PART III of IV

TURFGRASS CULTURE AND WATER USE

Different turfgrass species use water in different ways. New research helps to better explain this process.

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Over the last seven years, researchers have made advances in understanding turfgrass water use rate (WUR). Much emphasis is being given to the WUR associated with a particular turfgrass species, cultivar or cultural practice.

The idea is to develop grass systems that lose less water to the atmosphere and maintain more favorable soil moisture condition for plant growth.

Indeed, these low water use grasses and management practices are being defined, but turfgrass managers must understand that low water use does not necessarily mean less irrigation.

For example, WUR of creeping red fescue is nearly 15 percent less than that of tall fescue. But less water is needed by tall fescue to keep it at acceptable turf quality than the creeping red fescue.

Similarly, taller mowed grasses have higher WUR than shorter mowed grass, but the amount of irrigation needed to keep turfs at acceptable levels is less for the taller grass than the shorter.

In both examples, a deeper root system associated with tall fescue and

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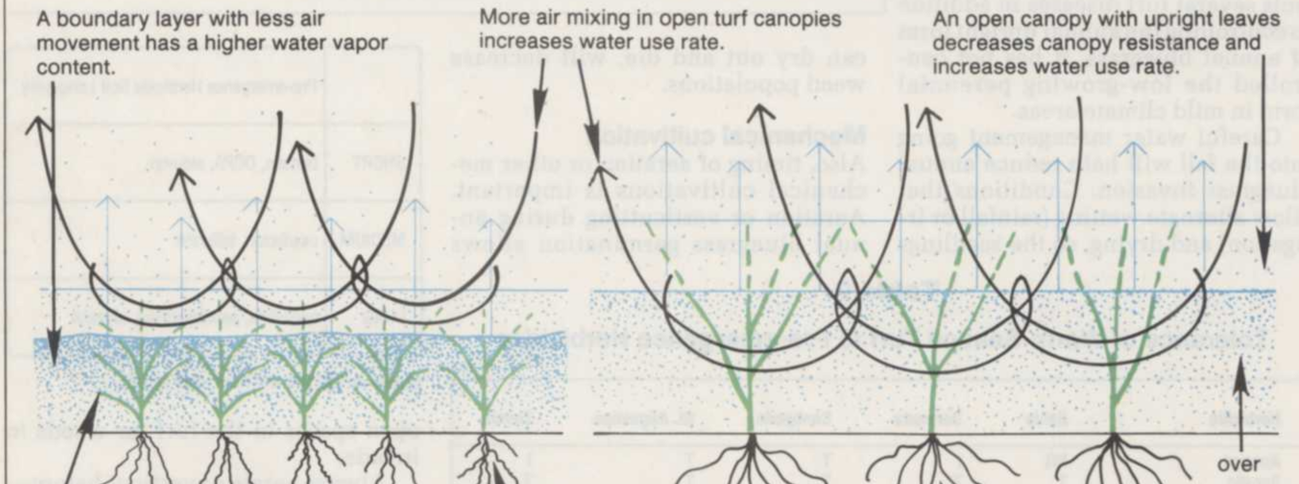
A RELATIVE COMPARISON BETWEEN TURFGRASS GROWTH AND WATER USE



Important Note: The intent of the above diagram is to show the relationship between turfgrass growth and water use. It should be understood that a decreased water use rate does not always result in water conservation and a reduced need for irrigation.

THE EFFECT OF MOWING ON TURFGRASS WATER USE RATE AND SUPPLEMENTAL IRRIGATION NEEDS

						IRRIGATION		
	SHOOT DENSITY	CANOPY RESISTANCE	ROOT DEPTH	WILTING TENDENCY	WATER USED BY TURF (WUR)	FREQUENCY	AMOUNT PER IRRIGATION	TOTAL
INCREASED MOWING HEIGHT	−	−	+	−	+	−	+	−
INCREASED MOWING FREQUENCY	+	+	−	+	−	+	−	−
NET EFFECT OF INCREASED MOWING HEIGHT AND FREQUENCY	0	+	+	0	+	−	+	−

Note: 0 = no effect, + = increased effect, and − = decreased effect

taller mowed turf than that associated with creeping red fesue is responsible for reducing the need for supplemental irrigation. The deeper root system is able to extract water from a larger volume of soil compared to a shallower less extensive root system.

In time, research will define lower water use in terms of a reduced need for irrigation. Until then, research results associated only with WUR should not become management policy. Soil and plant systems that use *less water* and *need less irrigation* are key components of a water conservation program.

Mowing

The two major aspects of mowing that influence water use are height and frequency. Grasses mowed at higher cutting heights have a reduced *canopy resistance* and, therefore, use more water than short mowed grass. Mowing frequently and short increases turf density.

