Turfgrass Irrigation

Circular 660

Bernd Leinauer and Dan Smeal[1]

Cooperative Extension Service • College of Agricultural, Consumer and Environmental Sciences

INTRODUCTION

Natural precipitation in New Mexico averages between 6 and 14 inches per year, and most plants used in the urban landscape have water requirements that exceed these rainfall amounts. Consequently, additional irrigation, particularly during the summer, is necessary to sustain a landscape in urban areas. Landscape areas are very rarely planted with a single species and instead utilize turf, trees, and other perennial landscape plants (Figure 1).

Water use data from cities in the Southwest show that 50% or more of domestic summer water use goes to outdoor watering. Turfgrasses can make up a large portion of our landscape and are generally identified as high-water-use ground covers. Based on this assessment, conventional wisdom would suggest that removing traditional grasses (such as Kentucky bluegrass, perennial ryegrass, or tall fescue) and replacing them with grasses that are considered low-water-use (buffalograss, blue grama, bermudagrass) or, better yet, removing grasses altogether, would conserve large amounts of potable water that could be put to much better uses. However, green space that includes turf areas provides many more benefits to urban life than aesthetics alone. These benefits include mitigation of heat island effects, erosion control, shade, a cool and safe surface for all sorts of exercise and athletic activities, and space for outdoor gatherings of friends, families, and neighborhoods (Figure 2).

For these reasons, grasses should be selected based not only on perceived water use but also on the purpose of the area. Nonetheless, many cities in the Southwest have started programs to remove turf and associated irrigation systems to conserve water without considering the effect this will have on the adjacent plants. Trees growing with turf, for example, have sustained severe drought damage or death three to five years after turf (and associated irrigation systems) has been removed. This shows that a good portion of the perceived high water use of the grass went to the trees and not the turf. However, over-irrigation of turf areas does occur and should be addressed and corrected. The purpose of this publication is to describe and outline proper irrigation of turfgrasses to help homeowners and turfgrass managers minimize water losses.

The goal of effective turfgrass irrigation is to provide the minimum amount of water required to obtain acceptable turf appearance or quality.

Figure 1. **Mesic (moderate moisture level) landscape with trees surrounding a large turf area.**

---

[1] Respectively, Extension Turfgrass Specialist, Department of Extension Plant Sciences; and College Professor, Agricultural Science Center at Farmington, both of New Mexico State University.

Figure 2. **Public park area with turf and trees.**

Under-irrigation results in water stress and a reduction in turf quality, and can also stimulate the growth of certain diseases and insect infestations. Over-irrigation not only wastes water but can reduce the effectiveness of fertilizers and pesticides, and, like under-irrigation, can stimulate the growth of certain diseases, weeds, and insects. Overall, improving an irrigation system's efficiency can help conserve water by reducing unnecessary losses due to wind drift, surface runoff, deep percolation, and evaporation from standing water when application rates do not match infiltration rates or the soil water-holding capacity. In order to irrigate efficiently, knowledge is required about the grass being grown, its water requirements, the type of soil at the site, and the irrigation system being used.

TURFGRASS SELECTION

Turfgrasses can be divided into two groups, cool-season and warm-season grasses. Cool-season grasses (Kentucky bluegrass, perennial ryegrass, tall fescue) are more cold-tolerant (hence the name) and exhibit a longer growing season in the Southwest than warm-season grasses (bermudagrass, blue grama, buffalograss, zoysiagrass). Historically, cool-season grasses have been the grass of choice in almost all of New Mexico. Our summers are dry and hot, but winters are cold and can also be dry. In our climate, it is generally easier to maintain cold-tolerant plants in the summer than drought-tolerant but cold-sensitive plants in the winter. Therefore, cold tolerance is usually the first desirable characteristic when selecting perennial plants, whether it is turfgrasses or bushes and trees. Moreover, many of our turfgrass areas must survive and recover from all sorts of abuse that we inflict. Very few plants besides turfgrasses can withstand the beating furnished by such activities as baseball, football, or soccer, and running children and/or dogs. It is therefore no surprise that we routinely select Kentucky bluegrass, perennial ryegrass, and tall fescue as grasses for our lawns since they are the only ones that combine traffic tolerance with cold tolerance and also offer a dark green and uniform appearance that is aesthetically pleasing for many of us during most of the year.

