Identify Soil Moisture Status More Accurately Than Ever Before!

Properly utilized, moisture meters and sensors can improve water conservation and provide healthier turf for better golf.

BY ADAM MOELLER

Moisture meters provide an objective value of soil moisture that can help conserve water and save money while improving playability and turf health.

What if I told you there are tools that could help you conserve water, save money, improve golf playability, and promote healthier turf? Accurate and cost-effective portable moisture meters and in-ground wireless moisture sensors are those very tools. Superintendent testimonials include "eliminates the guesswork involved in a crucial management practice," "helps us dial in our management better than ever before," and "every superintendent should have this tool." Sounds too good to be true, right? It's not!

Determining the amount of moisture in the soil is not easy, even with years of experience managing golf turf. If it is unknown exactly how much moisture is in the soil, it is not likely that water is always going to be applied accurately. Oftentimes referred to as an "art," traditional practices for evaluating soil moisture rely on visual cues from the turf and feeling the soil. For some, these techniques have worked in the past, but they remain very subjective and thus have inherent flaws. For instance, the soil looks and feels dry, but how dry is it? Can the turf survive

the day given the current amount of soil moisture, or should water be applied? The soil could appear to have enough moisture to one person but seem too dry to another. Uncertainty can dramatically impact irrigation programming implemented on the golf course, and the subjectivity of these decisions has long been a part of golf turf management.

Fortunately, the introduction of portable moisture meters and in-ground wireless moisture sensors to the golf course market has greatly improved the accuracy with which soil moisture is evaluated, thus reducing the subjectivity of traditional techniques. Let's be clear. Moisture meters are not a replacement for traditional soil moisture evaluation techniques, diligent scouting for wilt, or other subjective means of assessing soil moisture status and making irrigation decisions. Instead, moisture meters and sensors give superintendents the ability to objectively assess soil moisture quickly and accurately, improving irrigation decision making, leading to water conservation and better turf for golf. Additionally, being able to quantify soil moisture content allows for better communication to golfers and staff about how and why water is applied. While it is still an art, much of the guesswork can be eliminated with the use of these tools.

There is a wide range of hand-held moisture meters available that are all very accurate and cost effective.

Water is the most important natural resource used on golf courses around the world and, as such, conservation efforts should be a focus for every golf facility. It is our obligation as stewards of the environment to find ways to conserve water when and where possible. Moisture meters and sensors present an excellent opportunity to do so. A slight reduction in daily water use is likely if you have a more accurate understanding of the moisture in the soil when using moisture meters or sensors. For example, with better knowledge of the moisture in the soil, perhaps a fairway irrigation cycle could be reduced by a minute or two, which for an average 18-hole facility in the Northeast could translate into saving millions of gallons of water over the entire season (GCSAA Environmental Survey Data, 2008). Water savings will be even greater in areas of the country that use more water and have a longer growing season. Reduced water use

Moisture meters are not a replacement for diligent scouting for surface wilt and physically examining the soil for moisture. These traditional techniques are subjective, which is an inherent flaw that can be minimized with moisture meters.

Although moisture meters have been used primarily on putting greens, their use is expanding to approaches, fairways, and tees to aid in moisture evaluation and irrigation decision making.

also translates into significant cost savings. Irrigation pumping expenses and costs for purchasing water add up quickly over an entire year. Consider the same situation: a fairway irrigation cycle reduced by one or two minutes could save thousands of dollars over the season if irrigation water is purchased from a municipality and significantly more in arid parts of the country (GCSAA Environmental Survey Data, 2008).

In addition to improvements in water conservation, the use of moisture meters and sensors can offer huge playability and agronomic benefits. It is common knowledge that under- and over-watered soils can have serious impacts on golf conditions and turf health. Saturated soils create soft conditions, result in poor rooting, incite disease, and promote physiological stress to the turf, especially when combined with high air temperatures. Conversely, under-irrigated soil will not support healthy turf if conditions persist long enough, especially if the species is intolerant of drought. Thus, finding the balance between soils that are too wet and too dry and applying the appropriate amount of irrigation will continue to be a challenge for golf course superintendents unless soil moisture can be more accurately quantified. Soil moisture meters and sensors certainly help identify that balance. Moisture meters can also be used as training tools for the hand-watering crew to ensure the same amount of water is being applied by different staff members. With all the benefits that moisture meters and sensors offer, it is not surprising that their popularity has exploded over the past two years.

