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Soil Amendment Considerations for *Sand-Based Root Zones*

by Joe Betulius and Larry Lennert

If we think of a sand-based athletic field rootzone as a reservoir for the water, nutrients and oxygen needed by turfgrass plants, it's easy to see why the quality of turfgrass grown in pure sand rootzones commonly is poor. Although properly sized sands can provide a rootzone that drains rapidly and remains well oxygenated even after significant traffic is applied, adequate amounts of water and nutrients are often lacking.

Traditional Amendment Choices

To improve water and nutrient retention, various organic materials have traditionally been used as amendments in high sand content rootzone mixes. Peats are the most commonly used organic materials for amending sands, although other materials such as composts and rice hulls are also being utilized today.

The physical properties of organic amendments can best be described as highly variable. As an example, the organic matter and fiber content of two sphagnum peats, a reed-sedge peat, a compost and a muck peat soil were determined to range from 40 to 96 percent and 7 to 54 percent, respectively. In fact, golf green or sports field failure can often be blamed on the poor quality of the organic amendment used in a rootzone mix.

In addition, the physical properties of organic amendments begin to change soon after they are added to a rootzone mix due to decomposition of the organic matter. This negatively influences the performance of sand/peat mixes by causing infiltration rates to decline over time.

Newer Amendment Options

Although these amendments are not really "new," the use of several types of internally porous inorganic amendments (IPIAs) for both construction and maintenance of athletic fields with sand-based root zones has become much more common in recent years. These materials are gaining popularity because they have the ability to retain additional water and nutrients for turfgrass use, without undergoing the undesirable physical and chemical changes that occur to organic amendments.

The most frequently used classes of IPIAs include naturally occurring zeolites, nutrient-loaded zeolites, non kiln-fired diatomaceous earths (DE), kiln-fired DE and kiln-fired, clay-based porous ceramics. Although all of these materials are IPIAs, their physical and chemical properties vary greatly, and their particle size distributions can differ substantially. The combination of all of these product characteristics significantly affects the performance of rootzones amended with these materials.

Organic Amendment Effects on Soil's Physical Properties

Adding organic amendments to sand increases the water retention of the mix in two ways. The organic matter contained in organic amendments has its own internal porosity, which holds water. Additionally, small particles of organic matter partially fill the spaces between larger sand particles. This effectively increases the amount of small, water holding capillary pores, while reducing the amount of larger, non-capillary drainage pores in sand/organic amendment mixes. Infiltration rates of sand/organic amendment mixes decline further over time as organic amendments break down, reinforcing the need for routine aerification, core removal and topdressing.

Building a Bigger Reservoir

Similar to the organic matter contained in organic amendments, inorganic amendments contain internal pores. The amount of internal porosity and the size of the pores varies from product to product, and largely determines the water retention and release characteristics of each IPIA. However, unlike organic amendments, the particle size distribution of many IPIA products is equal to or greater than particle size distribution of sands used for athletic field rootzone mixes. The particle size of certain IPIAs are similar to sand, and adding these IPIAs to sand can increase water retention without reducing the amount of larger, non-capillary, drainage pores.

Conversely, the use of IPIAs with very small particle sizes may be detrimental. In one study, a zeolite with a particle size distribution much smaller than the sand it was added to significantly reduced both non-capillary porosity and infiltration rates of the sand/zeolite mix, versus the pure sand. This demonstrates the importance of determining the particle size distribution of IPIAs and the sand prior to designing a sand/IPIA root zone mix, and testing the physical performance of the mix prior to use.

By amending properly-sized sands with the proper IPIA, it is possible to create rootzones that hold adequate amounts of water for turfgrass use, yet drain more rapidly than the sand itself. This seems to be a very desirable combination of physical properties for sand-based root zones to possess prior to turfgrass establishment, since infiltration rates of athletic fields rapidly decline with age. In essence, it is possible to build a bigger rootzone reservoir for water and oxygen by using IPIAs to amend sands alone, or in combination with organic amendments.

