A LOOK AT TURFGRASS WATER CONSERVATION

by DR. ROBERT N. CARROW
University of Georgia

WITHIN THE PAST ten years, water conservation under turfgrass situations has become increasingly important. A number of factors have brought this about, including increasing competition for water recources, water shortages from periodic drought, awareness by turf managers that high fertilization and irrigation are not necessary to maintain a good-quality turf and often lead to other management problems, and the increasing cost associated with obtaining water.

The United States Golf Association has provided research funding in water conservation strategies for turfgrass managers and applied research to implement these approaches. To achieve maximum water savings while maintaining an adequate turfgrass for a particular site requires integration of a number of different strategies. A grower on a particular turfgrass area may not be able to use all strategies, but when relevant ones are incorporated into his management program, considerable water conservation can be expected.

Water Conservation Strategies

A primary, but long-term approach to decreasing water use is through the development of grasses with lower water use requirements. This requires a) developing cultivars of turfgrass species that have lower water use rates than current cultivars, b) developing improved cultivars of native species that already can provide reasonable quality turf under minimal water but are limited in natural adaptation range, and c) determine whether grass species not currently used as turfgrasses have a place in turfgrass management in a manner that would reduce water use.

Plant breeding obviously plays a dominant role in this approach. Breeders make plant explorations to obtain new genetic material. They evaluate new selections for quality, water use, and drought resistance. Hopefully, they will release some of the better selections after wide testing and also utilize them for breeding purposes to develop even better second-generation cultivars.

In order to evaluate grasses for their potential drought resistance and low water use, plant breeders must rely on rapid screening techniques. Plant physiologists enter the picture here and identify key plant morphological, anatomical, and physiological characteristics that impart drought resistance and reduced water requirements of turfgrasses. Once the most important characteristics are known, physiologists must then identify rapid, reliable ways for the plant breeder to screen for these characteristics.

Unfortunately, drought resistance is the most complex of all environmental stresses. Table 1 summarizes the many plant mechanisms that contribute to drought resistance. Determining which of these mechanisms are important for a particular turfgrass species or cultivar is a monumental task. Such basic information not only will enhance the efficiency of breeding programs, but also will provide criteria to develop more water-efficient cultural programs.

To put it in different terms, the soil-plant-atmospheric-continuum (SPAC) is composed of many factors, each of which affects water use. In this SPAC, least is known about the influence of the plant, particularly when an individual species and cultivar are considered.

A second strategy for water conservation is for turfgrass managers to alter current cultural practices to reduce water use. This will be a continuing process as more information comes forth on how specific cultural practices influence water use individually and in conjunction with other practices on a particular species and cultivar.

Cultural practices most likely to affect water use are mowing, N-P-K nutrition, irrigation practices, cultivation, plant growth regulators, thatch control, and certain pesticides. In addition, improved root growth by correcting soil physical, chemical, or biological properties will greatly enhance water conservation.

As more basic knowledge evolves about how plant and soil aspects are altered by individual or combinations of cultural practices, we can develop much better regimes. To be most effective, this will need to be done at the cultivar level, because within species, cultivars may vary substantially.

Third, breeders must develop turfgrasses that can tolerate high soil salt levels and poorer water quality. These grasses would be used with lower water quality, effluent water, and saltwater intrusion areas. Research by breeders, physiologists, and soil scientists on these problems is greatly hampered by location of the experimental site. Only a few of the current research facilities have soils with high salt content or poor water quality from ground water, effluent, or saltwater sources. Locations away from the established research facility are often not desirable because of the intensive management of turf and the necessity to obtain research data frequently. Problems associated with saline/sodic soils and poor water quality will increase in the future.

A fourth strategy closely associated with the previous one is the use of effluent water. This has been a common practice in arid regions. In the future,

TABLE 1

Turfgrass Morphological, Anatomical, and Physiological Characteristics Contributing to Drought Resistance

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Drought Resistance — various mechanisms that a turfgrass plant may have to withstand periods of drought. Two major types of drought resistance are:

1. *Drought Avoidance* — ability of a plant to avoid tissue damage in a drought period by postponement of dehydration. The plant is able to maintain adequate tissue water content and thus avoid or postpone the stress. Plant characteristics contributing to drought avoidance are:

- Deep, extensive root system
- High root length density
- High root hair density
- Good root viability
- Rolling, folding of leaves
- Thick cuticle on the leaves
- Hairy leaf surfaces
- Reduced leaf area through smaller leaves
- Reduced leaf area through death of lower leaves or tillers
- Slow leaf extension rates after mowing
- Leaf densities and orientations contributing to high canopy resistances
- Stomatal closure
- Stomatal density
- Stomata that are located so as to reduce transpiration
- Smaller conducting tissues
- Smaller mesophyll cells in leaves
- Possibly proline or betaine accumulation