Although there are several different manufacturers of moisture meters and sensors, most determine soil moisture in the same fashion, through Time Domain Reflectometry (TDR), which measures an electric signal within the volume of soil between the rods and converts it into volumetric water content. This technology can accurately predict volumetric water content in a wide range of mineral soils, ranging from sand-based putting green root-zones through high-clay-content fairways.

Whereas the technologies for meas-uring soil moisture may be similar, there is a difference between moisture meters and moisture sensors. Portable moisture meters (e.g., Spectrum Field Scout, Campbell Hydrosense II) are the most popular among superintendents because they are reasonably priced (most models between $500 and $1,200) and allow for quick moisture measurements in any location across the golf course. In-ground wireless moisture sensors (e.g., Toro Turfguard, UgMo) are a more advanced option for evaluating soil moisture status but are not as popular as portable units. The higher initial costs with in-ground moisture sensors (cost based on the number of sensors installed) is likely the reason these units are not used as frequently as portable meters. However, in-ground moisture sensors provide automated data collection and storage, display trends over time and often collect other data such as soil temperature and salt levels. Deciding between portable moisture meters and in-ground moisture sensors depends on your specific needs. Tracking salt levels is especially important in the arid Southwest, where salt levels can quickly elevate above damage thresholds in the summer. Turf injury from high salt concentrations is also important for those irrigating with effluent water and/or poor-quality irrigation water. Facilities that receive ample rainfall or are fortunate to have good water quality often pay little attention to soil salt levels. Portable meters that measure soil moisture, salt levels, and soil temperature simultaneously do not exist at this time, but there are portable salt and soil temperature meters that can be used as successfully as in-ground sensors. Portable moisture meters have gained the most interest this past year, so the remainder of this article will focus on their use.

USING PORTABLE MOISTURE METERS

Using moisture meters to aid in irrigation programming is relatively easy, but there are keys to success that need to be considered. First, moisture meters need to be directly compared with visual inspection of the soil, surface wilt, and response to irrigation inputs for a length of time before scheduling

decisions can be based on data obtained from the moisture meters. Every superintendent will have a different pace for reaching a comfort level for using moisture meters to guide irrigation programming decisions. However, the more the meters are used, the more rapidly superintendents become comfortable adjusting irrigation practices based on the data obtained from these units. Soil moisture can vary dramatically from one area to another, even in areas with similar soil textures, so developing a database for your course is a must. It is also important to realize that moisture trends at your course can be much different from those at a neighboring facility, so your database would likely be meaningless for another facility and vice versa.

TAKING MEASUREMENTS

Currently, most use of moisture meters has focused on soil moisture status in putting greens, but their use is expanding to approaches, fairways, and tees as well. At USGA Championships, soil moisture is measured in a minimum of nine locations on every putting green each morning and evening. The variation in soil moisture within a green can be quite large, so taking multiple readings per green is necessary to provide an accurate description of moisture levels. This technique should work well for most courses, but in many instances checking moisture thoroughly once per day will work adequately. It will also be beneficial to compare moisture content within soils at various elevations, i.e., plateaus, slopes, and low swales, within each green occasionally. Doing so will help pinpoint where, when, and how much hand-watering will be needed to ensure more consistent and uniform water content throughout the green.

