Water Use Efficiency Techniques from the Southwestern United States

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The growth and economic viability of small businesses, including golf courses is limited by the availability of water. In no other region across the United States is this challenge more pressing than in the desert southwest. As a result of the highest evaporative demand in the U.S., golf courses in the southwest use more water per acre (4.0 acre feet per acre) (5) than in any other agronomic region. By comparison, golf courses in the northeast region average only 0.8 acre feet per acre per year. Elevated water consumption in the southwest comes at a cost. Nationally, golf courses spend roughly $243 per acre for water annually. This figure nearly quadruples to $937 per acre in the southwest, where courses on average pay $107,800 per year. In southern Nevada, it is not uncommon for courses to pay over 1 million per year for water. Since 2001, water costs have climbed by 30% in the southwest and that trend continues today. Golf course superintendents in the desert southwest have to manage water efficiently; in most cases the business is not sustainable otherwise. The following discussion offers 5 examples of how turf managers in the southwest use water efficiently while continuing to provide quality playing conditions:

Irrigation Redesign

As the economy slowly crawls out of its slumber, capital improvement items such as irrigation redesign/renovation are slowly being considered. Redesigning an antiquated system has potential to offer many rewards, such as water conservation, energy reduction, improved turf quality and coverage, and labor and equipment savings. In some cases redesigning an inefficient system may help courses avoid fines imposed by local water regulatory bodies. One such example is Paradise Valley Country Club in Paradise Valley, AZ, where an irrigation redesign project was undertaken in 2007 (1).

Figure 1. A mini–triangulation system was developed to protect the true location of each sprinkler in the field.

In 2006, the facility used 626 acre feet of water on 122 acres of turf, or 5.1 acre feet per acre. This total exceeded the water allotment by about 40 acre feet (13,034,040 gal). The old system was operating at 62% Distribution Uniformity (DU). The irrigation designer, installer and supplier came together to guarantee a minimum operating efficiency of 80%, something that had never been done.

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Figure 2. The simple act of raising and leveling sprinklers can improve system efficiency by as much

Through careful engineering of head layout, optimal spacing throughout the golf course was achieved. By using survey grade mapping instruments, each sprinkler was staked to sub−centimeter accuracy. A mini−triangulation system was developed to protect the true location of each sprinkler in the field. As a result, DU´s above 80% were regularly achieved. The 501 acre feet used (compared to 626 acre feet before the redesign) shattered the club´s water use goal. With rising water costs, this savings is significant, and more importantly, they were able to produce quality turf while beating their water allotment.

Irrigation Nozzle Upgrades

Although upgrading the irrigation nozzles will not make up for poor design and inadequate pressure, they can offer substantial improvements in DU. In 2006, a study conducted by the Center for Irrigation Technology (CIT) (8) in Fresno, CA evaluated the water consumption at 5 California golf courses 1 year prior to nozzle upgrades and one year after. Results demonstrated that about 100 acre feet of water were saved in one year across all 5 courses. Water savings equaled approximately 6% per course. In travels throughout the southwest region, many courses struggling with poor distribution uniformity have upgraded to better performing nozzles. A recent conversation with a superintendent in Queen Creek, Arizona revealed that he has upgraded roughly 70% of the nozzles on his fairways over the past two years. He suggested the most dramatic improvements in DU can be seen with aerial photographs or comparing Google Earth® images over several years. The ˝donuts˝ (brown, dry areas surrounding the irrigation heads) have been eliminated where nozzles were upgraded.

Improving soil properties

Improving soil physical and chemical properties to encourage water penetration (water entering the soil surface) and infiltration (water moving through the soil profile) may seem a bit abstract with regard to water conservation, but experience with clubs that have employed soil modification strategies reveals there is water savings to be had. Soil water infiltration rates may be improved through both mechanical and chemical means:

Mechanical Methods

Aeration with solid or hollow tines − A study evaluating various cultivation strategies on four golf courses in the Phoenix, Arizona area revealed 4x/year aeration enhanced sodium leaching and turf quality. (7) Although increased soil water infiltration was not quantified in this study, one can assume hydraulic conductivity improved given that sodium leached from the upper soil profile in aerated treatments. At Auburn University, Elizabeth Guertal, studied the effects of 1,2 or 4 solid tine aeration events on soil compaction and saturated hydraulic conductivity (Ksat). Ksat increased with 4x/year aeration and improved turf quality on one of the test sites (2). Both these studies demonstrated that when soil water infiltration improves, so too does turf quality and the ability to leach salts.

Fairway topdressing with sand − On very hard, rocky soils surface runoff may result in water loss and turf managers often respond with more frequent, but light watering. Aggressive sand topdressing (0.5 − 1 inch per year) on challenging soils will improve turf quality, enhance salt leaching and may reduce water consumption. Furthermore, research suggests that

Figure 3. Utilizing soil improvement methods such as with deep tine aeration can reduce runoff and improved soil water infiltration.

