Florida specifically to work on water-related problems. He received his Ph.D. in turfgrass physiology from the Ohio State University, his Masters of Science from the University of Idaho, and his B.S. from the University of Deleware.