The "Irrigation Man" puts puzzle pieces together.

Putting the Water Puzzle Together

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IF YOU PLAN a long and successful career as a golf course superintendent, a sound, basic understanding of water management is the first prerequisite. Of course proper practices in mowing, pest control, cultivation, drainage, and nutrition will be important, but proper and correct irrigation practices are essential. They stand alone in the production of good turf for golf.

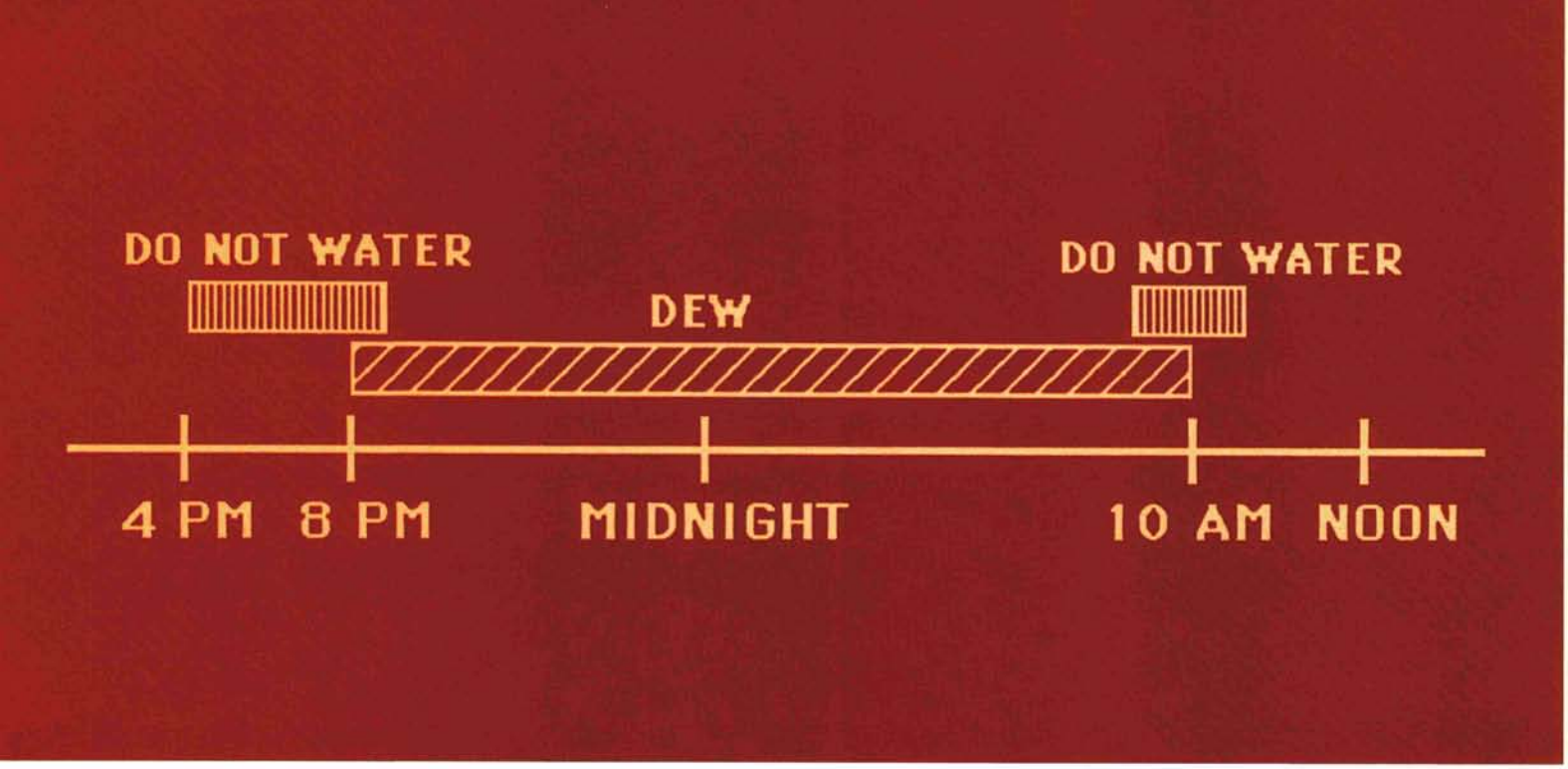
For decades, golf course superintendents have been encouraged to apply water deeply but infrequently. The healthiest grass plants are those with deep and extensive root systems.

The idea is to allow the upper root zone to dry out for a few days before applying the next irrigation. This technique, called wet-to-dry management, promotes the deepest possible root growth. Unfortunately, most irrigation schedules are not managed this way.