Joe Betulius is the general manager of TURFACE products, Profile Products LLC. Larry Lennert is director of research, Profile Products LLC.

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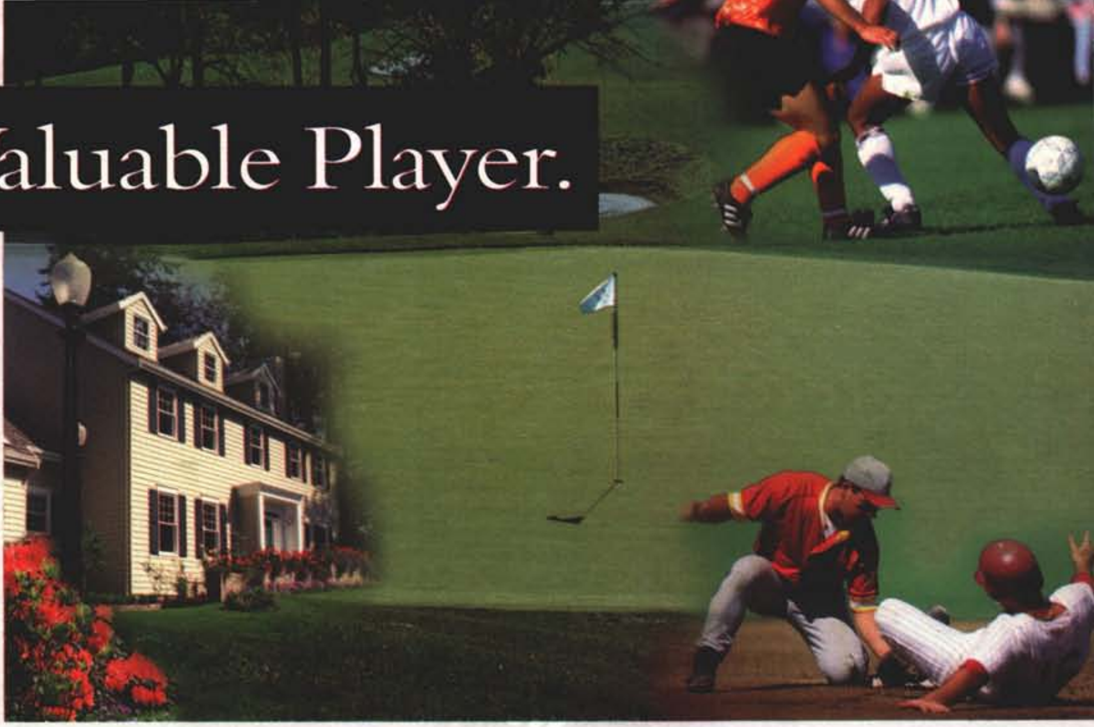

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Effective Irrigation Scheduling

Second in a series

by Robert Bodi

Any irrigator wants the best performance out of his or her sprinkler system. If you are blessed with a good system it is easier to achieve an effective schedule for the area you are trying to water. If you are less fortunate with a below average system it will be a slightly harder task. No matter the condition of your system it is worth the effort to learn more on how you can effectively water your irrigated areas.

Each and every project has different watering needs. You can have different watering needs within one project. More than likely there will be a seasonal adjustment that will need to be made as the watering requirements increase or decrease.

For us to determine how to water our areas in the most effective way, we must do some homework. In generic terms we must determine:

1. The rate at which we are able to put our water down
2. How much water actually goes into the soil and how fast
3. How much time it takes for the soil to retain an adequate supply of water

Soil is no more than a water holding tank for the plants that reside in it. The water is put in the tank, the plant uses it and rain or irrigation must refill it again and again. It is up to us as the irrigator to determine the best time to water and the right amount.