Dense turf resists the upward movement of water vapor through the turf canopy. A dense turf with a tight canopy also resists air movement down into the turf canopy.

The net result is less moisture lost from the turf canopy to the atmosphere. This process ultimately reduces turfgrass evapotranspiration (ET). With higher mowed turf the leaf canopy that expands above the mowing height is less dense. This allows for more air mixing that results in higher water use rates.

It is important to note that taller grass transpires more water, but has a more extensive root system that draws water from a larger soil resevoir than shorter grass. Thus, taller grasses avoid soil drought and plant wilt by expanding their roots into soil areas with enough moisture.

In contrast, lower mowing heights result in limited root systems that need more frequent irrigation to supply water to a shallower root system.

Therefore, turf managers interested in reducing irrigation needs should mow frequently at the highest feasible height. These management practices enhance canopy resistance and minimize detrimental rooting responses.

Nutrition

Fertilization is often needed to manipulate turfgrass function. Grass performing well with little help from fertilization is already at maximum water use efficiency with regard to quality. The primary goal of turf fertilization should be an increased shoot density with less emphasis on a darker green color. Turfgrass managers should strive to meet, but not exceed, the nutritional needs of the turf.

Nitrogen is the primary nutrient used to regulate turfgrass density and color. Water use rate increases with increased nitrogen nutrition. This occurs because leaf expansion above the normal mowing height occurs at a much faster rate. Leaves forced into this upper boundary layer lose water at a faster rate because they are in an area of greater air movement and reduced canopy resistance.

It is difficult to determine the level of nitrogen that will result in efficient water use. Many factors such as soil type, organic matter content, turf species and cultivar and use are involved.

In general, the soluble component of a nitrogen fertilizer should not be applied at rates that exceed 1 lb. N/1000 sq. ft. per application. Over-stimulation of growth with nitrogen is easily detected by excessive vertical leaf growth and an increased need for mowing.

Under these conditions, turf will have high WUR, and rooting development will be reduced. In time, excessive leaf growth will demand a greater water supply that cannot be met by the reduced root system. Turf wilt occurs more frequently as this imbalance develops.

What follows is usually a decision by the turf manager to increase the frequency—and sometimes the amount—of irrigation to offset the symptoms of wilt.

In severe situations, excessive irrigation can lead to reduced oxygen levels in the soil. The end to this scenario is usually "wet wilt," which occurs when the plant's demand for water cannot be met even though soil is visibly moist.

In this case, a poor functioning root system resulted from an increased water demand. This increase was, in turn, caused by improper nitrogen fertilization and frequent irrigation. Turf managers interested in conserving water should use the lowest amount of nitrogen that gives the desired turfgrass quality and function.

Potassium and iron are two additional elements that may give the turf

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Chemicals and turf water use

Various chemicals, such as pesticides and plant growth regulators (PGRs), are used in turfgrass management. Since they influence turfgrass growth, leaf area, rooting and canopy resistance, they also influence water use.

Anti-transpirants are not routinely used in turf culture but have received some attention since they have the potential to reduce ET. They reduce water use by inducing stomatal closure or by covering the stomata with a film.

Anti-transpirants may cause a detrimental effect on photosynthesis and evapotranspirational cooling. Manipulation of turfgrass morphology or canopy offers a greater potential for reducing ET than does regulation of stomatal functions by anti-transpirants.

Wetting agents have received limited testing in terms of water conservation. They do offer the advantage of increasing water infiltration rate on compacted soils, thatchy turf and hydrophobic sands.

Moving water into the soil faster may or may not effect ET. But it will make scheduling irrigation easier and reduce the chance for wasteful water runoff. Wetting agents used on steep slopes or mounded areas can reduce the need to over-irrigate or hand water contoured areas to maintain adequate soil moisture.

Pesticides are often needed in higher maintenance situations to provide a specific turfgrass function—generally improved appearance and density. In choosing a pesticide, more attention is given to efficacy. Little attention is given to what effect a product will have on the WUR, and more importantly the need for supplemental irrigation.

Herbicides, insecticides or fungicides are often applied alone or in combination with another. The information concerning the effect of pesticides on the WUR of turfgrass is limited.

At this time, we know that some pre-emergence herbicides cause reduced rooting. In high maintenance situations, reduced rooting may not evoke a visual response in turf appearance, since increased fertility and irrigation offset a decline in turf appearance.

As less water is available for turfgrass, additional injury from some pesticides may occur. Turf managers interested in conserving water

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manager an extra edge in managing turf exposed to drought stress. So far, research conducted in this area has shown improved turf performance under dry conditions, but no reports have documented the potential size for water conservation programs.