The problem is complicated even more by natural rainfall. Soils that are consistently too wet invariably lead to greater compaction and soil problems, heavier fertilizer requirements, weed and disease problems, and shallow rooting.

The turfgrass plant is composed of approximately 90 percent water, which is essential for every stage of growth, from seed germination to maturity. Water plays an important role in photosynthesis, cell development, temperature control, and nutrient translocation within the plant.

Water content within the plant is reduced during drought conditions. Most turgrasses will survive plant water losses of 30 percent or more. Moderate water stress may actually enhance plant quality by promoting deeper rooting, and increase the plant's resistance to water stress. During extended drought periods, many cool- and warm-season turfgrasses enter a dormant stage. Kentucky blue-



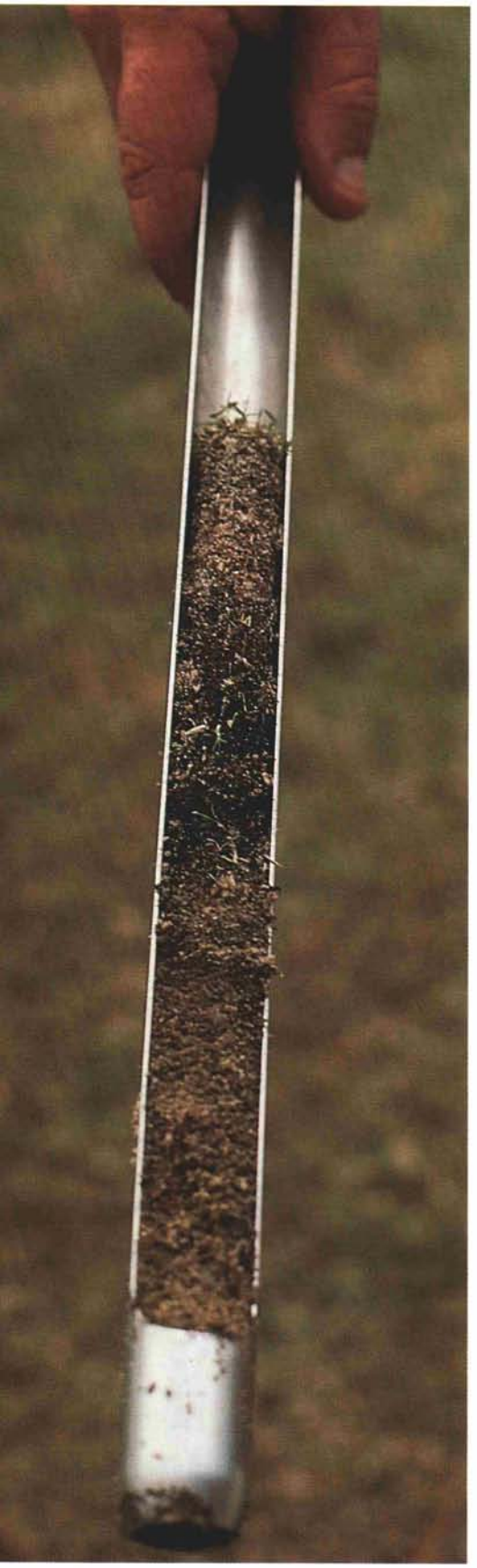
grass, perennial ryegrass, bentgrass, tall fescue, bermudagrass, zoysiagrass, centipedegrass, and St. Augustinegrass all have a drought dormancy mechanism. Once the drought is broken, new growth is initiated. Management and environmental factors, such as temperature, fertility, mowing height, etc. directly affect drought tolerance of turfgrasses.

Turfgrasses can also suffer from too much water. Root rot, caused by *Pythium* spp. is most active on young grasses grown on poorly drained wet soils. Excessive soil moisture frequently results in a condition called wet wilt. The root system cannot function because essential oxygen is displaced by excess water in the soil pore space. Turfgrass roots require 30 to 40 percent open pore space for optimum activity. If conditions of excess water persist, soils often become anaerobic (without oxygen), producing the condition called black layer. It is difficult to maintain turfgrass water supplies within this narrow range of too much or too little.

(Top) If water is applied during the "do not water" times indicated on this chart, the turf may remain wet long enough to cause the appearance of symptoms of disease caused by fungi.

(Above) Deep cultivation — a new tool for better water management.

THE TURFGRASS plant actually requires only a small amount of water for growth and development. Most water within the plant is used in the translocation process — the movement of water-soluble materials from one part of the plant to another. Practically all of this water is lost from the plant through transpiration, that is, water lost in vapor



The soil probe, an old tool essential to better water management.

form from the stem and leaves. Transpiration is a necessary biological plant function that helps cool the plant. Many people are surprised to learn an estimated 99 percent of the water taken up by the turfgrass plant is lost to the atmosphere, while only one percent is used for growth and development.

