Turfgrass water conservation essentials:

modified rootzones & current water management technologies

TURFGRASS WATER CONSERVATION is not just a concept of the minimum amount of water that can be used for turfgrass survival, it is also the concept of optimizing water use as a significant factor in getting the maximum performance from turf and not wasting water. Key elements of this concept are modifying root zones to promote optimal turf growth and taking advantage of improvements in turf irrigation technology.

MODIFIED ROOTZONES FOR EFFICIENT WATER USE

Soil uniformity. Uniform soil conditions make it easier to grow uniform turf and provide more efficient irrigation. However, turfgrass is frequently grown on nonuniform modified soils where topsoil has been removed or mixed with subsoil. Sod is often laid on compacted subsoils, which limit rooting into the underlying soil.

Soil variability increases the need for site-specific management in irrigation programming, using the knowledge of soil properties such as texture, structure, organic matter content, compaction, drainage, slope, fertility, and pH, as well as lighting and air movement. Water relations in soils depend on retention and transmission of water: soluble salts can control how much water is available to roots in salt-affected soils. As a soil dries or as soluble salt content increases, less water becomes available for plant uptake.

Sand-based designs. Sand-based profiles that have relatively narrow particle size distribution are widely used with or without amendment for highly trafficked turf areas such as golf putting greens and other sports turfs to ensure adequate water infiltration, percolation, and drainage, and to prevent the buildup of excessive soil water content. Profile designs that encourage the development of a water table can conserve water. These designs on limited slopes and when drained to field capacity can have a water content distribution ranging from unsaturated and well-aerated at surface depths to nearly saturated at the lowest depths.

Placing a finer-textured sand over coarser material such as gravel creates a zone of greater water retention (a perched, or suspended, water table) in the sand above the interface with the gravel layer. For example, the USGA Green Section specifications for putting greens use a 2-layer or 3-layer profile. The 2-layer profile is most widely used and has a 300-mm sand root zone mix of a specific particle size distribution placed over appropriately sized gravel. Drain tiles are installed in the gravel layer. During construction, these specifications are sometimes followed carefully, sometimes not; if not, undesired conditions may occur in plant-available water or drainage patterns.

The California design is a 1-layer system consisting of a specified well-draining sand placed over compacted (impermeable) native soil. Drain tiles are installed in trenches in the native soil. Water retained at the bottom of the root zone is more typical of a perched water table if there is very limited or no drainage into the underlying soil.

Drainage from the 2-layer USGA putting green profile tends to be independent of the sand mix, while the 1-layer California green profile drains slower, with finer sand mixes. Thus, the 1-layer profile tends to hold more water for turf use than does the 2-layer profile. The 2-layer profile has only a short-term effect on the perched water table due to the downslope subsurface movement of water. If the root zone mix is too deep, water stress increases, leading to localized dry spots, especially in the highest elevations of a putting green. If the top mix is too shallow on putting greens, it may be difficult to place the hole liner, and wet areas may occur, which can enhance development of black layer.

Better turf performance has been observed on root zones that retain more water with reduced rooting compared with root zones that retain less water with greater rooting. In sand-based root zones, greater rooting depth has not been related to better turf performance or greater efficiency in water use. There is evidence to suggest that greater water conservation can

Further Reading

Establishing and Maintaining the Natural Turf Athletic Field. 2004. S. T. Cockerham, V. A. Gibeault, and D. B. Silva. Oakland: University of California Division of Agriculture and Natural Resources Publication 21617.

Handbook of Turfgrass Management and Physiology. 2008. M. Pessarakli, ed. Boca Raton: CRC Press.

Turfgrass and Irrigation Water Quality: Assessment and Management. 2009. R. R. Duncan, R. N. Carrow, and M. T. Huck. Boca Raton: CRC Press.

Turfgrass Water Conservation. 2011. 2nd ed. Oakland: University of California Division of Agriculture and Natural Resources.

be achieved with sand-based root zones that retain more water.

Subirrigation. Subirrigation can use 70 to 90% less irrigation water than surface irrigation. Drainage tiles placed on top of plastic liners in subirrigation systems can be closed to prevent leaching. These tiles can be attached to pumps to draw water out or pump water into the sand profile. The water table can be raised or lowered as needed, depending on root depth. The particle size range and depth of the sand dictate the degree of capillary rise of water. Problems with subirrigation include managing high levels of soluble salts and sodium, as well as maintaining uniform root zone water content in sloping putting greens.

Topdressing with sand. Repeated sand topdressing increases infiltration on native soil putting greens and other sports turfs. Water that had previously run off sloping turf surfaces tends to be held in the sand layer. When dry, topdressed sports fields have a lower surface hardness. However, hydrophobic soil conditions, as found in localized dry spots or dry patches, frequently develop in sand media. These spots often occur in areas where irrigation coverage is inadequate, on slopes where water tends to run off rather than infiltrate, and on slopes facing the sun. Fully developed localized dry spots are difficult to rewet. Application of wetting agents, cultivation (aerification), thatch control, careful monitoring of soil water levels, and syringing are the most common corrective practices.

Several states offer automated, Web-based potential and reference ET values for irrigation scheduling. In California, the most commonly accepted source of ET data is the California Irrigation Management Information System (CIMIS, wwwcimis.water.ca.gov).

