WATERIGHT

Evaluating Sprinkler irrigation Uniformity

by
Tim P. Wilson and David F. Zoldoske

CATI Publication #970703

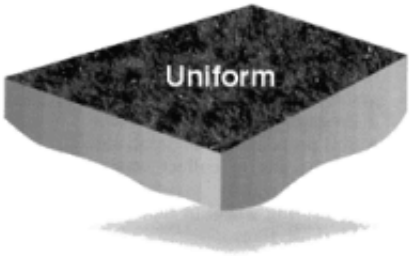
In order to ensure your health, it is important that you have your "vital signs" checked regularly. The basic "check-up" includes measuring your blood pressure, pulse and reflex movement. Based on these observations, doctors can quickly determine if your physical health is deteriorating.

You can and should do the same with your irrigation system. By checking a few "vital signs," you can determine if it is performing at peak efficiency and uniformity. A properly functioning system benefits both you and your plant material. These benefits include:

- Improved soil-moisture uniformity
- Lower water or power bills
- Easier irrigation system scheduling and management
- Reduced runoff and deeper percolation
- Healthier plants and turf grass that are more resistant to pests and disease.

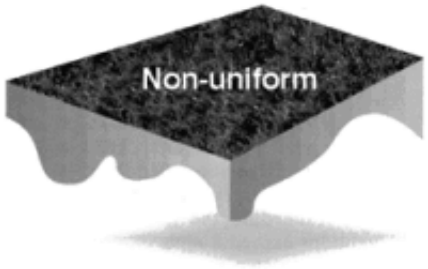
THE IMPORTANCE OF UNIFORMITY

We've used the term "uniformity," but what is it, and why is it important? Simply put, uniformity is how evenly a sprinkler delivers water over the ground (see illustration, at right). This is important to know because uneven or non-uniform systems create areas that are either too wet or too dry. This non-uniformity causes havoc with your irrigation scheduling. If you apply enough water to adequately dampen the dry spots, you'll place too much water on the wet spots. If you manage the wet spots, the dry spots most likely turn to "dead" spots. Both of these scenarios make healthy plants and efficient water use a difficult proposition.



These models illustrate Uniform and non-uniform water depths in soil after irrigation

Quite often we use the terms uniformity and efficiency interchangeably; but, in reality, they each define a different situation. To be more exact, efficiency is the ratio between how much water the plant beneficially uses compared to how much water the irrigation system applies.



Percent efficiency = 100 x water used by the plant / water applied

Uniformity, on the other hand, relates to how evenly you apply water over an area. Equipment selection and the design of the irrigation system affect the uniformity of your irrigation system. This includes sprinkler types, nozzle size, pressure, pipe size, installation and system maintenance.

System design and management are key to efficient irrigation systems. This means to get optimum performance from your irrigation system, you must properly design, maintain and manage it. If you don't optimize any of these variables, you'll reduce system efficiency.

SYSTEM EVALUATION AND INSPECTION

Now that we've established the importance of uniformity, you are ready to follow the step-by-step process to determine the uniformity of your system.

1) Establish a need. Do you have problem areas in your landscape? Do you have dry and wet spots in the same irrigated zones, and are they in a repeating pattern or random? Do you believe your water or energy bills are too high? Is your sprinkler-irrigation system under some type of routine maintenance program?

2) Choose the site(s) for evaluation. Base this on a site with the greatest need, a typical zone or large area. (Steps I and 2 are pre- evaluation procedures and are site specific.)

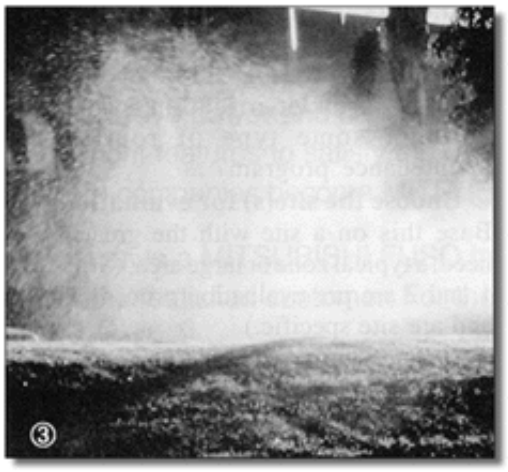
3) Inspect your system. Perform a detailed inspection of your system while it is operating. The following is a list of items to check and correct before you can properly evaluate the irrigation system.

