Soil and Irrigation Efficiency

Getting Tough On Water Use

Some tough decisions about water are going to have to be made in the next decade—and those decisions will greatly affect the sports turf industry. There are definite indications that Federal subsidies for water projects are drying up. "Some states are assuming that the Federal faucet has been shut off for good," warns Steve Swenerton, director of marketing for Toro Irrigation Division. Irrigation may never be the same again.

Swenerton cautions, "Anyone whose business depends on the availability of water cannot ignore the water conservation issue any longer. In the simplest terms, we are using up our water supply faster than nature can renew it. In California and the Southwest, water has been the subject of heated discussion for as long as anyone can remember. Recently, the effects of drought have been demonstrated vividly in the Southeast, Northeast and even the Pacific Northwest. Episodes such as these remind all of us that our water supply is finite, but they fade from memory quickly."

The debate over water conservation has taken a significant turn, says Swenerton. Instead of talking about water rights, agricultural runoff or water treatment, state and local officials are beginning to consider a free market approach to water conservation which would allocate existing water to developing areas and raise the price of water to market rates.

"Educating our customers on proper irrigation practices and informing them about the most water-efficient products is now more necessary than ever," states Swenerton.

The sports turf industry's best, and perhaps only, defense against a water crisis is efficiency. Irrigation systems, soils, drainage, turfgrasses, wetting agents, and soil amendments will all be involved in an effort to provide natural playing surfaces that recover from sports traffic quickly with a minimal amount of water. People in charge of important recreational turf facilities must therefore possess a thorough knowledge of water and its availability to turfgrass in the soil.

As agronomists figure out how much water is required by the different types of turf to grow and recover from sports wear, soil scientists are exploring the impact of many factors on the availability of water in the soil to the plant. Soil texture, compaction, salts in the water or soil, weather, slope, thatch, drainage, and other factors limit the amount of applied water available to the plant. Any water lost to these conditions must be added to the amount of water needed by the plant to determine how much water should be applied by the irrigation system. The fact that these conditions can change during the year adds to the difficulty of the puzzle.

The skill of the sports turf manager is tested further because he rarely has just one site to consider. Soil conditions may vary between fairways, greens or fields. Jim Barnes is in charge of 24 fields for the Broward County School District. No two are exactly alike. They don't drain alike, they don't accept irrigation at the same rate and they don't receive the same use. "Each field has its own irrigation schedule to make up for all the differences," he states.

The heavy and damaging use of sports turf is what distinguishes its water needs from those of lawns or utility turf areas. Turf under drought stress takes longer to recover. A sufficient supply of water is needed by the plant to fuel its growth. That supply must come from the soil. When the soil becomes compacted by heavy use, water in the soil becomes less available to the plant. Not only does sports turf require more water as its use increases, water can become less available.

Only a fraction of the water applied to turf is available to the plant. Part of it never enters the soil, instead it runs off the surface. A second part is pulled downward by gravity out of reach of the turfgrass roots. A third part is trapped so tightly in tiny pore spaces between the soil particles that it is unavailable to the plant. Only water that is loosely held in pore spaces in the root zone is available to the plant.

The number and size of pores varies according to the type of soil. Clay and silt contain a great number of small pores. Sand contains a smaller number of pores but they are larger. Loam soils are in between clay and sand in texture. Water is not held as tightly in large pores. As a result, clay and silt soils retain more than twice as much available moisture as sandy soils.

The drawbacks to clay and silt soils for sports turf are they compact easily when wet and lose their ability to drain properly. Since they hold twice as much water, twice as much water must be applied from surface irrigation to wet a clay soil to the same depth as a sand soil. This can be important when the turf manager is trying to encourage deep rooting. Clay holds more moisture nearer to the surface than sand increasing the soil's susceptibility to compaction.

How well a soil drains is based upon its texture, layers of different soil below the surface, and the capacity of a drainage system to remove gravitational water. Two forces are involved. The first is adhesion, the force that holds water in the pore spaces. The second is gravity. Water drains through the soil until the two forces balance. This point is called field capacity. The available water held in the pore spaces serves as a reservoir for turfgrass roots to draw from as necessary.

Many times drainage problems are caused not by the texture of the topsoil, but by layers of soil below. The size of the pores in these layers affect water flow. A layer of heavier soil with smaller pore spaces will slow the movement of water downward, but won't stop it. However, it may slow it down to the point that water builds up above the layer. A layer of coarse soil with larger pore spaces will stop water movement until the soil above the layer becomes nearly saturated. Even then, the soil above the coarse layer will hold up to three times more water than it would without a coarse layer below it. This type of water holding through layering is called a perched water table.