Warm-season grasses have a lower irrigation requirement because they use water more efficiently and have a shorter growing season. When selecting plants for water conservation, a decision must be made about the importance of aesthetics and function. Is a green, playable surface that withstands traffic almost year round required, or do you simply need a landscape with ground cover where color or lack thereof is not as important? If traffic tolerance is not an issue but water conservation is important, there are options available. Buffalograss and blue grama are native grasses that have a cold tolerance that makes them applicable to all of New Mexico. These grasses will withstand mowing heights of 3 to 4 inches or can be left unmowed as ornamental grasses. Unfortunately, they can be used only for areas that receive little or no traffic where the main purpose is to contribute to the aesthetics of a landscape. Bermudagrass or zoysiagrass are warm-season grasses that exhibit an active growing period similar to buffalograss or blue grama but are more traffic-tolerant and can therefore be used on areas that receive a significant amount of foot traffic. On the other hand, traditional cool-season grasses tolerate traffic well and stay green in many parts of New Mexico almost year round (Figure 3) but require more water.

WATER REQUIREMENT

Water Use and Evapotranspiration

The water requirement of a turfgrass stand is the sum total of 1) the amount of water required for growth and other processes in a plant's metabolism, 2) the

Table 1. Summer Mean Evapotranspiration (ET) Rates of Different Turf Species in Inches Per Week and Inches Per Day*

Cool-season grasses	Warm-season grasses	in./wk	in./day
Tall fescue		2.0 – 3.5	0.28 – 0.50
Perennial ryegrass		1.8 – 3.1	0.26 – 0.44
	Seashore paspalum	1.7 – 2.2	0.24 – 0.32
	Blue grama	1.6	0.22
	Buffalograss	1.5 – 2.0	0.21 – 0.29
	Bermudagrass	1.0 – 2.2	0.16 – 0.34
	Zoysiagrass	1.3 – 2.1	0.19 – 0.30
Kentucky bluegrass		1.1 – 1.8	0.16 – 0.26

* Data compiled from several authors.

amount lost through transpiration from the leaves and stems, and 3) the amount lost through evaporation from the soil surface. With only 1 to 3% of the water taken up by the turfgrass plant used in the metabolic process, the total sum of the losses from evaporation and transpiration (referred to as evapotranspiration or ET) provides an accurate measure of irrigation water requirements. Turfgrass ET depends on climatic conditions, water availability, cultural regimes (e.g., mowing height, fertility), and species and cultivars selected. Evapotranspiration can be measured directly from a plant stand or estimated indirectly from climatic parameters provided by a weather station.

Comparing literature values of ET or water use rates from several turfgrass species reveals interesting results: buffalograss can exhibit an ET rate equal to or higher than Kentucky bluegrass (Table 1). This indicates that water use rates of grasses in moist or wet soil are not only determined by genetic predisposition but also by the moisture availability in the rootzone. If soil water is abundantly available, plants will take up more water than under limiting moisture conditions (luxury consumption). As such, the proper question is not how much water do turfgrasses use, but with how little water can they survive and still meet desired quality expectations? All turfgrasses, including Kentucky bluegrasses and tall fescue, can survive with less than 100% ET (100% of irrigation amounts listed in Table 1) using physiological mechanisms that allow plants to adapt to drought. Irrigating below 100% ET replacement is called deficit irrigation and can be used as a practice to conserve irrigation water.

Figure 3. **Warm- (tan colored) and cool-season (green) turfgrasses in March.**

The average daily ET for cool-season and warm-season turfgrasses measured at NMSU's Agricultural Science Center at Farmington during six years of a variable irrigation study are shown in Figure 4. These ET values were derived from soil water balance studies whereby ET for a given period was calculated to be equal to the irrigation applied, plus precipitation, plus or minus the change in soil moisture within each period at the minimum irrigation level where the turf exhibited acceptable quality. Average annual water use over the six-year period totaled 38 inches for cool-season turf (Kentucky bluegrass and tall fescue) and 24 inches for warm-season turf (bermudagrass and buffalograss). In general, cool-season turf uses more water than warm-season turf to maintain an acceptable quality and appearance because it has a longer active growing season and because its average daily water requirement (or ET) during the summer is between 15 and 20% greater than that of warm-season turf (Figure 4, Tables 2 and 3).