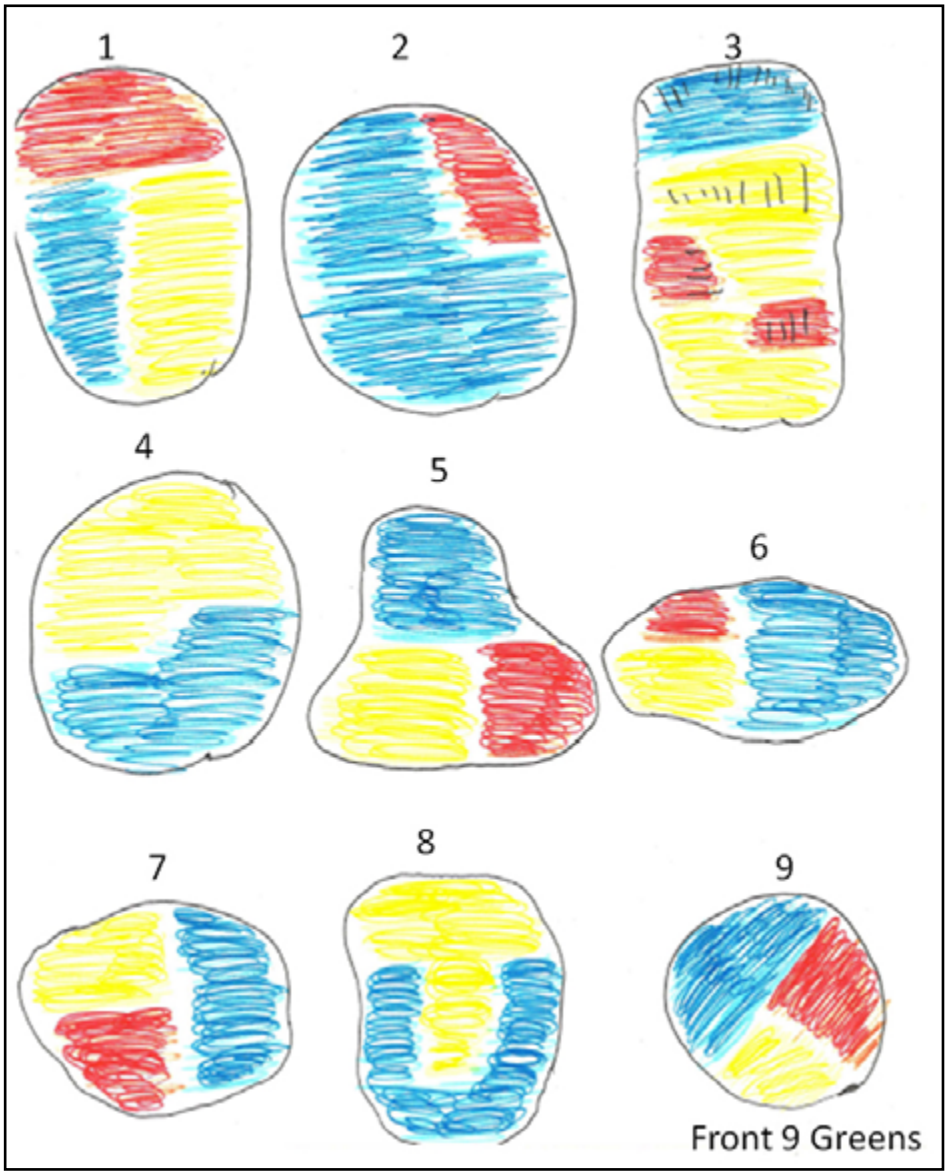
SELECTING ROD LENGTHS

The length of rods installed on the moisture meter can dramatically impact the readings obtained. For best results, the rods should be long enough to measure moisture within the volume of soil where the majority of the root mass is located. If the majority of your roots are located in the top 2 inches of the rootzone, 7-inch rods may provide some useful information, but shorter rods will provide the best picture of soil moisture that turf roots can access. For *Poa annua* putting greens, root depths often vary between 0.5 to 3 inches in the summer, so 1.5- or 3-inch rods are best. Creeping bentgrass typically has a deeper root system in the summer, so 3- or 5-inch rods may be more appropriate. Having multiple sets of rods of different lengths provides flexibility and would be helpful in a greater variety of situations.