If water is applied at the surface faster than the texture of the soil will allow gravity to pull it through, or if the subsurface drainage system can't remove water as fast as gravity pulls it through the soil, then the soil becomes saturated. This condition occurs when the large pore spaces fill with water. Normally adhesion will hold only a film of water in these pore spaces so that

As the demand for potable water exceeds suppl

the remainder of the space can be occupied by gases, such as oxygen. The roots need oxygen to carry out their functions and to take up nutrients from the soil solution. Disease organisms thrive in soils lacking oxygen during periods of high temperature, states Dr. John Hall, extension turf specialist at Virginia Polytechnic Institute, Blacksburg, VA.

To gain control over water movement in the soil, turf specialists have utilized both mixtures and layers of soils. The United States Golf Association Green Section specifications for greens are based upon mixing and layering different textures of soils. The Prescription Athletic Turf system for athletic fields is all sand, but recently a small amount of clay has been mixed into the top few inches. Even the texture of pure sand changes as organic topdressings, decomposing organic matter and air- and water-born materials become mixed into the surface. To correct some of these problems, aeration, verticutting, cultivation and topdressing are frequently used to maintain sufficient drainage through soils used for sports turf. These methods can also be used to break through soil layers below the surface. One example is sand slitting, in which a small trencher or vibratory plow cut narrow trenches in the soil and then backfill them with sand.

Wetting agents are a chemical solution to some drainage problems. These materials temporarily correct conditions in the soil, especially at the surface, that cause the soil or thatch to reject water. They can increase both the infiltration (entering the surface) and percolation (passage through the soil) of water. Dry spots not only deprive the turf of needed water, they reduce the penetration of soluble fertilizers and nutrients into the soil. Wetting agents can improve drainage and reduce the potential for sports to compact wet soil.

Of course, the best drained soil will become saturated without adequate subsurface drainage. Agricultural specifications for subsurface drainage are inadequate for sports turf. Agricultural drain pipe is often too deep and too far apart for sports turf needs. The texture of the soil and the force of adhesion work together to control how water moves laterally as well as vertically. Water doesn't just move down, it also moves all other directions despite the pull of gravity. Just like a drop of water placed in the center of a paper towel moves all directions, so does water in soil. This adhesive force is known as capillary action.

A properly designed drainage system takes into account all directions water can move. The drain lines must be close enough together so that water will move sideways to reach them without saturating the soil. A heavy subsoil can be graded to utilize gravity and adhesion to remove water from the soil. The water moves down until it reaches the subgrade and then it follows the slope to the drain lines at the bottom. For existing sports turf areas with poor lateral drainage, a series of narrow parallel trenches can be made which lead to a collection or drainage point. Small drain pipes can be installed if desired. These trenches are then backfilled with sand to the surface. When the soil becomes saturated, water will begin to enter the porous sand where gravity takes over. The water moves to the bottom of the trench and is carried away by the drain pipe or follows the slope of the heavier subgrade to the collection point. According to John Moreland of Cambridge Systems, these trenches can create a wicking action

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sports facilities will be forced to use water as efficiently as possible.

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that sucks excess water from the adjacent soil.

Sports turf that is used frequently during both periods of heavy and light rainfall needs a drainage system designed to remove water from a typical shower during the rainy season. A less intensive system should be used only when the use of the area can be restricted during wet conditions. Playing on saturated soils only compounds drainage problems by encouraging compaction.

The type of turfgrass utilized also affects the depth and texture of the drainage system. The roots of most cool-season grasses grow no deeper than 12 to 18 inches into the soil. Tall fescue roots extend between 18 to 48 inches below the surface while bermudagrass and zoysiagrass roots can reach eight feet down. By encouraging roots to grow deeper, the turfgrass manager can improve the drought tolerance of his turf. He can then irrigate less frequently.

Some turfgrasses by nature are more drought tolerant than others. Bermudagrass, zoysiagrass, tall fescue and red fescue are the most drought tolerant. Kentucky bluegrass and perennial ryegrass have moderate drought tolerance while creeping bentgrass has low drought tolerance.

While most attention is paid to the top two or three inches of sports turf soils where compaction takes place, some consideration should be given to managing the root zone below this level. Soil texture and layers in the deeper portions of the root zone can hamper water, nutrient and root penetration. Deep aeration and cultivation once a year is being tried successfully by a number of sports turf managers to encourage deep rooting and to conserve water.