Avoiding black layer. Sand sports surfaces grown with aggressive, high-density cultivars of creeping bentgrass and bermudagrass can accumulate excess organic matter, which can seal the surface, causing loss of roots, turf stress, and the formation of black layer. Management practices to prevent or remove black layer include providing more oxygen to the affected zone through reduced irrigation (with emphasis on syringing), cultivation, topdressing to prevent layer formation, improving drainage, controlling organic matter, and monitoring fertility practices.

CURRENT WATER MANAGEMENT TECHNOLOGIES

Strategies to reduce unnecessary irrigation water use should include efficient irrigation systems and scheduling irrigation based on the actual water requirement of turf needed to maintain a desired quality level.

High-efficiency irrigation. To achieve high-efficiency irrigation, minimize losses such as droplet evaporation, surface runoff, leaching, and wind drift. Correct sprinkler head selection and spacing can match water spray patterns with the shape of the landscape, which helps avoid areas that are over- or underirrigated. Divide larger irrigated areas into hydrozones, areas of similar watering requirements. Consider subsurface irrigation systems: they have shown great potential for water conservation, despite difficulties associated with determining spacing and depth of trays, pipes, or emitters; higher cost of installation; difficulty in monitoring and/or troubleshooting damaged parts; potential interference with maintenance practices; and the inability to establish turf from seed when irrigated below the surface.

Estimating irrigation amounts. Irrigation amounts can be estimated based on climatic factors or calculated from the plants' water status by monitoring soil moisture or by using remote sensing technologies that detect and quantify drought stress. Evapotranspiration (ET) losses from a turfgrass stand provide an accurate measure of irrigation water requirements. These losses have been closely correlated with atmometer evaporation, open pan ET, and potential (model) ET estimates (ETp and ETo). ETp and ETo estimates are most commonly used when turfgrass irrigation scheduling is based on ET losses.

To match actual turfgrass ET, most ET estimates require adjustments in the form of multipliers or crop coefficients (Kc) to meet local climatic conditions and specific maintenance situations. Kc can vary from 0.4 to 1.1, depending on ET reference, quality expectations, season, grass type, maintenance level, and micro- and macroclimate. Crop coefficients can also be used to calculate irrigation amounts. Irrigation below 100% ET replacement (deficit irrigation) does not necessarily result in a significant loss of turfgrass quality and function.

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Smart controllers. Smart controllers automatically adjust to daily changes in evapotranspiration. Using them instead of traditional irrigation scheduling can yield water savings as high as 80%. Some municipal water authorities and utilities have introduced rebate programs for installing smart irrigation controllers. Irrigation scheduling based on soil moisture aims to keep the root zone within a target moisture range by replenishing ET and drainage losses. This is considered to be the most intuitive way of determining how much and when to irrigate.

Soil moisture sensors. Soil moisture sensor technologies currently used to schedule landscape and turf irrigation include dielectric sensors and heat-dissipating sensors for measuring soil water content, and tensiometers and granular matrix sensors (gypsum blocks) to measure soil water potential. Both types have advantages and disadvantages, and consideration must be given to the soil type, range of moisture measured, and expected soil salinity.

Tensiometers estimate soil matric potential and do not require soil-specific calibration, but they do need regular maintenance. Granular matrix sensors measure the electrical resistance between two electrodes embedded in quartz material and correlate the resistance with the matric potential of the root zone.

To calculate irrigation requirements based on volume, soil moisture tension or suction values must be converted to volumetric soil moisture content using a moisture release curve. Dielectric sensors record volumetric soil moisture directly; measurements can be affected by the length of the rods, soil texture, soil density, and soil electrical conductivity.

Absolute moisture values can vary considerably over a landscape. If a sensor is installed in a location representative of an irrigated area, and if it records moisture extraction between maximum and minimum over time, using this data can lead to more consistent irrigation scheduling than using absolute values alone. Reported reductions in irrigation water applied range from 0% to 82% when soil-moisture-based controllers were used for scheduling compared with either traditional or ET-based irrigation scheduling.

Crop water stress indices and normalized difference vegetation indices calculated from remotely measured reflectance of canopies have been suggested for irrigation scheduling of cool- and warm-season turfgrasses. However, to date no automated remote sensing irrigation scheduling technology based on reflectance is commercially available.

How do modified root zones and current water management technologies relate to sports turf? The construction and management of sports fields are directed to support the performance characteristics of safety, playability, durability, and aesthetics at some level of expectation. Water management, as expressed in irrigation, is key to meeting those expectations. Occasionally one finds a sport field that has been built by merely scraping off a spot and seeding it. Most often, though, the construction involves modifying the root zone in some manner. In either case, the turf manager must learn how to irrigate that field and ensure that the root zone grows the best grass possible. Water management technologies have been developed to make that job just a little easier and to obtain the highest efficiency from the water that is applied. ■

This article was adapted from *Turfgrass Water Conservation*, Second Edition (University of California Agriculture and Natural Resources, ©2011, Regents of the University of California), which was written by scientists for turfgrass managers and decision makers to address many of the issues relating to turfgrass irrigation. This excerpt is used by permission.

This publication, along with many other useful resources for the turf professional, can be found at http://anrcatalog.ucdavis.edu/TurfLawns/