The term evapotranspiration refers to water lost from the soil by evaporation and by transpiration from the plants growing on it. It relates to the water use rate of any crop, and it varies with climatic conditions. For example, the ET rate (evapotranspiration rate) is increased by factors such as sunlight, soil and air temperature, humidity, and wind speed. Turfgrasses use the most water on sunny days with low relative humidity and moderate wind speed. High ETR days occur mainly in the summer, with much lower rates in the spring, fall, and winter. Your local weather bureau and state extension service have information on evapotranspiration rates for your area.

Turfgrasses differ in their rates of water use. Grasses with low rates of water use may require less than 1.0 inch per week, while those with high rates may need 2.5 inches per week in the summer. For example, bermudagrass requires about 1.0 inch per week, whereas tall fescue requires 2.0 inches per week during the summer in the Piedmont of Georgia. Bentgrass putting greens at times during the summer have water use rates of up to .33 inch per day. It is possible to estimate with reasonable accuracy the general water requirements for putting greens, tees, fairways, and roughs if the grass species and climatic conditions are known.

TALLER mowed turfgrasses have a higher evapotranspiration rate than shorter mowed turf because of their open canopies. They require less frequent irrigation, however, because they have a deeper root system that can extract water from the lower root zone. Shorter clipped grasses have fewer roots, and they usually require more frequent irrigation. A turfgrass maintained at a taller height and mowed frequently will help reduce evapotranspiration water loss.

Raising the mowing height during drought is best for turf. Mow frequently enough so that no more than one-third of the leaf tissue is removed in any one clipping. This old philosophy helps increase turf survival and decrease the rate of water use. The rooting depth, growth rate, soil and climatic conditions, and turf species determine the actual rates of water use.

Putting green grasses are mowed at heights of 3/16 of an inch or less on many golf courses. Closely mowed turf has a tendency to develop shallow roots. Healthy root systems of shorter mowed turf, however, benefit from deep and infrequent irrigation. Studies have shown a sound water program is equal to or more important than the mowing strategy for today's golf turfgrasses.

A deep and infrequent irrigation philosophy has many advantages for the golf course superintendent. The primary goal is to wet the entire root zone, but avoid saturation. The better programs strive to provide optimum root zone moisture for only level ground and lower areas. The higher and drier areas should be treated with supplemental water and aerified if necessary to help prevent dry wilt. This supplemental irrigation helps avoid overly wet soil and unhealthy conditions in lower areas.

Using this type of deep but infrequent water management, the program objective is to wet the root zone deeply once or twice weekly. A good guideline is to supply about one inch of water per week during dry weather. One inch of irrigation for one acre requires about 27,000 gallons of water. Most 18-hole courses in the Green Section's southeastern region irrigate about 50 acres, so the total water output is significant.

Once water is deeply applied throughout the root zone area, subsequent irrigation is based on evapotranspiration rates and soil drainage. For example, many courses in the Southeast allow about 30 to 40 percent of the root zone to dry before the next irrigation of their hybrid bermudagrass fairways. Drying of the upper six to eight inches of fairway soil may take five to seven summer days. The measured precipitation to rewet the root zone may be from 0.5 to 1.0 inch of water, depending on soil conditions.

A blue-green leaf color generally indicates a shortage of moisture. Every golf course superintendent has one or more drought stress indicator areas, usually where excessive thatch, sandy soil, or non-uniform irrigation coverage exists. Some isolated dry areas may reappear within two to four days after the last deep irrigation. It is better to hand water these areas, especially on the putting greens. Most other locations will still have adequate soil moisture that is easily detected with a soil probe.

Isolated dry spots or hydrophobic areas are common in golf turf. Soil fungi and bacteria have been commonly associated with them. Most golf course super-

intendents have had success with spot aeration and rewetting isolated dry spots individually with a hose and shower nozzle. Wetting agent applications, such as the new pellet or granular formulations, temporarily help alleviate the isolated dry spots.

MOST golf courses will have fewer dry spots with the implementation of a deep irrigation program. Water will move both laterally and horizontally through the root zone with the higher water volume. One longer irrigation period or several repeatable shorter cycles are usually effective in rewetting the soil profile uniformly. Repeatable cycles are helpful on heavy texture soils or soils with lower infiltration rates. The irrigation cycle is repeated every few hours to allow for infiltration and to reduce water runoff.

