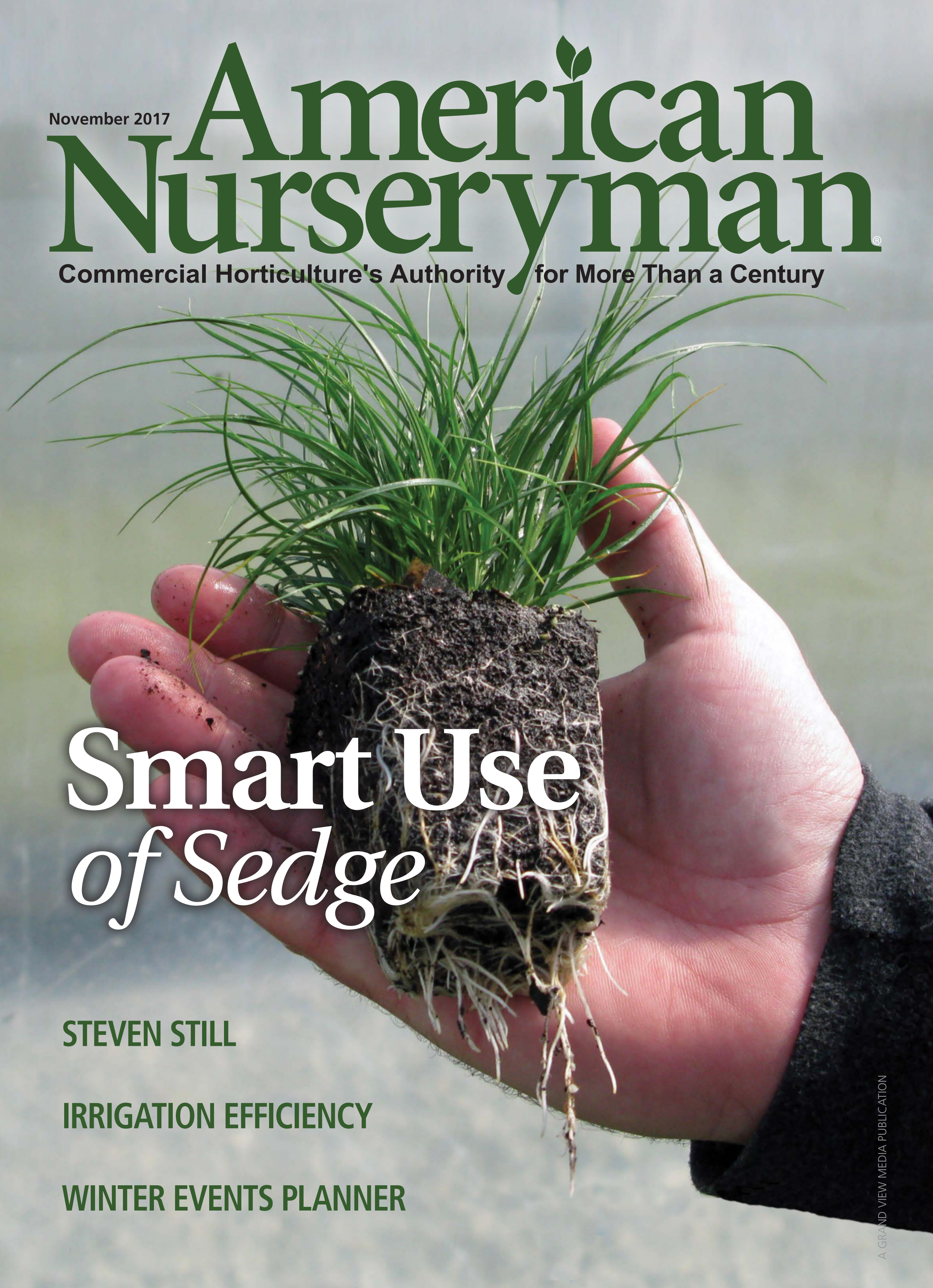

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IRRIGATION EFFICIENCY

WINTER EVENTS PLANNER

A GRAND VIEW MEDIA PUBLICATION

Improving Irrigation Efficiency Reduces Water Use

Whatever the method of irrigation, growers must manage water resources for cost savings as well as resource efficiency. Researchers with the Clean WateR^3 coalition provide real-world solutions to managing irrigation to reduce water use.