Figure 4. Sand topdressing fairways will yield improved turf conditions and surface drainage while reducing the potential for runoff.

sand topdressing can improve surface drainage and reduce surface runoff (4). Experience working with several golf courses committed to aggressive sand topdressing has demonstrated that salinity levels can be reduced by more than 50%, a function of improved surface water infiltration. A review of their historical water inputs reveals an interesting development – prior to sand topdressing the courses deficit irrigated, meaning the water inputs fell below the evapotranspiration (ET) rates. Such an irrigation regime was done out of necessity. Watering at or above ET would result in wet, unplayable surfaces and runoff would occur. However, turfgrass quality suffered during periods of high evaporative demand and salinity and sodium climbed to harmful levels. Once soil infiltration rates were improved, water inputs were increased to yield quality turfgrass conditions without sacrificing playability. Furthermore, the better performing soils would accept water and offered the ability to leach salts.

Chemical Methods

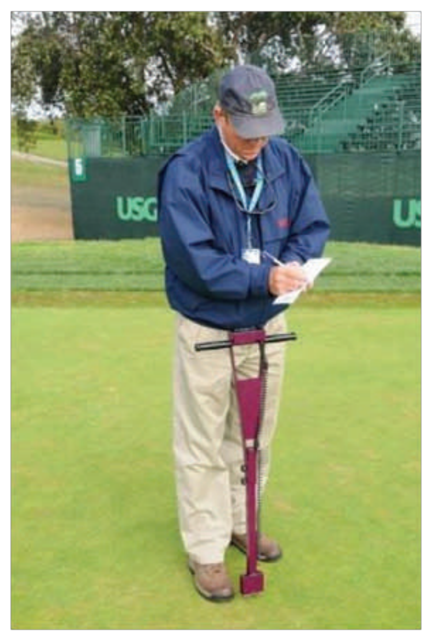
Mitigating the sodium hazard – Elevated sodium can affect soil physical properties like dispersion of clays and organic matter. Adding calcium and magnesium where sodium accounts for much of the problem will improve soil flocculation and water penetration. On sodium affected soils, turf quality and sodium leaching were improved when 4 times per year aeration and 80lbs/1000 sq. ft. gypsum was applied in a 3 month period (7). It was thought that turf quality improvements were a result of reduced soil strength and increased soil moisture in areas receiving a combination of aeration and gypsum.

Wetting agents – Especially on sandy soils more than 18 months old wetting agents can improve soil water penetration and increase soil moisture (3). However, on fine textured soils the data supporting the benefits of wetting agents is less convincing. Research in central California demonstrated that wetting agents helped to retain higher soil moisture when compared to untreated controls (6). Dr. Keith Karnok, professor at the University of Georgia observed increased soil moisture where dense bermudagrass turf was established on fine textured soil with the use of wetting agents. However, Dr. Karnok acknowledges that although the results were encouraging, the "jury is still not out" with regard to the benefits of wetting agents on fine textured soils (personal communication).

Using soil moisture and salinity sensing technology

At the Desert Mountain properties in Scottsdale, AZ where six golf courses are maintained, Mr. Shawn Emerson, Director of Agronomy, and his agronomic team have utilized a combination of in–ground soil moisture and salinity sensors and hand–held moisture meters to reduce water and energy use. Given that all six courses irrigate with recycled water, there was a real concern for elevated salinity levels. To mitigate salts, previously, each course would leach approximately twenty times per year, each time utilizing about 450,000 gallons of water for all six courses. The frequency of leaching has been reduced to only six times per year once the salinity sensors were installed, yielding a savings of 6.3 million gallons of water per year. Moreover, a reduction in leaching means beneficial nutrients such as potassium, nitrogen and calcium are applied less frequently since they are not leached from the turfgrass rootzone.

Figure 5. Utilizing soil moisture and salinity sensing technology has the potential to yield substantial water savings when applied throughout the golf course.



Desert Mountain recently implemented the IBM Intelligent Operation Center software for Smarter Cities® that enables the agronomic staff to manage the incoming and outgoing water, monitor for system leaks and analyze trends in water use from one location in real time. A recent October rain event triggered the operation center to shut off the irrigation

Figure 6. Many courses will omit overseeding on 30 to 50 acres of rough. It is estimated that 1–2 acre feet per acre in water is saved as a result of this practice annually.

system at all six courses, saving millions of gallons of water in one night. Prior to utilizing the sensors and installing the IBM system, each course used approximately 5.5 acre–feet per acre annually, nearly 1 Billion gallons of water. The courses now use approximately 4.9–5.0 acre–feet per acre, yielding a savings of over 10 million gallons per golf course per year.

Eliminating overseeding

Many courses in the desert southwest have reduced overseeded acreage. Although it is difficult to quantify the water savings resulting from this strategy, it is estimated that courses may save 1–2 acre feet per acre per year. Many courses will omit overseeding on 30 to 50 acres of rough, a practice strongly encouraged by USGA Green Section Agronomists. As a result the water savings and reduced labor and energy costs is substantial.

Conclusion

In the southwest region, the cost of water, the electrical costs to pump it on the golf course and labor costs associated with maintaining the system demand that golf course superintendents manage water efficiently. The five strategies described above are being utilized by many southwestern superintendents and will hopefully encourage turf managers in other regions to incorporate similar ideas into their agronomic plan. Courses implementing many of these strategies have proven that water can be saved while producing quality playing conditions. Examples of successful water stewardship by the golf industry need to be shared with county, state and even federal officials.

Resources:

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