Irrigation water quality

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Water quality

The quality of the water is largely a matter of two things. One is the salt content of the water, which is expressed as the total dissolved solids (TDS) in parts per million (ppm). The second is the amount of sodium in the water, relative to the amount of calcium and magnesium. This is reported as the sodium adsorption ratio (SAR).[1]

The salt effect is related to the availability of the water in the soil to the grass roots. When the salinity in the soil is high, the grass cannot use the water from the soil. This is like a chemically induced drought. The solution to high salinity is leaching of the salts from the soil by addition of more water.

The sodium effect doesn't matter in sand rootzones, because sand particles cannot be moved by sodium. In soils that contain clay, however, when the sodium is too high, the soil structure deteriorates when sodium displaces calcium and magnesium. The solution to high sodium, as measured by SAR, is to add gypsum (calcium sulfate) to the soil.

Here is further reading about soil water content and salt.

[1] For more about this, see my handout on *Soil and water management: 3 problems, 3 solutions*: http://www.seminar.asianturfgrass.com/water_and_soil_handout.html

Effective use of a soil moisture meter

For effective use of a soil moisture meter, we need to be able to answer this question: What is the best level for soil moisture?[2] If you would ask me that question, I would tell you that there really isn't a best level, that it depends on the golf course, and on the grass type, and on the soil conditions, and on the greenkeeping style, and on the desired playing conditions of a specific golf course. As a very broad question, that is the correct answer – there is not a best level.

But at the level of an individual golf course, the answer to that question is different. For a specific golf course, with its grass, soil, greenkeeping style, and desired playing conditions, there is what we might call a best level for soil moisture. I can't tell you what that level is, but I can describe how you would find out. Essentially, we want to restate the question of what is the best level into a slightly different question: How can I identify when irrigation water should be applied? A soil moisture meter allows us to answer that question correctly, every time.

[2] The text in this section is modified from an article I wrote on this subject for *Golf Course Seminar* magazine (Japan) in 2011.

Scientific Background

In a simple consideration of soil moisture we can think of two key states. One state is when the soil is wet and is holding as much

water as it possibly can. This is not a flooded situation. This is the state when it has rained, or irrigation has been applied, the soil has been saturated, and then through the force of gravity the excess water has drained to a level below the rootzone. At this state, the soil is holding its maximum level of plant-available water, and at this state the soil is termed to be at field capacity.

A second state is when the soil moisture is much less, when there is a reduction in plant growth rate because of limited water availability. For golf course turf, we see a problem when the grass wilts, and the grass wilts when the soil moisture is so low that the roots are not able to obtain enough water to maintain turgor pressure in the leaves. When the grass wilts, we say that the soil moisture is at the wilting point.

For different soils and grasses and greenkeeping methods, the field capacity and the wilting point will vary. But for a specific golf course, with its unique combination of grass and soil, the field capacity will be relatively constant, and so will the wilting point. As an example, volumetric soil moisture might be 35% in the top 10 cm of a putting green at field capacity, and volumetric soil moisture might be 10% in the top 10 cm of that green when it is at the wilting point.

The Solution

To answer the question of how can I identify when irrigation water should be applied, this is the process I would follow.

1. After a heavy rain, when the soil is sure to be at field capacity, make measurements of soil moisture. Depending on the soil types and amount of organic matter and type of moisture meter, this number will vary. Maybe it will be 24%. Maybe it will be 42%. The actual number does not matter. But as a greenkeeper you should know exactly what the normal level for field capacity is at your course and with your meter. Now, if you ever find that the soil moisture is more than the normal field capacity, you can know that there must be a drainage problem or a soil irregularity.

2. When the soil is becoming dry, and dry spots start to appear, and the grass starts to wilt in the dry spots, make measurements of soil moisture in the wilted areas. This is best done in the afternoon when dry spots start to appear. "But I can't have dry spots!", you will say to me, "or the grass will be damaged." I can suggest that you monitor the dry spots very carefully and after getting the readings with the meter, that you then add water to let the grass recover, and also that you do this testing of soil moisture at the wilting point when the growth potential is high. If you measure the soil moisture at the wilting point when growth potential is high, you will not only have rapid recovery from the wilting, but you will also be checking the soil moisture when the grass has a high demand for water. The wilting point will probably be in the range from 5% to 15% soil moisture, depending on the grass type and the

type of meter.