While Figure 4 can be used directly to help schedule irrigations of turfgrasses growing near Farmington or other northern New Mexico locations with similar climatic conditions and growing season lengths, it does not accurately reflect turfgrass ET at sites in central or southern New Mexico where weather conditions differ and growing seasons are longer. However, by correlating measured

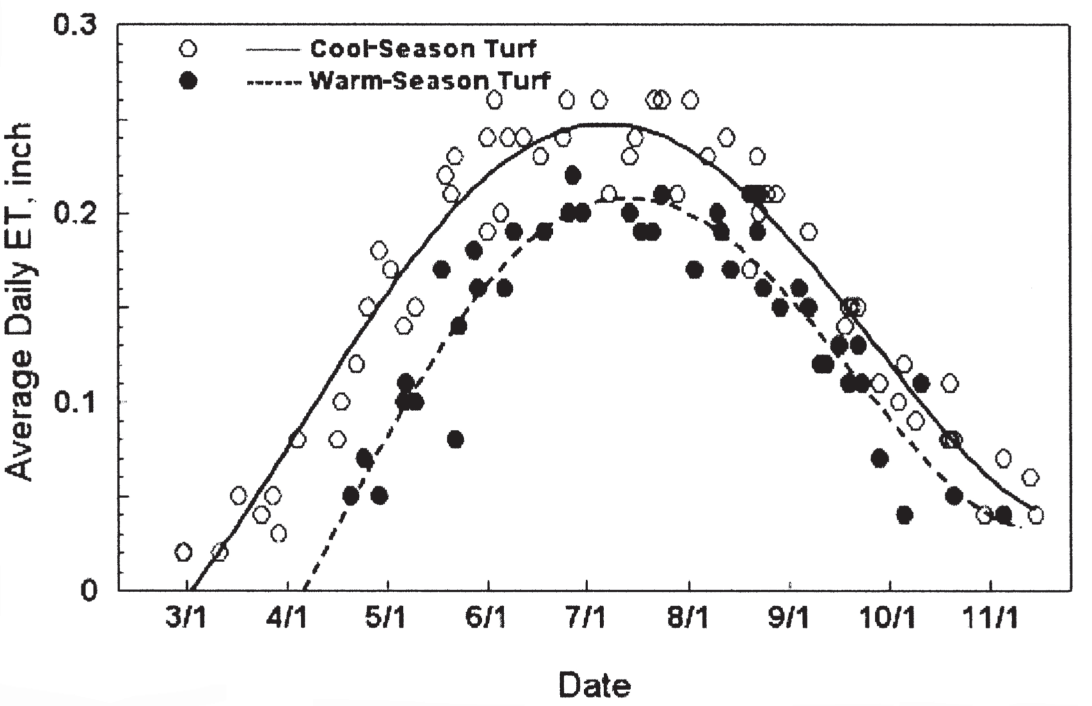

***Figure 4*. Average daily water use (ET) of cool-season and warm-season turfgrass at NMSU's Agricultural Science Center at Farmington during six years of study.**

ET with ET derived from climate parameters (reference ET or ET$_o$), the Farmington data were used to formulate a correction factor or crop coefficient (K$_c$) that can be used to estimate turf ET at other sites in New Mexico where accurate weather data are available. The NMSU Climate Center (http://weather.nmsu.edu/) maintains several weather stations that collect data required to calculate reference ET. By using the K$_c$ with these data, along with a time scale to account for differences in growing season lengths between sites, ET estimates were formulated for sites in central and southern New Mexico (Tables 2 and 3).

Drought Resistance

If turf areas are irrigated significantly below ET replacement levels, the stand will lose color, turn brown, and lose aesthetic appeal. Therefore, the amount necessary to irrigate turf areas is determined by the desired aesthetics or visual appearance and whether or not recuperative ability is required. Turf areas that are heavily trafficked, such as athletic fields, parks, or home lawns, may require higher irrigation amounts than listed in the tables because of necessary regrowth of turf in worn-out areas. Nonetheless, nearly all turfgrasses will survive short periods of drought stress in times of water shortages when municipalities impose watering restrictions and adjustments have to be made to irrigate even less than the numbers listed in the tables. However, these periods of drought need to be followed by periods of recovery during which the turf is adequately watered either from precipitation or irrigation. Both buffalograss and Kentucky bluegrass have shown good recovery from long drought periods when compared to other warm- or cool-season grasses. If turf is exposed to a permanent and severe chronic drought, the plants may die out and the area will have to be re-established.