> **Soil is no more than a water holding tank for the plants that reside in it.**

Precipitation Rate

The rate that we can put water down is referred to as the precipitation rate (PR), and is expressed in inches per hour. There are several ways to determine the PR of your system. First and easiest is to refer to the manufacturer's literature for the equipment that is sprinkling your area. Usually it will give you the PR. You will need to know the PSI of your system to be able to read the chart correctly and determine the PR. There is also a formula that you can use to find out your PR. It is 96.3 x gpm (flow) divided by the amount of square footage of the area covered.

Example

Let's say that you have a zone that has six heads in it. The heads deliver 4 gpm each. The zone covers 600 square feet. The formula would work in this manner: 96.3 x gpm / Area or 96.3 x 24 / 2000 or 2311 / 2000 or 1.15 inches per hour. What that means is that you would be able to put out 1.15 inches of water per hour of run time for that zone. The best way to determine the PR of your system is to do a "catch can" test. This is where you actually put out several cans and run the system. You will need to time the watering cycle to be able to determine the PR. Place the cans in the middle of the heads if possible. Next, turn on the zone for, say, 10 minutes. If there is not enough water to measure after 10 minutes, then leave it on longer. Be sure to keep up with the time. Measure the water in each can. If you used multiple cans you would need to pour the contents of each can into one can. Measure the total water in the can. Divide it by the number of cans. This will give you the average amount of water in the cans. Let's say that you came up with a 0.25-inch average in the cans and it took 20 minutes run time. If it took you 20 minutes to achieve 0.25 inches it would be safe to say that you would have 0.75 inches in the can if you ran it for an hour (0.25" x 3 = 0.75 inches per hour).

Soils

Now that we have determined how much water we can put into our soil with our system we need to determine how our soil or "holding tank" will let the water in, hold it, and how much water the plant can safely use before our next watering cycle.

We must first determine the type of soil that we have to be able to know how the water will be absorbed and held. Generally soils are divided into three types (see Table 1).

Use Table 1 to determine the type of soil that you have. The inches column refers to the amount of water that is known as the water holding capacity of a soil given in inches of water per inch of soil thickness. If you have Bermuda turf with roots 6 inches deep in loamy soil, then you will have a water holding capacity of 0.75 inches for your turf (6 x 0.125 = 0.75). As the water is used out of the soil, it must be replenished before the turf gets to what is called the wilting point. The term used for the difference between the field capacity and the wilting point is available water holding capacity

(AWHC). To be sure that you do not get to the wilting point you need to know the amount of water that you can afford to take out of the soil. This is referred to as the Management allowable depletion (MAD). For turf grasses it is 50 percent of the AWHC. Therefore if you have the same 6 inches of roots in loamy soil you would have a MAD of 0.37 inches (0.75 x 50 percent = 0.37). This is the highest amount of water that you should take out of the soil before irrigating again.

Now that we understand how much water our system can put down and how much we can afford to use before we irrigate again, we need to know how fast we can water our soil without it running off. This is called the infiltration rate of soil. Table 2 shows how many inches of water can be taken in for our different types of soil with turf grass cover.

With our example from above we still have loamy soil with Bermuda grass with 6 inches of roots. We have determined that we need to water after we loose 0.37 inches of water in our soil. So that means we need to put 0.37 inches back into it to fill up our holding tank again.

Water Usage By Plants

So we now know how to figure out our PR, AWHC and MAD. (Sounds like the way you talk to your spouse with little ones around when you don't want them to know why you are saying, doesn't it?) Well, we need to be able to know how to find out just how much water is being taken out to find out how much water we need to put back in.

The major factor in water usage by plants is evapotranspiration rate. And yes, there is another abbreviation for this, too. it is referred to as the ET rate. You can usually find out historical ET rates for your area from government extension offices or sometimes a radio or television farm report. However you find it out, it is a vital tool for understanding how to water your plants. The ET rate is usually given as a monthly average. This means that you need to divide it by the number of days in that month to determine the daily ET rate. If you have a monthly ET rate of 6 inches with 30 days in the month, you would have a daily ET rate of 0.2 inches (ET rate of 6 inches divided by 30 = 0.2). Now one more little factor to use. It is called the crop coefficient. And guess what, there is no abbreviation for this one. We'll keep it uniform and refer to it as the CC. The CC is the fractional amount for different plants because they have different transpiration qualities. You need to know the CC of what you are growing to be able to adjust the ET rate for figuring out the watering requirements of the plants. If we have an ET rate of 0.2 and a CC of 0.9 then our adjusted ET rate would be 0.18 (0.2 x 0.9 = 0.18). This is referred to as our adjusted ET rate or ETA.