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Dr. M. Ali Harivandi, an extension water specialist in California, has shown that soil texture greatly affects how much water is needed to wet soils to certain depths. For example, less than one inch of water will wet sand to a depth of one foot. To wet the same depth of clay soil takes nearly two and one half inches of water. One and a half inches of water will wet a loam soil to a depth of one foot. The sand may have to be irrigated more frequently, but roots will be encouraged to grow deeper and draw from the moisture reserve below the surface.

Once the sports turf manager has a grip on the rate at which water enters and drains through soil, he can precisely determine how much water must be applied through irrigation. He does this by comparing how fast the irrigation system applies water to how fast the soil can accept it. First find out how much water is applied per minute by the particular irrigation system by asking your irrigation distributor or manufacturer. He will know based upon the pressure, flow, overlap and nozzles used. Next send a sample of the soil to a soils lab for a percolation test. This will give you the amount of water the soil can take in per minute.

A less sophisticated way of doing the same thing is to take a three pound coffee can, cut both top and bottom out, drive the can into the soil one inch, and then fill it with two inches of water. Time how long it takes for the water to enter the soil. Next, take other three pound coffee cans with the open end up and position them on the turf area. Turn the irrigation on for one minute and measure how much water is in the cans in inches.

Divide the time it took two inches of water to enter the soil by two. Then compare it to how much water would fall into each coffee can in the same time. If the irrigation system is applying water faster than the soil can take it in, water is being wasted as runoff.

Automatic irrigation systems are providing the sports turf manager with the ability to come closer to matching water infiltration and percolation to the application rate. Controllers with repeat cycles enable them to schedule short, repeat cycles that give the soil time to catch up with applied water. Repeat cycles are especially useful on heavy soils or sloped sites.

The first object in irrigation management is to wet dry soil to the desired depth. To encourage deep rooting you may want to wet it to depth of six to 12 inches. According to Harivandi, that would take between one half and three quarters of an inch for sand, three quarters to an inch-and-a-half for loam, and between an inch-and-a-quarter and two-and-one-half inches for clay. This is the amount of water that must percolate into the root zone. Runoff must be subtracted from the amount of water applied.

The next step is to determine when available water in the soil has been exhausted by the plant. At this point the plant will begin to show symptoms of wilt. Since checking all turf sites for wilt symptoms may be impractical, irrigation specialists have devised a calculation, based upon weather, to estimate when levels of available water are running low. This calculation is called evapotranspiration (ET) and can be fed into many computerized irrigation controllers for automatic adjustment of cycles. ET information is available in some locations from the weather service or other governmental agency. Weather stations are now available from certain irrigation manufacturers to provide local calculation of ET.

Another method to gauge plant water use for high priority sites involves the use of moisture sensing devices. Moisture sensors can be installed at any soil depth. They can be linked to certain computerized irrigation controllers to signal the need for irrigation or to stop irrigation when soils are sufficiently moist.

Things that increase evapotranspiration are high temperature, wind, sunlight and low humidity. When water evaporates it cools. Turfgrasses counteract the effects of high temperatures and hot sun by releasing water through small openings in their foliage which evaporates and cools them. This natural process is called transpiration. Wind increases the rate of evaporation while high humidity slows it down.

Water used for transpiration must be replaced by soil moisture for the plant to carry out other necessary biological functions, including photosynthesis and growth. When transpiration is high, the plant will use up available soil moisture faster. If evapotranspiration exceeds the ability of the soil to supply the turf with water, it will wilt. One method of slowing ET in windy, cold conditions is to apply a film over the foliage called an antidessicant. An antidessicant should be not applied in hot, dry, sunny conditions since it will reduce the ability of the plant to cool itself.

Harivandi points out that under the same climatic conditions, cool-season turfgrasses generally use more water than warm-season turfgrasses. So, ET is not the same for all turfgrasses. This is why in order for computer programs for irrigation systems to work properly, the type of turfgrass must be entered. These programs also require information on soil texture.

A final consideration of water supplied to sports turf is salinity. In some regions of the country, irrigation water contains high levels of dissolved salts, especially reclaimed water. Excess salt in the root zone restricts the intake of available soil moisture by turfgrass roots. Generally, the level of salt in the water does not greatly affect the plant. It's when these salts accumulate in the root zone that problems occur.

The most practical way to "flush" salts out of the root zone is by periodically overirrigating. Instead of applying just the amount of water needed by the turf under current ET conditions, apply additional water to leach the salts through the root zone.

Jim Barnes at Broward County Schools says that a couple of heavy rains can flush out his fields. He advises those sports turf managers in areas without heavy rainfall to flush out their soils twice a year to remove accumulated salts.