THE ROOTZONE

Soil Types and Soil Moisture Relationships

In order to irrigate efficiently, knowledge about the soil type that makes up the turfgrass' rootzone is necessary. The properties of the soil along with the turf's ET and the irrigation system's precipitation

Table 2. Estimates of Average Daily ET Rates (inches) of Cool-Season Turf During a Typical Year at Three New Mexico Sites Based on a Consumptive-Use Model Developed at Farmington

Time Period	Farmington	Tucumcari	Albuquerque‡	Las Cruces
1/1 – 1/15	0	0	0.01	0.01
1/16 – 1/31	0	0	0.01	0.02
2/1 – 2/15	0	0.03	0.02	0.03
2/16 – 2/28	0	0.04	0.03	0.05
3/1 – 3/15	0.02	0.07	0.05	0.07
3/16 – 3/31	0.04	0.09	0.08	0.12
4/1 – 4/15	0.07	0.13	0.12	0.16
4/16 – 4/30	0.11	0.18	0.16	0.20
5/1 – 5/15	0.14	0.20	0.19	0.23
5/16 – 5/31	0.19	0.24	0.22	0.24
6/1 – 6/15	0.23	0.29	0.25	0.27
6/16 – 6/30	0.26	0.27	0.26	0.26
7/1 – 7/15	0.25	0.26	0.25	0.25
7/16 – 7/31	0.24	0.30	0.24	0.24
8/1 – 8/15	0.21	0.28	0.22	0.22
8/16 – 8/31	0.19	0.25	0.20	0.20
9/1 – 9/15	0.16	0.23	0.17	0.17
9/16 – 9/30	0.14	0.21	0.16	0.17
10/1 – 10/15	0.11	0.16	0.13	0.14
10/16 – 10/31	0.09	0.15	0.11	0.12
11/1 – 11/15	0.07	0.14	0.09	0.11
11/16 – 11/30	0	0.10	0.05	0.09
12/1 – 12/15	0	0	0.02	0.04
12/16 – 12/31	0	0	0.01	0.01
Total	**38.5**	**55.1**	**45.8**	**53.1**

‡ Reliable multi-year weather data for Albuquerque were not available. Therefore, ET for Albuquerque is presented as an average between Las Cruces and Farmington.

Table 3. Estimates of Average Daily ET Rates (inches) of Warm-Season Turf During a Typical Year at Three New Mexico Sites Based on a Consumptive-Use Model Developed at Farmington

Time Period	Farmington	Tucumcari	Albuquerque‡	Las Cruces
3/16 – 3/31	0	0	0	0
4/1 – 4/15	0	0	0.06	0.11
4/16 – 4/30	0	0.12	0.07	0.14
5/1 – 5/15	0.08	0.15	0.13	0.18
5/16 – 5/31	0.12	0.19	0.16	0.20
6/1 – 6/15	0.17	0.24	0.20	0.22
6/16 – 6/30	0.21	0.22	0.21	0.21
7/1 – 7/15	0.21	0.21	0.22	0.22
7/16 – 7/31	0.19	0.21	0.20	0.20
8/1 – 8/15	0.16	0.20	0.17	0.17
8/16 – 8/31	0.15	0.17	0.15	0.15
9/1 – 9/15	0.12	0.15	0.13	0.13
9/16 – 9/30	0.10	0.14	0.11	0.12
10/1 – 10/15	0.08	0.10	0.09	0.10
10/16 – 10/31	0	0.10	0.05	0.09
11/1 – 11/15	0	0.14	0.06	0.11
11/16 – 11/30	0	0.10	0.05	0.09
12/1 – 12/15	0	0	0	0
Total	**24.4**	**33.7**	**29.25**	**34.1**

‡ Reliable multi-year weather data for Albuquerque were not available. Therefore, ET for Albuquerque is presented as an average between Las Cruces and Farmington.