So we have learned many abbreviations. They are all important in determining how to schedule our irrigation systems for our most efficient watering. Here is an example and summary of everything and how it ties all we have talked about together:

Example

We have our Bermuda grass with 6 inches of roots in loamy soil. We know that our intake rate is 0.30 for this soil. It is on the high side because it has been aerofied properly. The MAD is 0.37 inches. We have an irrigation system that can deliver 1 inch per hour. Our daily ETA is 0.18. How de we determine our scheduling times?

If our ETA is 0.18 that means that we are basically using 0.18 inches of water per day. We can only afford to take out 0.37 (MAD) total before watering again. So if we divide the MAD by the ETA we will come up with our frequency of watering two days (0.37 divided by 0.18 = 2.05 days).

So every two days we need to put back into the soil 0.37 inches. We have a given of an intake rate of 0.30 inches. Remember that means that we cannot exceed 0.30 inches per hour in any given watering or it will be a waste. Our system has a PR rate of 1 inch per hour. That means our system will deliver 0.016 inches per minute (1 inch divided by 60 minutes). Therefore we cannot exceed 18 minutes per cycle (intake rate of 0.30 divided by 0.016 equals 18.07 minutes). But we can only water 18 minutes per cycle maximum. Therefore we need to water only for 12 minutes and wait approximately 30 to 45 minutes and water for 11 minutes to fill up our tank again and not have any runoff.

This is the best way to have successful water management for your project. There are several steps to go through, but in the long run you will have healthier turf while preserving as much water as possible.

Robert Bodi is certified through the Irrigation Association and teaches irrigation in a college degree program. He served on the STMA Certification Committee and was a member of the TNLA board for two years.

Table 1

Soil Type	Appearance
Sandy Soils	Dry—loose, non-moldable Wet—forms ball, crumbles
Loamy Soils	Dry—slightly moldable Wet—moldable
Clay Soils	Dry—cracks in surface Wet—sticky

Texture	Inches
Coarse	0.083
Medium	0.125
Fine	0.167

Table 2

Soil Type	Soil Intake Rate
Sandy soils	0.3-0.5 inches per hour
Loamy soils	0.15-0.3 inches per hour
Clay soils	0.05-0.15 inches per hour

The Roots of the Matter

by Mary Owen

Roots are the foundation of a turf. They perform functions vital for plant growth. This article will discuss the structure and function of roots, the effects of the environment and cultural practices on root growth and strategies for increasing rooting. It will focus on roots and root systems of both cool season grasses and warm season grasses used for sports field and other natural turf playing surfaces.

Root Systems

Turfgrasses have two different root systems during their lives. The first—the primary or seminal root system—develops from the embryo and emerges directly from the germinating seed. It functions actively for six to eight weeks providing water and nutrient uptake for the tiny seedling.

During this seedling growth phase and shortly after the first leaf emerges, an adventitious root system begins to form. This root system originates from buds at nodes on the crown. It replaces the seminal root system, becoming the main functioning root system for the plant. Adventitious roots also will form at nodes on the lateral stems: stolons, rhizomes and tillers. These root systems allow the lateral stems to eventually develop into plants functioning to a large degree independently of the main turfgrass plant.

Turfgrass roots are fibrous and multi-branched. Each root tip is covered by a cap that protects the tender meristem (growing point) as the root bores through soil. The meristem replenishes the root tip and provides for growth of new cells in the root. The new cells behind the meristem eventually stretch and lengthen; this action pushes against the root cap and is what actually makes the root grow longer.