- Broken heads (see photo 1)
- Poorly adjusted heads (see photo 2)
- Heads that are crooked or not plumb
- Plugged or semi-plugged nozzles
- Mismatched heads
- Nozzles that are mismatched to the precipitation rate
- Pressures that are too high or too low (see photo 3)
- Compaction or heavy thatch
- Sunken heads
- Sticky electric valves
- Spray deflection by plants or hardscapes
- Inoperative rain switches or soil-moisture sensors.

These sprinklers have broken heads, therefore creating a lawn fountain and water puddle.

Typically, you can repair the above items at a minimal cost of time and money. You then can observe and correct most of these problems when the irrigation system is operating.

Adjust your sprinkler heads so they water the intended areas and not walls and rocks as shown here.



When the water pressure is too high, the sprinkler produces smaller water drops and the overall uniformity is impacted.

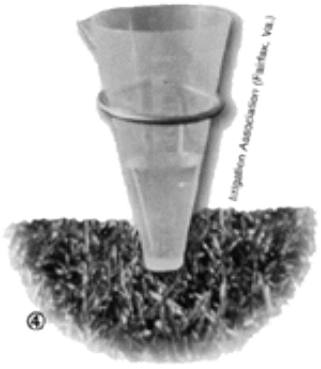
4) Review your schedule. Check your current watering schedule and management techniques. How have you programmed your controller? Are you using a rain switch or soil-moisture sensor? How is the system scheduled guesswork, weather stations, historical ET or the popular "pour on the water until the dry spots are gone" method? Do you modify the schedule for seasonal weather changes?

PERFORMING FIELD TESTS

Once you have fixed all the obvious problems, you are ready to evaluate your irrigation system.

5) Test the system. You will need the following tools to evaluate your system's performance and uniformity:

- Pressure gauge with Pitot tube
- Soil probe, auger or small shovel
- Catch cans to collect water (see photo 4)
- Measuring wheel or tape measure
- Marking flags
- Pencil and note pad
- Watch.



A typical catch can.

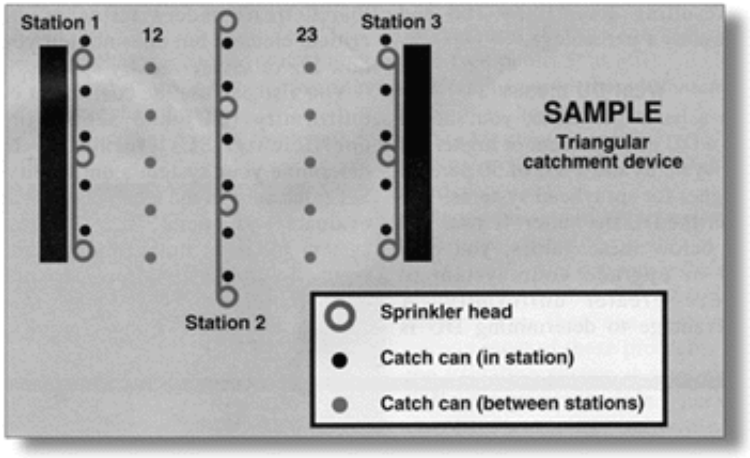
After you select the test site, operate the system for a few minutes so that you can place marking flags near each head in the zone. If you use more than one valve, select a different color flag to mark each zone. Take a moment to make sure everything is working and operating correctly. Also, reschedule the test if wind conditions exceed 8 mph.

Your next step is to measure the nozzle pressure of your rotor sprinkler heads. Insert the Pitot tube directly in the nozzle discharge and record the highest pressure reading. On low-flow nozzles, hold the Pitot tube about 0.125 inch away from the nozzle in the center of the stream. You will want to check pressures at the beginning, middle and end of each zone of sprinklers you test. Also note the sprinkler location. If you are testing a spray-head system, use the adapters to attach a pressure

gauge to a spray head. Follow the same procedure as outlined with the rotor system.

Lay out your catch cans based on your zone's style of head layout either triangular or rectangular. Keep the cans at least I yard from the head to avoid spray deflection by the catch cans. You may want to use low- profile catch cans, especially when testing low-angle sprinklers. A key phrase to help you place your catch can is "at a head and in between heads." (See illustration, page 36). Use cans of the same type and set level. Try not to vary your pattern of layout within the zone. Most irrigation experts recommend 16 to 20 catch cans per tested zone on larger rotor systems.

Before conducting the test, note whether your zone is stand-alone or overlapping. A stand-alone test area receives its water from the operation of only one valve. Additional valves or zones don't contribute to the coverage or test area. This is typical of residential spray-head systems. An overlapping zone is typical of large commercial areas such as a sports field or park where several valves or zones contribute and overlap during operation.



The chart maps out where to place your catch cans in relation to our sprinkler.

Use a soil tube to measure root-zone depth.