By Andrew Ristvey, Lorence R. Oki, Darren L. Haver and Bruno J. L. Pitton

Whether you irrigate by hand, drip, sprayer, rotating sprayer or boom, there are several different procedures that should be used to improve irrigation system efficiency. Irrigation efficiency is a concept that denotes the use of water that minimizes waste. A high level of irrigation application uniformity is essential to maximize irrigation efficiency. Uniformity entails the even and consistent application of water over surfaces like containers or soil. However, even with a high level of uniform distribution, irrigation may be inefficient if excess water is applied. Depending on the application system, whether it is by hand, drip or spray, several strategies to audit irrigation systems are available to an irrigation manager.

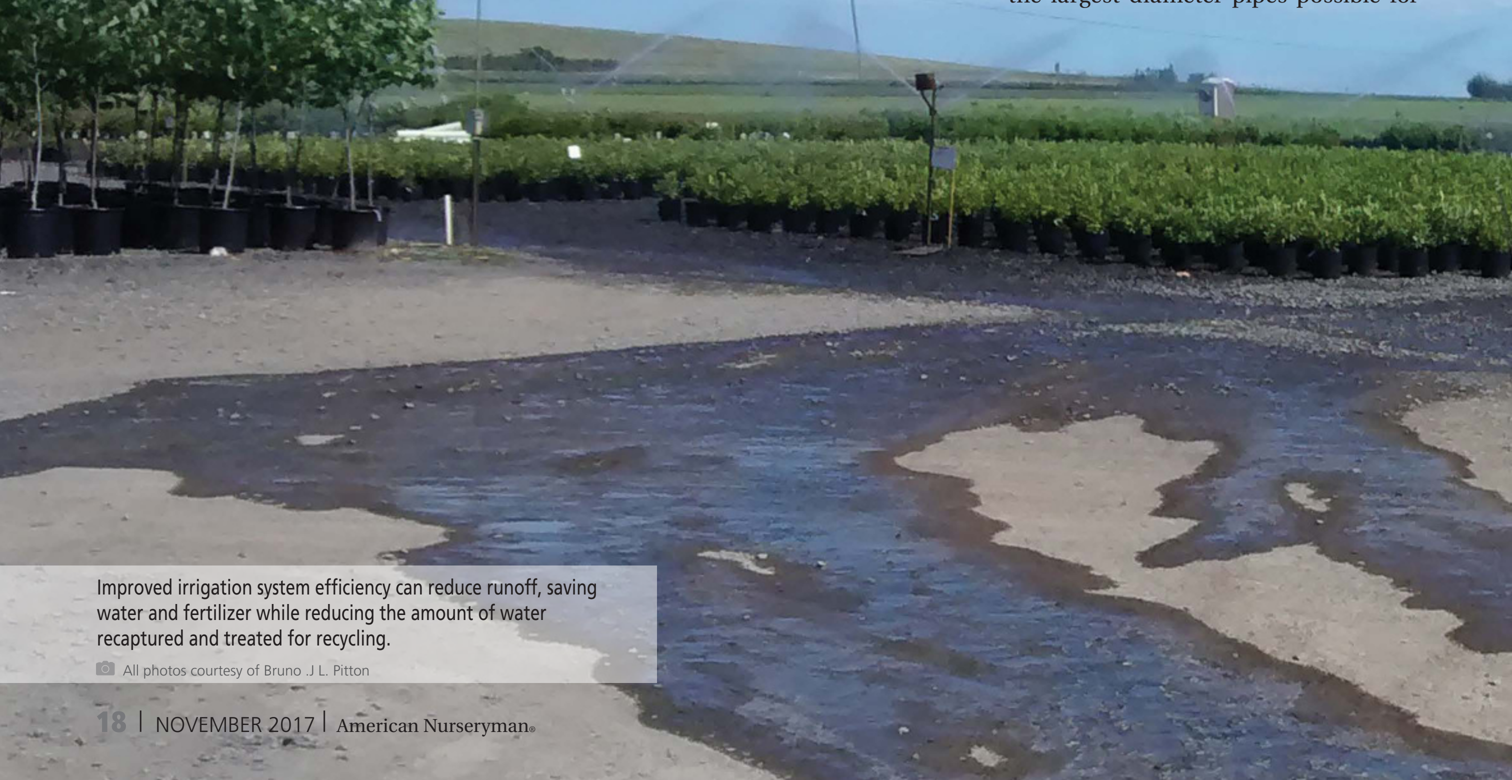
Irrigation managers are faced with efficiently providing plants with water to support growth, while ensuring that all plants receive adequate water. This can be especially challenging during periods of extreme heat. Limitations in system design and efficiency can hamper those efforts, decreasing the availability of water and its potential distribution to plants. These inefficiencies can waste time, decrease profits and create environmental problems. Discussed in this article are aspects of irrigation management to increase water use efficiency, potentially increasing the amount of water available for distribution and decreasing the risk for waste.