As a root matures, the cells become specialized. The cells of the endodermis (the outer layer of the root) behind the area of cell elongation are able to develop the long, slender, almost microscopic extensions called root hairs. These hairs greatly increase the surface area that can actively absorb water and nutrients. The roots of cool season grasses can form root hairs only from specialized cells in the epidermis called trichoblasts; warm season grasses can develop root hairs from all cells in the epidermis.

A new root is white and slender. As it matures, it turns brown and becomes thinner. Its ability to absorb water and nutrients declines. Eventually the whole root dies, sloughing off just below the crown. This cycle of root growth, maturity, aging, death and replacement is a natural, ongoing process. It may be accelerated by environmental or climatic conditions or by cultural practices.

Just as different grasses vary in leaf texture, color or growth habit, they also vary in the size, depth and distribution potential of their root systems. Warm season grass root systems are deeper and more extensive with roots that tend to be larger in diameter than the finer, more shallow systems of cool season grasses.

Healthy turfgrass roots are well branched. The ability of a turfgrass plant to effectively compete for water and nutrients is directly related to the extent of branching.

How Do Turfgrass Roots Grow?

Cool season grasses

To understand the cycle of cool season grass root growth, consider the cycle of carbohydrate production and use. In photosynthesis, plants, using the energy of sunlight, produce carbohydrates from CO2 and H2O. These carbohydrates, when broken down through the process of respiration, provide energy to the plant. Roots contain no chlorophyll so they cannot photosynthesize. They depend on the leaves for carbohydrates for their energy needs. The absorption of nutrients and the movement of water and nutrients from cell to cell within the root require energy.

Carbohydrates produced at the time shoots are actively growing will be used in the areas of most rapid growth (leaves) before they are sent to the roots for respiration and energy production.

When temperatures are too cool for rapid shoot growth, carbohydrates will be available to the roots. When temperatures are warmer, and when shoot growth is stimulated during very warm weather, carbohydrates will be used by the leaves before any are translocated to the roots.

The roots of cool season grasses grow and function most vigorously when soil temperatures are cool. Spring is the most intense period of root initiation and growth, with fall slightly less active. Since temperatures for maximum root growth, (ranging from 50 to 64 degrees Fahrenheit) are slightly lower than those for maximum shoot growth (ranging from 59 to 75 degrees Fahrenheit), roots grow rapidly before shoot growth begins in the spring and after shoot growth stops in the fall. Even when cool fall temperature stops shoot growth, roots are still actively growing. Carbohydrates are moved into stems and to a lesser extent into roots at this point, providing for slow but continued growth in cold (not frozen) soils until active growth resumes in spring.

Turf grown in reduced light situations will lose even more roots. Turf which has been stimulated by high levels of nitrogen for rapid shoot growth during warm weather may lose large amounts of roots even while shoots remain active.

When air temperatures rise in summer, the efficiency of photosynthesis in cool season grasses is reduced. The leaves produce fewer carbohydrates for translocation to the roots. As energy available for root growth and work is reduced, root growth slows, limiting the root system's ability to absorb water and nutrients from the soil and transmit them to the other parts of the plant.

As air temperatures rise, soil temperatures will follow. As soils warm, root respiration increases. As respiration increases more and more carbohydrates are used up. So, when temperatures warm, the use of carbohydrates increases while the supply decreases. Eventually this can lead to root starvation and death resulting in a net loss of roots to sustain the rest of the turfgrass plant. Roots will not be replaced until cool weather resumes.

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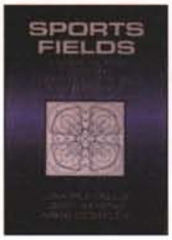

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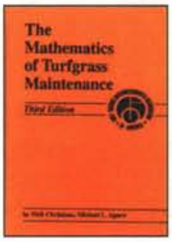

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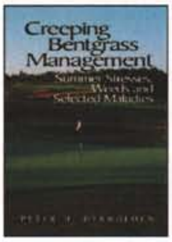

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