Table 4. General Soil Water Properties and Management Allowable Depletion in Various Soil Textures

Soil Texture	Plant Available Water (inches/foot)	Infiltration Rate (inches/hour)	Management Allowable Depletion (%)
Clay	1.5	0.12	30
Silty Clay	1.9	0.18	40
Clay Loam	2.4	0.25	40
Silty Clay Loam	2.4	0.25	50
Sandy Clay Loam	1.8	0.20	50
Sandy Clay	1.9	0.12	50
Silt	2.0	0.40	50
Silty Loam	2.4	0.43	50
Loam	2.0	0.54	50
Sandy Loam	1.4	0.75	50
Loamy Sand	0.8	0.88	50
Fine Sand	0.7	1.25	60

rate will determine how long and how frequently a turf area should be watered. Water movement into the rootzone (infiltration rate), movement through the soil profile (percolation rate), and the amount of water that a soil profile can store (porosity) are determined by the size of particles that make up the soil. These soil particles are classified into three groups according to their size or diameter: clay, silt, and sand. The smallest are clay particles (diameters of less than 0.002 mm), followed by silt particles (diameters between 0.002 mm and 0.05 mm), and then sand particles (diameters 0.05 mm and greater). Sand particles are further divided into coarse, medium, and fine. Soils very rarely consist of particles from only one class and are usually mixtures of two or all three particle classes. Therefore, soil textures are classified by the fractions of each class, and classifications are named for the primary constituent (e.g., sandy clay or silty clay). A fourth term, loam, is used for a roughly equal concentration of sand, silt, and clay, and results in even more classifications (e.g., clay loam or silt loam).

Generally, soils comprised of predominately smaller soil particles hold more water than soils having larger particles (Table 4). Conversely, sandy rootzones drain faster than clayey or silty soils because of higher infiltration and percolation rates. Consequently, more water can be applied to a clay soil than a sandy soil and time intervals between irrigation events can be longer with finer-textured than coarser-textured soils. However, because water infiltrates slowly into clayey, loamy, and silty rootzones, these soils may have to be irrigated multiple times with short run times to allow the water to infiltrate into the rootzone to prevent excessive water runoff that might occur with a single, extended run time. If irrigation is applied in larger amounts and faster than water can infiltrate, unnecessary puddling and runoff will occur.

When irrigation is applied from above ground, the uppermost portion of the rootzone becomes saturated first and water then percolates downward through the rootzone. When water application ceases, this downward movement of water into the soil profile will continue until equilibrium is reached and downward soil water movement eventually stops. This stable state is called field capacity. Theoretically, if 1.5 inches of water are applied to a dry sandy loam with a field capacity of 1.5 inches/foot, the applied water would only fill the top foot and not drain below that depth. If only 0.75 inch of water was applied to the same soil, it would theoretically fill only the top 6 inches of the soil profile.

Compaction and Layering

If the soil profile is uniform, infiltration rates are constant over the entire depth and can be used as a measure for irrigation scheduling. However, compaction, layering of different soil types, or organic matter accumulation (thatch) can all interfere with water movement since water does not move freely through a layered profile. For example, incorporating organic materials such as peat or compost uniformly into a rootzone 4 to 8 inches deep prior to turf establishment can be beneficial and helpful in nutrient and water retention. However, if the same compost is applied onto the turf surface after establishment it will eventually end up within the rootzone as a layer and interfere with water percolation and deep rooting.

Management Allowable Depletion

Plants can take up water from the rootzone provided the soil moisture level does not drop below a minimal level, also called the permanent wilting point. The amount of water held in the soil between field capacity and the permanent wilting point is referred to as plant available water. Loams and silt loams hold more plant available water than clay soils even though field capacity may be greater in clay soils (Table 4). A higher percentage of the total water held by clay soils is bound to the surface area of the soil particles and is not available for uptake by plant roots. The maximum amount of plant available water (expressed as a percent) that can be removed from the rootzone before stress occurs or visual appearance declines significantly is called maximum (or management) allowable depletion (MAD). Table 4 lists MAD values for different soil types. Warm-season grasses allow for slightly higher MAD than cool-season grasses.