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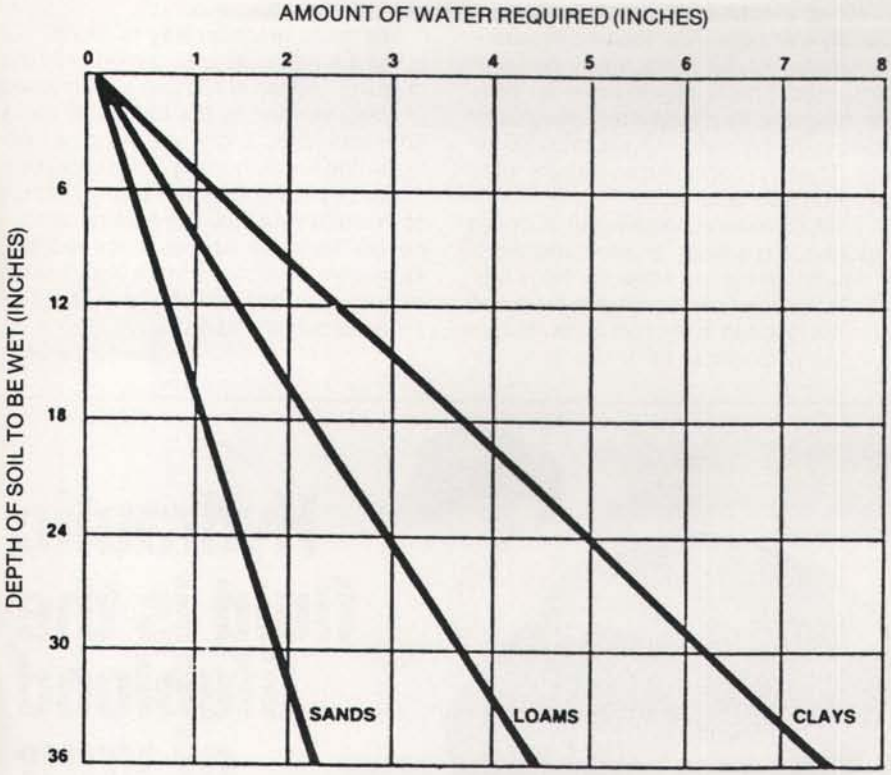

Inches of water required to wet soils to given depths (assuming no runoff).

The only way to accurately replace the amount of available water in the soil used up by ET and plant functions is to have control over the irrigation system. In the case of sports turf that means being able to irrigate high-wear areas separately from lower-wear areas. It also means being able to customize irrigation according to varying soil and turfgrass types.

Golf courses have led the industry in irrigation efficiency since they are also one of the largest users of irrigation water outside of agriculture. Irrigation designers go to great lengths to select sprinkler heads and organize them into zones to match environmental conditions, use, soil and turfgrass. Valve-in-head and valve-under-head sprinklers provide single-head control if desired, especially around greens. More and more courses are utilizing part-circle heads on the perimeter of fairways to separately control these high-use areas from the roughs. At the same time, target golf is leading to contouring and shrinking the size of fairways on some golf courses.

Courses in windy locations are experimenting with low-pressure heads that produce larger droplets to reduce losses to evaporation and drift. They conserve energy as well as water by reducing the load of the pump system.

Athletic field irrigation systems are also being improved. Most football fields built today are zoned to irrigate the portion of the field between the hash marks separately. The center of a football field receives the most wear and is usually more compacted than the rest of the field. The center of the field at Joe Robbie Stadium in Miami, Fl, also has separate drainage.

Soccer fields require separate zoning of the penalty areas. The area in and around the goal mouth receives the greatest wear by far. Similar problem spots occur on baseball fields where the outfielders stand. There is no rule that says the outfield must be the same turfgrass as the infield. More drought and wear tolerant turfgrasses could be used in the outfield than in the infield.

In the case of all sports turf, winter overseeding changes water needs. Uniform coverage is necessary for ryegrass to germinate and establish. The interval between irrigation cycles would also be shorter for the shallower-rooted ryegrass. Overwatering, on the other hand, can lead to an outbreak of pythium and increased compaction.

If Toro's Swenerton is right, water conservation and irrigation efficiency will be dollars and cents issues in the near future. A sports turf facility that does not devote the money for correcting soil deficiencies, irrigation hardware and drainage now, will pay the price later in water. In any case, money spent in these important areas, will not be a waste. The turfgrass will perform its best and withstand the greatest use while consuming the least amount of precious water. That should be every sports turf managers goal.