A deep irrigation philosophy is complemented by a vigorous aerification program. It is difficult to implement deep irrigation on compacted soils. The soil must be conditioned to accept 0.5 to 1 inch of water a night. Aerification helps relieve soil compaction, improves root growth, and allows for more rapid water movement into the root zone.

For putting greens, the new deep-tine aerification equipment is very effective in improving water infiltration rates and soil conditions to a depth of 10 to 12 inches. Previous aerifiers only penetrated three to four inches. The deep-tine aerifier allows much deeper root zone modification. Incorporating a good topdressing soil into the holes has also helped maximize root growth. The new aerification equipment makes it possible for more clubs to adopt the deep irrigation philosophy.

Spikers and slicers are excellent tools to relieve soil compaction in the upper root zone temporarily. These tools should be scheduled on a weekly or bi-weekly basis where improved water penetration is needed. Spikers and slicers help water move through surface crusts, black algae, topdressing layers, and thatch. They also assist in the exchange of soil oxygen in the upper root zone.

Aerifying according to specific turfgrass needs will also aid in the success of this irrigation philosophy. Most water is applied to turfgrasses during the summer. Aerifications enable water to enter the soil during subsequent irrigations.

Irrigating on a daily schedule during dry weather is a less desirable alternative. Daily irrigation does provide some insurance against drought, even though the long-term agronomic effects are most undesirable. Wet areas frequently appear in low and poorly drained locations. Black algae is common.

Daily irrigations sometimes help the golf course superintendent maintain a better relationship with certain club members. These players request softer playing conditions, especially on the putting greens. They expect every approach shot to stop at or very close to their pitch marks, regardless of how the shot was played. Unfortunately, they do not realize their request is not only detrimental to their own long-term enjoyment of the game, but to the long-term quality of the golf course turf as well. The USGA Green Section has long advocated firm putting greens, to the benefit of the golfer and his course.

MANY GOLF courses establish a permanent, repeatable irrigation schedule, such as every other night, twice weekly, or once weekly. This practice is often, but not exclusively, found at golf courses with limited labor. The schedules may work with some success from time to time, but they are predetermined to fail because they are largely unattended and not associated with actual daily water use rates. Overwatering or underwatering invariably occurs. There is absolutely no sure way to carry out a proper irrigation program without involving the daily good judgement of an irrigator.

The best superintendents use a soil probe to help determine when and how much to irrigate. The soil probe is an excellent tool to check turfgrass root depth and soil moisture. Few other more reliable tools exist in the business. Insert the probe into the soil. The resistance of the soil to insertion, along with soil moisture texture and degree of root systems, will help determine irrigation requirements.

EARLY MORNING seems to be the preferred time for irrigation because it reduces disease problems. For some managers, this may mean 4 a.m., and for others 10 a.m., but whatever the time, the irrigation program must be started early enough to complete the watering cycle before it conflicts with the day's play.

Most disease-causing fungi require 16 to 22 hours of free moisture for disease symptoms to occur. When to water is a very important question. Many times the answer is dictated by the use pattern of the turf. Let's assume that dew falls at 8 p.m., and it might not dry off until 10 a.m. the following morning. With this in mind, the turf is at a 100 percent relative humidity for 14 hours. Under normal circumstances, this is not long enough to promote disease. If the turfgrass is watered at 4 o'clock in the afternoon, however, it will not dry off before dew falls at 8 o'clock. The wet period has been extended by four hours, and now it falls in the range of time necessary for disease organisms to infect turfgrass. If the turf is watered at 9 o'clock in the morning, the wet period is extended again by one to two hours, and the minimum time requirement for infection is present. In either case, it is important to remember not to water turf at any time that will extend the natural wet period.

Turfgrass can be watered during the day, so long as it is allowed to dry before the evening wet period. It is also acceptable to water in the early morning, at 3, 4, or 5 o'clock. Extra irrigation may sometimes be needed for certain maintenance requirements during undesirable irrigation times. The golf course superintendent should anticipate such circumstances and plan preventive fungicide applications as they are needed.

Night watering has been performed on golf courses for many years. The night hours are the most desirable time to irrigate larger turf areas without interfering with play. Other nighttime advantages include lower evaporational loss, reduced wind, lower temperatures, lower plant stress, and a longer time for water to soak into the soil.

TODAY, most golf courses have automatically controlled irrigation systems. With proper design, engineering, installation, and system maintenance, the modern golf course superintendent has an extraordinarily accurate means to finally solve the water puzzle. But automatic irrigation systems are not really automatic. They alone cannot fit all the water puzzle pieces together. They alone can never solve the problem. The solution lies only with the golf course superintendent and his basic understanding of water management fundamentals. That's the way it is and that's the way it will always be.