Overlapping areas require multiple-valve operation. You'll need to set your cans, run a valve for a set period and operate the overlapping zone for the equivalent or appropriate time. In some rare instances, you may need to operate more than two valves before you can evaluate the test area. Operate the valves as you normally schedule them. That is, if you run the valves sequentially, you should operate them sequentially during the test. Otherwise, it may affect the operating pressure.

Next you want to activate the zone: turn it on for 3 to 10 minutes for sprays and I0 to 30 minutes for rotors. You want an average of about 25 milliliters before shutting off the valve. Alternatively,

you can use cups or small containers, measuring the depth of water with a ruler. Keep track of the runtime in minutes. Collect the data from the catch cans. Sketch a map of the test zone showing the location of the heads and catch cans. Hold each can level and read the volume or measure the water's depth in 0.1-inch increments. Record amounts and locations on the sketch you made after you set out your cans.

During your field work, you also should collect information on head and row spacing, nozzle pressure, soil type and root-zone depth (see photo 5, page 36). By taking a few samples and examining the rooting depth, you can determine whether you need soil amendments or deeper irrigations.

6) Analyze the test results. After you complete your test, you can analyze the results to determine whether your system operates efficiently. The test shows you how evenly your irrigation system distributes water over the area in question. It also points out weak spots you can modify and repair. From the collected data, you can determine your precipitation rate. With the soil and root-zone information, you can develop more accurate watering schedules as well. (For this example, we will only calculate DU measurements.)

7) Calculate DU. Distribution uniformity (DU) emphasizes under- watered areas and is the calculation that irrigation auditors typically use in landscape audits. Its formula is:

Percent DU = Average catch in the low quartile x 100 / Average catch overall

Rank the catch-can readings from low to high. Take the average of the lowest 25 percent of the catch-can readings. (For example, if you use 16 catch cans, take the average of the four lowest readings.) Divide the average lower quartile by the average of all the catch-can readings. Multiply the resulting decimal by 100 and express as a percentage.

WHAT DU MEANS

As a basic guideline, you should have a DU of 70 percent or higher for rotor systems and a DU of 50 percent or higher for spray-head systems. The higher the DU the better. If your DU falls below these values, you may need to upgrade your system to achieve greater uniformity. A disadvantage to determining DU is that it treats under-watering as the critical element but does not tell you how big or severe the dry spot is. You also can use the coefficient of uniformity (CU) and scheduling coefficient (SC) formulas to determine your system's uniformity. Set catch cans in the area you want to evaluate and operate the sprinkler system for a set time. Measure and record the amount of water each catch can collects. Then use that information in the following equations:

CU = 100 x 1 - average deviation / Average catch

One of the limitations of the CU calculation is that it treats under under-watering and over-watering the same.

SC = average catch overall / Average catch in the critical dry area.

The SC allows you to define how big the critical dry area will be and to determine the irrigation run time required to alleviate the dry area. To calculate the SC, use a computer modeling program, such

as Space or Hyper-Space. Because grounds managers normally irrigate to the dry spot, DU and SC are more useful for establishing irrigation schedules. Irrigation auditors have used the DU in audits for many years. However, due to limitations with the DU approach, the SC concept is gaining a large following, particularly in the turf and golf industry.

8) Calculate the precipitation rate. The following calculation will help you determine your system's precipitation rate (perhaps to compare to your soil's infiltration rate):

Precipitation rate (inches/hour) = average can reading (ml) x 3.66 / Test time (minutes) x entrance area tocatch can (square inches)

or

Precipitation rate (inches/hour) = Average depth reading (tenths of inch) / Test time (minutes)/60 minutes

PROCEDURE REVIEW

As a review, remember the steps necessary to evaluate your sprinkler irrigation system. First, select and prioritize your sites. Second, inspect and repair the irrigation system as needed. Finally, conduct the test and analyze the data.

At this point, you can make decisions about how, when and if to make changes to your system. Now you also can calculate more accurately the watering schedules for your site.

If, for example, your system has a high uniformity, then you will spend most of your efforts in perfecting the system's scheduling. If you have a low uniformity, then you must make decisions regarding how much time and money to spend on upgrading the irrigation system. Usually it is an accumulation of minor things that contribute to low uniformity. However, in some cases, only a major redesign of the system will make an appreciable difference.

The single most important aspect of conducting an evaluation of your irrigation system is to look at the system and make sure it is operating properly. By closely evaluating your irrigation systems, you will gain a much clearer picture of its performance. Because you conduct most landscape irrigation under darkness, you may not be aware of any repairs your system might need. Therefore, be sure to maintain your sprinkler- irrigation system at the designed efficiency and uniformity to achieve optimum performance.