3. After you know the wilting point and the field capacity, you can then start to evaluate how soil moisture changes during dry times as the grass uses water and the soil moisture moves from field capacity to the wilting point. For tournament conditions, soil moisture will usually be maintained just at the wilting point or one or two percentage points above the wilting point. This ensures that the greens will be as firm and as fast as possible. If I were a greenkeeper, for everyday play I would try to manage soil moisture to be at about 5% above the wilting point. This would minimize ballmarks and disease while still keeping enough moisture in the soil for the grass to grow.

4. The field capacity and the wilting point will be different for every golf course. And if you have different grass types of soil conditions on your course, then you may find differences in field capacity and wilting point between greens. The value of soil moisture content that a meter reports will also depend on the meter and especially on the depth of the measuring rods. By following step 1 and step 2 above, the range of soil moisture for a site can be determined. Then, the general objective should be to apply irrigation as necessary to keep the soil moisture above the wilting point, but generally closer to the wilting point than to the field capacity. For example, if I found the wilting point on my bentgrass greens was 9%, and the field capacity was 27%, then I would want to keep soil moisture somewhere in the range of 10% to 20%.

Do you know how much salt is in the irrigation water?

The usual thing to think about with irrigation is the quantity of water applied and when to apply that water.[3] Those are important, of course, but one needs to know what is in the water too. That is, to manage irrigation effectively, one needs to know both the water quantity and the water quality.

[3] This text is from an article published in *GCM China* in March 2015.

The most important thing to know about the water quality is the amount of salt in the water. The salt is invisible. If there is a low amount of salt, the grass will be fine. If there is a higher amount of salt in the water, it will still be invisible to the eye when the water is applied, but that salt can accumulate in the soil and cause severe damage to the grass. If you know how much salt is in the water, the potential problem can be managed before any harm is done. But if the salt accumulates undetected, applied more and more at each irrigation, without anything done to manage it, the grass can be damaged severely.

Before the season when the most irrigation water is applied, make sure a representative sample of the water is tested so you know how much salt is in it. The salt will be reported in one or both of these units. One unit is the electrical conductivity (EC) of the water, reported as decisiemens per meter (dS/m). A second unit is total dissolved solids (TDS), reported as parts per million. As

more salt dissolves in water, the more current can be conducted. So a measure of the conductivity is an easy way to estimate how much salt is dissolved in the water. A standard conversion between the conductivity (EC) units and the TDS units is 1 dS/m = 640 ppm. To measure the TDS, a liter of water can be evaporated, and the remaining salt, which doesn't evaporate, is measured. To get an estimate of TDS, measure the EC and multiply by 640.

What happens when salt is applied with irrigation water? Let's imagine a case where the TDS was 800 ppm. The EC in this case would be 1.25 dS/m. For every liter of water applied, there are 800 mg of salt. During the summer, the daily water use of the grass (the evapotranspiration, ET) may be about 5 mm.

I like to think of this in terms of one square meter. In one square meter, 5 L of water is equivalent to a 5 mm depth of water. In one day, if water is supplied to replace ET, that would be 5 L of water applied to one square meter. And each liter of our water has 800 mg of salt. In 5 L, there would be 4,000 mg – 4 g of salt. That isn't much. A fertilizer application might be made at 20 or 30 or 40 g of product per square meter. But what happens when irrigation is applied every day? Applying 5 liters of water gives 4 grams of salt per square meter, every day, and over 1 week, that makes 28 grams of salt. That much probably won't burn the grass. But what about the 56 grams of salt that have been supplied with the irrigation water over 2 weeks?

That much salt could do some damage to the grass, especially if the soil water content decreases. That will concentrate the salt, because the grass uses water, but the salt remains behind in the soil. The symptoms of salt damage to grass look like dry spot, or drought stress, or wilting. But when you check the soil, you will find that there is still water in the soil. The soil is wet, but the grass looks like it is dry. This is because high salt in the soil makes it so the grass roots cannot obtain enough water from the soil. It is like a chemically-induced drought.

The solution to salt in the water is counterintuitive. Even though the water contains salt, the way to manage this is to add more water than ET – to add more water than the grass uses. This causes some water to leach below the rootzone, and the water that leaches carries some salt with it. More about that management in a future article. First, though, make sure you know how much salt is in the irrigation water.