One final consideration when using moisture meters is to ensure users are inserting the rods completely into the soil. The plate the rods are mounted on should be flush with the turf. If even a small gap exists between the turf and the bottom of the moisture meter, the reading will be skewed. This scenario can easily occur if the user is not careful, and inconsistencies in irrigation inputs are likely.

DATA STORAGE AND MAKING IRRIGATION DECISIONS

Once the data are collected, storing the information for future use is helpful, although not necessary. Collecting and storing the data can be as complex or simple as you wish. Todd Raisch, superintendent at Ridgewood Country Club in Paramus, N.J., created a



Color-coded drawings of greens are a way of distributing the information collected with moisture meters to the hand-watering crew so they can accurately apply water at the right volume and location.

detailed Microsoft Excel file that displays soil moisture trends easily. Todd's goal is to bring the moisture content in all the greens to between 19.5 percent and 22 percent moisture each morning. Based on historical data collected at Ridgewood C.C., this is the range of soil moisture in the morning that ensures the turf has adequate water to survive the day without the need to add water. As the day continues, staff members scout for surface wilt and hand-syringe to cool the turf as needed, but water is not applied to the soil until the following early morning hours. Daily measurements are recorded in the morning and again in the afternoon before programming the irrigation system to determine moisture loss and replacement needs. Conversely, other superintendents have had success with taking minimal notes while measuring soil moisture.

Distributing the information to employees who will be applying irrigation based on the data from the moisture meter can be as simple or complex as you choose, as well. For instance, putting greens can be divided into quadrants (or even smaller sections), and a detailed graph showing the percent volumetric water content for each quadrant in each green can be easily created with software made available from the manufacturer of certain moisture meters. At Sunningdale Country Club in Scarsdale, N.Y., superintendent Sean Cain takes a different approach, using a system he modeled after learning about the unique hand-watering program used at The Ford Plantation Golf Club in Savannah, Ga. Here, moisture and firmness are rated on an alphabetical (A-D) and numerical (1-5) scale, respectively, with the subsequent values dictating the amount of water applied to the green. Sean has a member of his staff obtain moisture measurements that then are translated onto a color-coded drawing for each green on the course. If the percent moisture is > 18 percent, the quadrant is colored blue and not hand-watered. A value between 12 percent and 16 percent is colored yellow, indicating to the hand-watering crew that the quadrant should receive a small amount of water. A reading < 12 percent is red, indicating that the quadrant should receive a moderate amount of water. These simple color-coded drawings are one example of how the moisture data can be quickly distributed to improve the accuracy of applying irrigation. There are many ways to use moisture meter data to your benefit. Choose the method that works best for you, and once you find a system that works, be as consistent as possible to avoid confusion and errors.

The Rules of Golf allow for repair of ball marks but not tufts created by spike marks. Tufts created by moisture meters can look very similar to spike marks, so the operator should gently tamp down any tufts created when checking soil moisture to avoid any confusion.

RULES OF GOLF IMPLICATIONS

Often overlooked with the frequent use of moisture meters is their impact on the Rules of Golf. If the rods are inserted or removed from the turf too aggressively or at an angle, they can leave a small tuft, similar to tufts caused by golf spikes. The Rules of Golf allow for repair of ball marks but not tufts created by spike marks under Rule16-1c. Golfers may easily confuse moisture meter tufts with spike marks, so the employees using the moisture meter should lightly tamp down any tufts that may be created when checking the green to avoid ruling issues and frustrated golfers.

CONCLUSION

Determining soil moisture status and applying irrigation will always be a balance of art and science. However, the subjectivity that previously existed with assessing soil moisture can be greatly reduced with moisture meters and sensors. The proper use of these tools will help promote water conservation, irrigation cost savings, and better turf for golf. Still sound too good to be true?

LITERATURE CITED

GCSAA, 2009. Golf Course Environmental Profile Vol. 2. Water use and conservation practices on U.S. golf courses. http://www.eifg.org/programs/EIFG_GCEP_Summary_Vol_2.pdf

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