Example 1:

A Kentucky bluegrass/tall fescue mix (cool-season grasses) with a rooting depth of 18 inches is grown on a sandy loam that holds 1.4 inches of water per foot at field capacity. The total soil water available at field capacity over the rootzone depth equals 2.1 inches (1.5 foot root depth x 1.4 inches per foot). Approximately 1.05 inches (50% MAD x 2.1 inches) of water can be lost from the turf stand before irrigation must be applied. Cool-season grasses extract approximately 0.25 inch of water per day in Albuquerque during the summer (Table 2). If 1.05 inches were available in the rootzone (see Table 4), irrigation would only need to be applied every 4 days (1.05 inches / 0.25 inch = 4.2 days) and the amount of water to apply would be 1.0 inch 0.25 inch x 4 days).

THE IRRIGATION SYSTEM

Irrigation can be applied to turf areas in many different ways: flood irrigation, soaker hoses, subsurface drip, a single sprinkler (rotary, whirling-head, stationary, or oscillating) attached to a garden hose, or a pop-up sprinkler system. Despite all the choices available, irrigation from a pop-up sprinkler system has become the accepted practice for irrigating turf areas. Pop-up systems can provide high-quality turf and can also help conserve water if they provide uniform and efficient irrigation. In order to achieve this, a system needs to be designed, installed, and maintained properly. An efficient irrigation system avoids unnecessary losses due to wind drift, surface runoff, deep percolation, and evaporation from standing water, which occurs when application rates do not match infiltration rates or the soil water-holding capacity. To ensure uniform irrigation and water spray patterns that match the shape of the area, equal consideration must be given to the hydraulics (water pressure and flow, pipe sizing) and to sprinkler head configuration (triangular vs. square configuration), spacing (head to head), and nozzle selection. In a rectangular lawn for example, nozzle sizes should be “matched” so that corner sprinklers (which cover a 90° arc) and edge sprinklers (which cover a 180° arc) have flow rates that are 25% and 50%, respectively, of full circle sprinklers (which cover a 360° arc).

Irrigation System Output

In order to efficiently schedule irrigation on turfgrass, the output or precipitation rate of the irrigation system needs to be determined. A precipitation rate is usually expressed in inches per hour and can be determined 1) through a calculation using flow rates and the surface area of the lawn or 2) by means of an irrigation audit.

Calculating Output with Flow Rate and Surface Area

The actual flow rate of an existing irrigation system (or zone) can be measured directly using the home’s water meter, a separate flow meter (if installed), or a bucket and stopwatch. If flow rates are determined with the main water meter, all faucets, valves, or leaks downstream of the meter should be

Figure 5. **Catch can for irrigation audit.**

Figure 6. **Turf area with catch cans for irrigation audit.**

closed and should remain closed while measuring the sprinkler system's output. Potential openings include sinks, showers, toilets, swamp cooler valves, and other outdoor faucets. Check the water meter for a few minutes prior to beginning the measurement to ensure that no water is running (as indicated by a rotating red triangle on most meters). Record the meter reading and open the valve to the irrigation system (or zone). Run the system for a measured time period (e.g., 15 minutes) and then take another meter reading. Divide the number of gallons used by the number of minutes to derive the flow rate in gallons per minute (gpm).

The same information can be determined from a separate totalizing flow meter installed just downstream of your irrigation system's valve, pump outlet, etc. The flow meter method works well for all types of irrigation systems including sprinklers attached to a single hose, sub-surface drip systems, or pop-up sprinkler systems.

If a flow meter is not available and irrigation is applied by hose or a single sprinkler, the flow rate can be estimated using a bucket and stopwatch. Place the end of the hose or the sprinkler in a 5-gallon bucket and record the time it takes to fill the bucket (in seconds). To calculate the flow rate in gpm, divide 5 by the number of seconds it took to fill the bucket, then multiply the result by 60.