2. *Drought Tolerance* — ability of a turfgrass to tolerate a drought period. Two potential ways are:

a) *Escape* — where the plant has a life cycle such that it lives through the drought in a dormant state or as seed.

b) *Hardiness* — where a plant develops a greater hardiness (tolerance) to low tissue water deficits. This process normally involves a greater drought tolerance of protoplasm and protoplasmic membranes from alterations in their properties, and binding of water to protoplasmic constituents. Osmotic adjustments to aid in maintaining adequate tissue water content may also be involved during long-term or short-duration stress periods.

this practice may spread to humid regions, especially in urban settings where potable water is at a premium. As this occurs, problems will develop that may not appear in arid or semi-arid regions. Refinements in cultural practices will be required to insure efficient, safe use of effluent water.

Water harvesting is a fifth alternative that may be applicable in certain locations. This is already practiced in the form of runoff ponds on some sites. Contouring and sealants (mechanical or chemical) to promote runoff on selected areas while collecting the runoff for irrigation may prove practical in some cases.

A sixth approach is by improved irrigation scheduling. Technology is developing rapidly in this area and can assist the grower in reducing water runoff, leaching, and excess evaporation losses. Technological tools assisting turf managers in irrigation decisions are a) soil-based — to monitor soil water status; b) plant-based — to monitor plant water status; and c) atmospheric — to monitor atmospheric conditions.

Examples of soil-based tools are an increasing array of soil moisture sensors in addition to tensionometers and moisture resistance blocks that have been available for many years. Often these sensors work on different principles than tensionometers or moisture blocks and may not have the limitations of these instruments.

The oldest plant-based irrigation guide is observation for wilt, but being able to determine stress before visual wilt symptoms would be very beneficial. Systems that monitor canopy temperatures are now available and can be used to help schedule irrigation.

Examples of atmospheric-based tools are weather pan evaporation and estimating evapotranspiration (ET) by various environmental-based formulas (Penman equation, others). State-of-the-art irrigation controllers, coupled with weather-monitoring devices, are now available from major irrigation manufacturers. Further improvements in atmospheric-based approaches can be expected as the data base builds and growers begin to use the full capabilities of these systems.

Irrigation system design and engineering offers a seventh water conservation approach. Essential factors that improve water use in irrigation design are:

- Designing for application uniformity and thereby minimizing wet and dry spots; zoning irrigation heads of similar areas together.
- Using fewer sprinkler heads per zone but adding more zones; matching application rate to soil infiltration by using low-volume heads on heavy soils or multiple irrigation applications.
- Providing the turf manager with sufficient data and controller flexibility to develop the most efficient irrigation program.

An eighth strategy is development of specific water conservation and drought contingency plans at all levels — specific turf site, city/county, water district, and state. A review by the turf manager of the previous strategies will reveal how water conservation measures can be incorporated into such plans. Just as with pesticide issues confronting the lawn-care industry, input into regulatory and governing agencies before plans are developed has been the most successful tactic.

A manual detailing how to develop plans and incorporating data to calculate projected water saving through implementing specific water conservation measures would be a valuable tool for turf managers, regulatory personnel, and governmental officials.

A ninth strategy, but not of least importance, is education. Individual turf managers will be increasingly challenged by more sophisticated technology (*i.e.*, infrared thermometers for canopy temperatures and complex controllers with tremendous ability to provide detailed information); the need to refine management programs to smaller and smaller units (green by green, tee by tee); pressure to incorporate all possible water conservation tactics; expectations to provide data on the degree of water saved; the necessity to alter many management practices for a specific cultivar in order to achieve maximum benefits; and other similar challenges.

To this base of knowledge, managers will need to understand new technological and scientific advances in turfgrass science in order to intelligently incorporate these into their management schemes. At the industry level, the USGA Green Section, manufacturers, and university personnel must find efficient ways to transmit the latest knowledge rapidly and in a comprehensive, understandable manner.

Well-irrigated example for high-quality turf on tees, athletic fields, etc.

Moderate water stress. An example of common irrigation practices for fairways, most athletic fields, business grounds and good home lawns.

Severe water stress. An example of infrequently irrigated turf, roughs and for survival of grass.

Zoysiagrass under the same irrigation regimes as described above.

Centipede grass under the same conditions.