Potassium and iron have been reported to increase root growth which may account for their role in reducing wilt and improving drought avoidance. Reduced levels of nitrogen combined with iron can result in turf greening similar to normal rates of nitrogen. The implication here is that applications of iron plus nitrogen, especially in the spring, will result in a lower rate of vertical leaf growth and reduced WUR.

Irrigation

Current irrigation practices have probably evolved partly as a result of the equipment available for irrigation rather than a complete understanding of turfgrass water needs. Manual sprinkler systems, such as quick couplers, moveable pipe and traveling sprinklers required a lot of labor for a single irrigation. With these systems, it was desirable to provide as much water as possible during a single irri-

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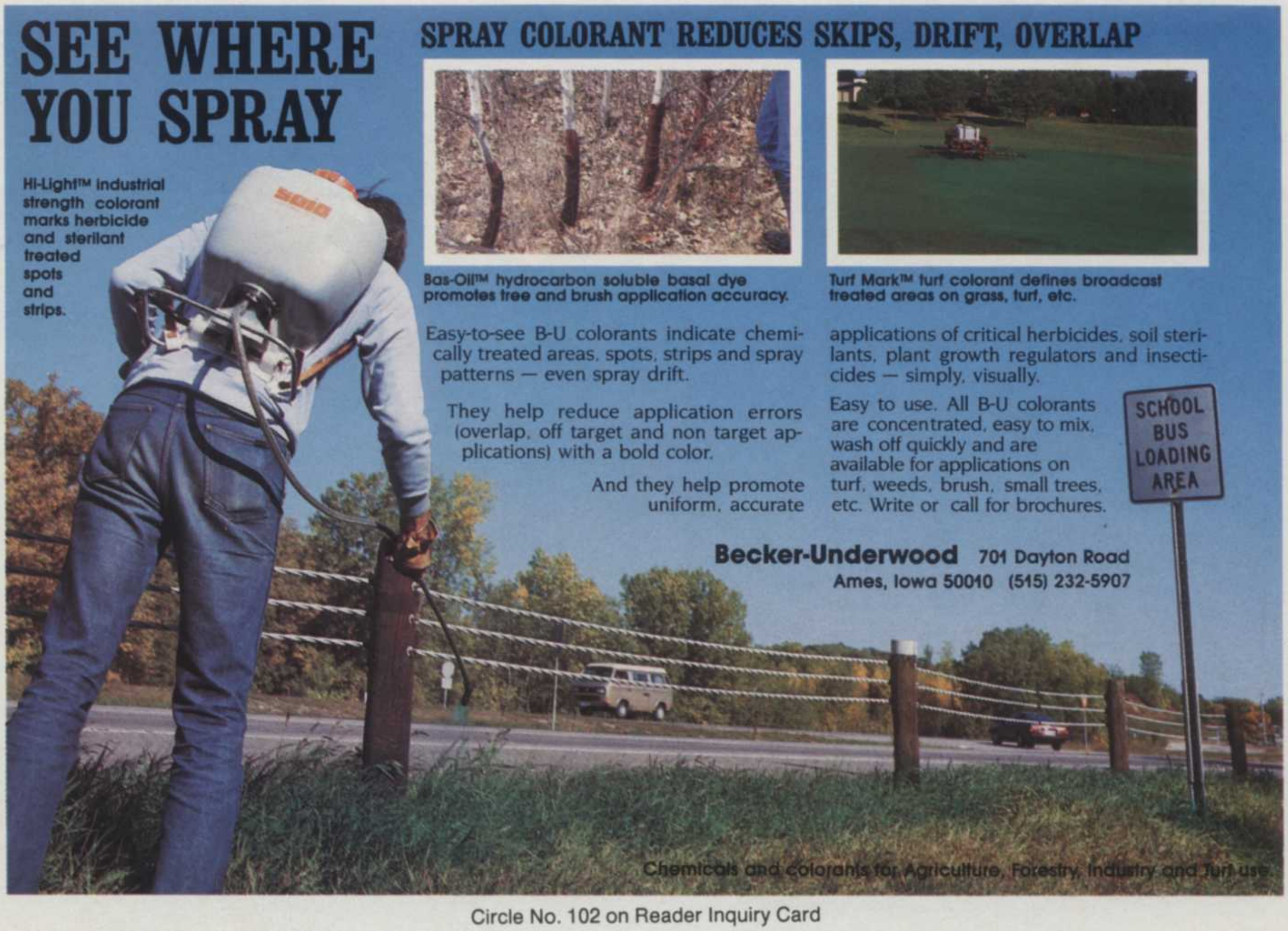

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should avoid pesticides that have a history of causing slight phytotoxicity, reduced root growth or both. With or without visual symptoms of phytotoxicity some turfgrasses may be stunted by pesticides.

This can alter the turf canopy by making it more resistant to water loss. Turf leaves are less likely to expand into the upper boundary layer where air movement and water loss occurs more rapidly.