Alternatively, the system's flow rate can be calculated if the operating pressure and system nozzle sizes are known. A pressure gauge, available from local plumbing or irrigation supply stores, can be attached to a faucet near the sprinkler system valve or to a pipeline or sprinkler within the system. To obtain an average operating pressure for the system, take several pressure measurements from sprinklers closest to, and farthest away from, the system's valve and calculate an average value. A pitot type pressure gauge can also be used to measure the output pressure at individual nozzles of impact and rotor type sprinklers while in operation. The flow rates of impact type sprinklers with circular nozzles can be calculated using the equation:

Figure 7. **Lawn area with drought-stressed center due to lack of uniform irrigation coverage.**

$$FR = 28.62 \times d^2 \times \sqrt{P}$$

Where:

FR = flow rate in gallons per minute (gpm)
d = nozzle diameter in inches
P = operating pressure in pounds per square inch (psi)

With rotor and spray sprinklers, the flow rates at the measured pressure should be available from manufacturer specification catalogs. The total zone flow rate can then be estimated by summing the flow rates of all sprinklers on the zone.

A comparison of the calculated flow rate to the measured flow rate (if available) can sometimes be used to detect underground leaks in the system that may not be recognized otherwise. The average precipitation rate of the system is based on the flow rate and the lawn area covered by the system (or zone) and is calculated with the following equation:

$$PR = (FR \times 96.3)/A$$

Where:

PR = precipitation rate in inches per hour
FR = total flow rate in gpm
A = area being watered in square feet

Determining Output with a Catch Can Test

While the average precipitation rate provides a starting point for scheduling irrigations and is invaluable in calculating irrigation volumes, it does not provide information on a system's efficiency or uniformity. The efficiency, defined as the percentage of water delivered by the system that is beneficially used, is a function of the distribution uniformity of the system and the amount of water lost to evaporation, wind drift, runoff, and deep percolation. A system is considered 100% efficient if all water applied is distributed evenly only over the lawn area, with every drop being used by the grass to sustain growth and quality.

A catch can test is used to measure precipitation rate and to evaluate the distribution uniformity of a system or irrigated zone. To conduct the evaluation, a number of short, straight-sided, flat-bottomed cans (e.g., coffee cans) or containers similar to calibrated rain gauges (Figure 5) are placed in a grid-like pattern within the irrigated area (Figure 6). Some market-available irrigation audit kits include containers that list inches as a graduation on the side of the container. The Irrigation Association recommends a minimum of 24 catch devices per zone be used in a professional audit.

The turf area is irrigated for a recorded length of time, and the water intercepted by each can is measured and recorded. To calculate the average precipitation rate, divide the sum of all can measurements by the number of measurements.

Generally, no sprinkler irrigation system provides 100% uniformity, and each irrigated area consequently exhibits drier and wetter parts. Sections that receive less water than the average may show signs of stress and reduced aesthetic appeal earlier and are more visible than sections that receive irrigation amounts at or above average (Figure 7). Therefore, irrigation is adjusted for the drier parts of the lawn, which results in overwatering the wetter parts somewhat.

In order to determine an appropriate irrigation run time, the mean precipitation rate is multiplied by one of two scheduling coefficients. These coefficients, or run-time multipliers, are called Midpoint Uniformity (MU) and Distribution Uniformity (DU) coefficients. Both coefficients influence the amount of water being applied, and the selection of either one depends on the turf quality desired.

Midpoint Uniformity (MU) is calculated using the mean of the lowest (driest) 50% of the catch cans divided by the mean of all catch cans. The low-quarter distribution uniformity (DU_{lq}) is derived by dividing the mean of the driest 25% of the cans by the mean of all cans.

Example 2:

A catch can test with 24 cans was conducted on a lawn to collect information on the system's precipitation rate and uniformity. The test was run for 30 minutes and the average amount of water measured in all containers was 0.43 inch. The average precipitation rate was then 0.86 inch per hour (0.43/30 x 60). The driest 6 containers (25% or low-quarter) averaged 0.25 inch (0.50 in./hr) and the driest 12 containers (50%) averaged 0.31 inch (0.62 in./hr). The MU and DU_{lq} would be calculated as:

Table 5. Distribution Uniformity Ratings for Pop-Up Sprinkler Systems Used for Turf Irrigation

	Rating				
Sprinkler Type	**Excellent**	**Very Good**	**Good**	**Fair**	**Poor**
Fixed Spray	0.75	0.65	0.55	0.50	0.40
Rotor	0.80	0.70	0.65	0.60	0.50
Impact	0.80	0.70	0.65	0.60	0.50

MU = 0.31 inches / 0.43 inches (or 0.62/0.86)
= 0.72

DU_{lq} = 0.25 inches / 0.43 inches (or 0.50/0.86)
= 0.58

Cool-season turf in Albuquerque during June or July has an ET requirement of 0.25 inches of water per day (Table 2). If the irrigation system were 100% efficient ($DU_{lq} = 1$), total runtime to provide sufficient water to the turf area would be 18 minutes (0.25/0.86 x 60) per day.

