SUBGROUND IRRIGATION ON GREENS AND TEES

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INTRODUCTION

In Europe as well as many other parts of the world, water is becoming increasingly scarce as populations, industry and agriculture all expand. For this reason, there is growing attention being focused on recreational turf areas and their real or perceived waste of water. In Germany, for example, it is becoming increasingly difficult for developers to obtain permits to build golf courses because of public pressure and the many strict conditions concerning water usage that must be met. During summer months, irrigation of turf areas has even been prohibited on occasion because of water shortages in the area. However, highly trafficked turf areas, such as greens and tees on golf courses, are usually built with sandy rootzone mixes that show low water holding capacity. The high intensity of play and the low cutting height of these turf stands necessitates additional irrigation during the vegetation period when natural precipitation is insufficient. Because the amount of water needed to maintain turf at its optimum performance can only be roughly estimated, turf areas are often overirrigated. This can be detrimental to the turf stands and can waste substantial amounts of water. Some evidence for overirrigation includes algal and moss infestation, fungal diseases and *Poa annua* encroachment, particularly on very close cut turf. For these reasons, both environmental and physiological, it is important to try to limit or reduce unnecessary water use on turf.

STRATEGIES TO REDUCE IRRIGATION WATER

Four main strategies aimed at reducing drinking or ground water consumption for the irrigation of turf are currently being investigated by researchers. The first strategy is the irrigation of turf with reclaimed or effluent water to minimize or avoid the use of high quality water. The second strategy is the breeding of drought resistant species or cultivars, or the use of grasses that are low in their evaporative loss of water. However, the literature suggests that at very low cutting heights, such as greens and tees, the differences in water loss become marginal, at least for the cool season grasses. The third strategy is to minimize water use by scheduling irrigation based on plant and/or soil water status rather than based on a time schedule. The fourth strategy is to investigate alternative methods of irrigation, such as subground irrigation.

SUBIRRIGATION

Subirrigation, which encompasses subsurface drip irrigation, subsoil irrigation, and subground irrigation, is a term used to describe the application of water to turf from beneath the surface. Subsurface drip irrigation applies water laterally to the rootzone from perforated tiles or emitters buried either close to the surface or just below the normal root penetration (Krans 1975, Stroud 1987). Subsurface drip irrigation does not include drainage through the same pipe system. Subsoil or subground irrigation describes a subirrigation system that both irrigates and drains through a system of connected perforated pipes on a plastic barrier used for isolation of the subgrade and for maximum water storage. Turf usually grows on a 30 to 40 cm (12" - 16") deep rootzone consisting of either a pure sand or a sandy rootzone mix. Currently there are two systems available, the PAT (Prescription Athletic Turf)-System and the Cellsystem. One advantage of subirrigation systems is that the turf area can be used during irrigation. Other advantages include energy savings due to a lower operating pressure, and water savings (Snyder *et al.*, 1974). According to Stroud (1987) and Chevallier *et al.* (1981) up to 50% of irrigation water can be saved by using subground irrigation compared to a sprinkler system, because of improved distribution uniformity (no sprinkler overlap), no losses of water due to wind drift, and no evaporation losses during the irrigation process itself.

PRESCRIPTION ATHLETIC TURF SYSTEM

The patented Prescription Athletic Turf (PAT-) system is considered to be an improved version of the earlier PURR WICK-system and was also developed by William H. Daniel. The system consists of a 30 cm (12") deep rootzone (minimum) overlying a plastic barrier that seals the subgrade. Drainage and irrigation is achieved through 5 cm (2") diameter pipes that are connected to 10 cm (4") collector pipes. Turf canopy can be additionally watered with a sprinkler system. Soil moisture probes operate subirrigation and excess water is removed from the rootzone through pumps, by means of suction. The sensors automatically control suction, subirrigation, and surface irrigation (Daniel *et al.*, 1973, Daniel 1990).

CELLSYSTEM

The 1966 patented Cellsystem was invented in Canada by James P. Izatt, and was first built into greens and tees on the Royal Nairobi Golf Course in Nairobi, Kenia in 1962. The 40 cm deep rootzone consists of sand only and also overlays a plastic barrier. Drainage and irrigation are performed through 8 to 10 cm (3" to 4") diameter slitted pipes that are connected to a non-slitted collector pipe. Connected at one end of the main collector pipe is the water inlet with an attached 1.2 cm (0.5") diameter hose that supplies irrigation water into the collector pipe. Attached at the other end is the outlet consisting of an adjustable overflow, that regulates drainage and allows the adjustment of a fluctuating water table within the rootzone. Water movement inside the sandy rootzone is achieved solely through capillary raise and gravitation. No additional forces through pumps are applied (Moesch 1975). In Germany, there are 20 soccer fields that use Cellsystem for irrigation and drainage and three golf courses that use it in their 18 green and tees.

STUDY

A widely held view among many of the people working in turf in Germany is that subground irrigation does not work properly and actually needs more water than sprinkler irrigation (e.g. Skirde 1978). However, this view is based only on anecdotal information, and has never been tested under rigorous experimental conditions.

To study the effects of a subground irrigation system on water use of 3 turfgrasses, experiments were conducted at Hohenheim University over a three year period on a specially designed research green. The green was divided into four 35 m^2 (376 ft^2) plots, two of which were irrigated with a commonly used sprinkler system, and two which were irrigated with a Cellsystem subground system. The 3 turfgrass species tested were: creeping bentgrass (*Agrostis stolonifera* cultivar 'Penncross'), slender creeping red fescue (*Festuca rubra trichophylla* cultivar 'Barcrown') and Supina bluegrass (*Poa supina* cultivar 'Supra) at a cutting height of 5 mm (1/3"). Over the 2 year experimental period, the plots were subjected to 3 drought periods lasting from 6 to 12 days, followed by recovery periods. During each drought and recovery period the following measurements were taken: Crop Water Stress Index (CWSI) (calculated from leaf surface temperature using infrared thermometry), volumetric soil water content (measured by TDR), and quality-ranking. At the end of each vegetation period rooting data in different depths were collected, and overall water consumption was measured. The main results of the study were: 1) CWSIs were significantly higher on sprinkler irrigated turf at the end of each drought period, 2) soil water content in 0-10 cm (0-4") depths was significantly higher on subground irrigated plots at the end of each drought period, 3) rooting in 20-30 cm (8-12") depths was significantly more extensive in subground irrigated plots and 4) water use was 90% lower on subground irrigated fields.

WATER SAVINGS

In order to compare the results of the study to an actual golf course, data on rooting and water usage were collected from a subground irrigated golf course in southern Germany. The course is located in an area that is exposed to heavy winds all year round and has Cellsystem built into the 18 greens of the golf course. Although in some years there is no precipitation over the entire vegetation period (Zinser, pers. comm.), each of the 18 700 m^2 (7,500 ft^2) greens is irrigated with 80 to 100 m^3 (21,100 to 26,500 gal) of water per year. Rooting in 10-20 cm (4"-8") and 20-30 cm (8"-12") depths on these greens was significantly more extensive than on greens of a nearby golf course irrigated with sprinklers (unpublished data).

CONCLUSIONS

It was not part of the study to quantify how much of the water savings was actually due to the improved drought avoidance of subground irrigated turf, how much was related to the savings during the irrigation process itself, and how much was due to the water storage capabilities of subground irrigation. Nonetheless, due to improved water distribution and drought resistance characteristics, subground irrigation shows great potential for water savings on confined areas such as golf greens and tees.

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