Thus, pesticides that reduce growth may also reduce water use. But the net result of reducing the need for irrigation may be negligible, especially where root systems are decreased.

Some chemicals are selective herbicides at one rate and plant growth regulators at another. Chlorflurenol is now used as a broadleaf herbicide, but was previously used as a plant growth regulator.

Plant growth regulators are used to reduce the need for mowing and to inhibit seed head development. Since they influence plant height and leaf extension rate, they also influence canopy resistance and transpiration rate.

A 30 percent reduction in turfgrass evapotranspiration has been reported with products such as EL-500, PP-333 and Embark. Some experimental PGRs have shown improved summer performance during periods of solid drought. It is possible that spring-applied PGRs cause a reduced growth rate that conserves soil moisture and also provides a better carbohydrate balance for summer growth.

Whatever the cause, PGRs offer a promising area of research to investigate turfgrass water conservation and improved summer performance. At this time, some caution should be used when water conservation is your main goal. It is likely that some PGRs will cause reduced root growth associated with less leaf growth.This may impair any drought avoidance mechanism inherent in a grass species. Also, some PGRs cause a flush of growth after the chemical wears off.

This additional growth may rapidly deplete stored soil water and negate any overall water conservation during the summer. It appears that PGRs which do not reduce root growth or cause a flush of growth may offer a means of water conservation.

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gation. That reduced the number of times irrigation was needed. Water application by this method is very similar to the standard recommendation: irrigate as deeply and infrequently as possible to promote an extensive root system.

This recommendation is ambiguous, since it does not provide a basis for actual amount or frequency of water application.

The main purpose for irrigating deep (to the bottom of the effective root zone) and infrequently is to develop an extensive root system that continually expands into regions of available soil moisture. This prepares the plant to avoid soil drought.

The main disadvantage of irrigating too frequently has been cited as a shallow root system that becomes dependent on continued frequent irrigation.

Research in Colorado has indicated that turf appearance was best when water lost by ET was supplied by irrigation every two days. In fact, Kentucky bluegrass maintained an acceptable turf quality with 25 percent less water by irrigating every two days compared to 4.7 and 14 days.

This may sound like a contradic-

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tion to the accepted practice of deep and infrequent irrigation. But it instead should serve as a way to define what actual frequency of irrigation and amount of water are needed to provide a desired level of turf quality.

Another statement that often makes frequent irrigation unattractive as a possible water conservation technique is that WUR increases as irrigation frequency increases. This undisputed statement has been clearly documented by research.

These results have only observed water use as related to irrigation frequency rather than the water needed to provide the desired turf quality and function. Turfgrass managers should be more concerned with the amount of additional water that is needed by irrigation rather than the amount lost to the atmosphere. In many situations, turfgrass can perform quite well when water supplied by irrigation is less than the maximum WUR.

The advantages and disadvantages of irrigation frequency have been discussed. But no one fixed irrigation interval is better for plant growth or more efficient for water conservation than another.

Ideally, the interval between irrigation and amount of water applied at each irrigation should be ever changing. ET rates, rooting depth and even turf function are dynamic and change on a monthly, weekly and daily basis.

In semi-arid regions of the country, very light rains may occasionally occur. These rains of only a few 100ths of an inch are not likely to make a significant change in soil moisture. Irrigating during or immediately after these light showers will add to the efficiency of a rain; the added irrigation will increase soil moisture.

Cloudy, cool conditions associated with occasional summer rains in semi-arid climates are also an efficient time to irrigate. At that time, the evaporative demand is lower than normal conditions which promote high ET.

Turf managers with labor intensive irrigation systems will have fewer options available for saving water by precise irrigation scheduling. Automatic systems programmed for site-specific irrigation can more efficiently play the odds of rainfall by irrigating more frequently with less water.

In addition to advanced irrigation systems, instruments and techniques exist that can help the turf manager interpret the need for irrigation.

Electronic moisture sensing devices, tensiomenters, Class A pan evaporation or combinations of these have been used to reduce water application by as much as 89 percent over conventional methods of scheduling irrigation.

Turfgrass managers should consult their local cooperative extension service and conduct on-site experimentation to determine if these techniques can help in water conservation programs.

Soil cultivation

Turfgrasses exposed to traffic often decline in growth because of soil compaction. Compacted soils are dense and poorly drained, resulting in less oxygen for root and shoot growth.

Reduced shoot and root growth are responsible for a lower water use rate. Soil coring and aerification will improve the quality of turf on compacted sites and also increase the water use rate. Even though core aerification increases water use, its advantages on compacted sites reduce the need for additional irrigation and enhance turfgrass drought avoidance.

Core cultivation should be avoided during hot, dry conditions. Excessive drying may increase the need for supplemental irrigation under these conditions. **LM**