Since the DU is not 1, watering for 18 minutes will leave some of the lawn under-irrigated and drought-stressed. A run time of 31 minutes (18 minutes / DU_{lq}) is necessary to irrigate the driest 25% of the lawn adequately. Using MU as a coefficient results in a run time of 25 minutes (18 minutes / MU). Applying MU represents a more conservative approach, which helps conserve irrigation water but can also result in a turf area of a lesser quality.

Low-quarter distribution uniformity is also used to assess and rate irrigation systems. Table 5 lists the rating of selected sprinkler types used in landscape and turf irrigation based on DU_{lq}.

As our example showed, the uniformity of a sprinkler system has a significant impact on the amount of water required to irrigate a landscape. If 50 inches of ET are deemed necessary to maintain a cool-season turf stand, improving the irrigation uniformity from a DU_{lq} of 0.55 (which is considered good for pop-up fixed spray heads) to 0.75 will decrease the total irrigation requirement from 91 inches to 67 inches. Uniformity data summarized from over 6,800 irrigation audits across all types of residential and commercial lawns in Utah, Nevada, Colorado, Arizona, Texas, Oregon, and Florida show an average DU_{lq} of 0.50, regardless of the type of sprinkler head being used (Mecham, 2004). In order to irrigate all areas of a lawn adequately with an irrigation system that has a DU_{lq} of 0.50, the amount of irrigation water is **twice** what the grass plant needs to maintain an adequate quality level.

SUMMARY

- The goal of effective turfgrass irrigation is to provide the minimum amount of water required for acceptable appearance or quality of the turf, thereby avoiding both over- and under-irrigation.
- In order to irrigate efficiently, knowledge is required about the grass being grown, its water requirements, the type of soil at the site, the irrigation system being used, and the system's uniformity.
- In general, warm-season grasses such as bermudagrass, buffalograss, or blue grama require less water than cool-season grasses such as Kentucky bluegrass, perennial ryegrass, or tall fescue. However, depending on the purpose and function of the turf area, grasses should not and cannot be selected solely based on a perceived water-use; traffic tolerance, recuperative ability, and aesthetic appearance should also be considered.
- Improving an irrigation system's uniformity and efficiency can help conserve water by reducing run times without affecting quality and by avoiding unnecessary losses due to wind drift, surface runoff, deep percolation, and evaporation from standing water when application rates do not match infiltration rates or the soil's water-holding capacity.

REFERENCES

Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration: *Guidelines for computing crop water requirements* [Irrigation and Drainage paper No. 56]. Rome: Food and Agriculture Organization of the United Nations.

Cockerham, S., and B. Leinauer. 2011. *Turfgrass water conservation*. Richmond: University of California, Division of Agriculture and Natural Resources.

Hunter Industries Inc. 2010. *Handbook of technical irrigation information* [Online]. Retrieved August 2, 2011, from http://www.hunterindustries.com/Resources/PDFs/Technical/Domestic/LIT194w.pdf

Irrigation Association (Ed.). 2004. *Landscape irrigation auditor training manual*. Falls Church, VA: Author.

Mecham, B. 2004. Using distribution uniformity to evaluate the quality of a sprinkler system [Online]. Retrieved December 22, 2011 from http://irrigation-toolbox.com/ReferenceDocuments/TechnicalPapers/IA/2004/IA04-1120.pdf

New Mexico Climate Center. 2011. NMCC climate station data retrieval system [Online]. Retrieved August 2, 2011, from http://weather.nmsu.edu/cgi-shl/cns/oldformat.pl

---

__Bernd Leinauer__ is a Professor and Extension Turfgrass Specialist in the Department of Extension Plant Sciences. He received his M.S. and Ph.D. degrees in Crop and Soil Science from Hohenheim University in Stuttgart, Germany. His Extension and research program focuses on developing water management strategies for turf areas to reduce the amount of water used for irrigation.

January 2012 **Las Cruces, NM**