Proper design = efficiency

Managing operating pressures is critical for uniform and efficient water application. Designing an efficient system entails having the correct pumps, irrigation lines and emitters that work with specific operating pressures. Properly sized irrigation lines are an important part of maintaining operating pressures from pump to emitter.

Water traveling through irrigation lines experiences pressure loss due to friction. As water moves through pipes, friction against the side walls creates turbulence and causes a drop in pressure. The faster the water travels, the more friction is created against the walls of the pipe, reducing pressure in the lines. Long pipe lengths exacerbate the pressure loss.

Small diameter pipes, with a high side wall surface to cross sectional area ratio, will have a greater negative impact on water pressure than large diameter pipes. By comparison, large diameter pipes have small side wall surface to cross sectional area ratios and water moves at slower velocities, reducing friction. Use the largest diameter pipes possible for



Improved irrigation system efficiency can reduce runoff, saving water and fertilizer while reducing the amount of water recaptured and treated for recycling.

All photos courtesy of Bruno .J L. Pitton the operation (depending on pumping capacity) to reduce pressure loss due to water velocity and friction. As a rule of thumb, select pipe sizes to maintain water velocities in the pipes at less than 5 feet/second. However, for an existing system, the remaining strategies described below will improve the efficiency of water application.

Check operating pressure. Place pressure gauges strategically along the irrigation system: from the pump, along mains and down laterals. If possible, temporarily replace an emitter or sprinkler with a pressure gauge. Take note of pressures while the irrigation system is operating. This will show if pressure loss is an issue.

All emitters, including drip, spray or rotating sprayers, are designed to operate within specific pressure parameters to apply water efficiently and evenly. Higher or lower pressures than those specified by the manufacturers will cause imbalances within the system. Improper pressure at the pump, loss of pressure down the line from friction or old, worn out or clogged emitters, will cause your irrigation uniformity to decrease.

Sprayers operating at lower-than-specified pressures will not distribute water evenly because water droplets will be too large and will not be thrown uniformly. At higher than specified pressures, water droplets become too fine and are subject to wind and evaporation. High pressures actually cause a reduction, not an increase, in the distance water is delivered from a sprinkler. This inconsistency may result in over-application of water for some plants and under-application of water for others. At the correct manufacturer-specified pressure, sprayers will throw water droplets of the correct size, at the proper distance and in the proper pattern, thereby increasing uniformity.

Even if proper operating pressures are achieved, make sure that the emitters, nozzles and sprayers are not worn, clogged or corroded. A brand new, unused sprinkler has a nozzle with an aperture of a specific diameter. In time that aperture may wear or clog, changing the pressure needed to apply a specific volume at a specified distance. An old trick is to have a drill bit of the same diameter of the emitter aperture. Dropping the bit into the aperture may quickly reveal a problem. If the drill bit is very loose in the aperture, replace the nozzle.

When replacing nozzles or sprinklers, make sure to use the correctly sized nozzle and sprinkler. Mixing different nozzles and sprinkler types and sizes in an irrigation zone will reduce application efficiency.

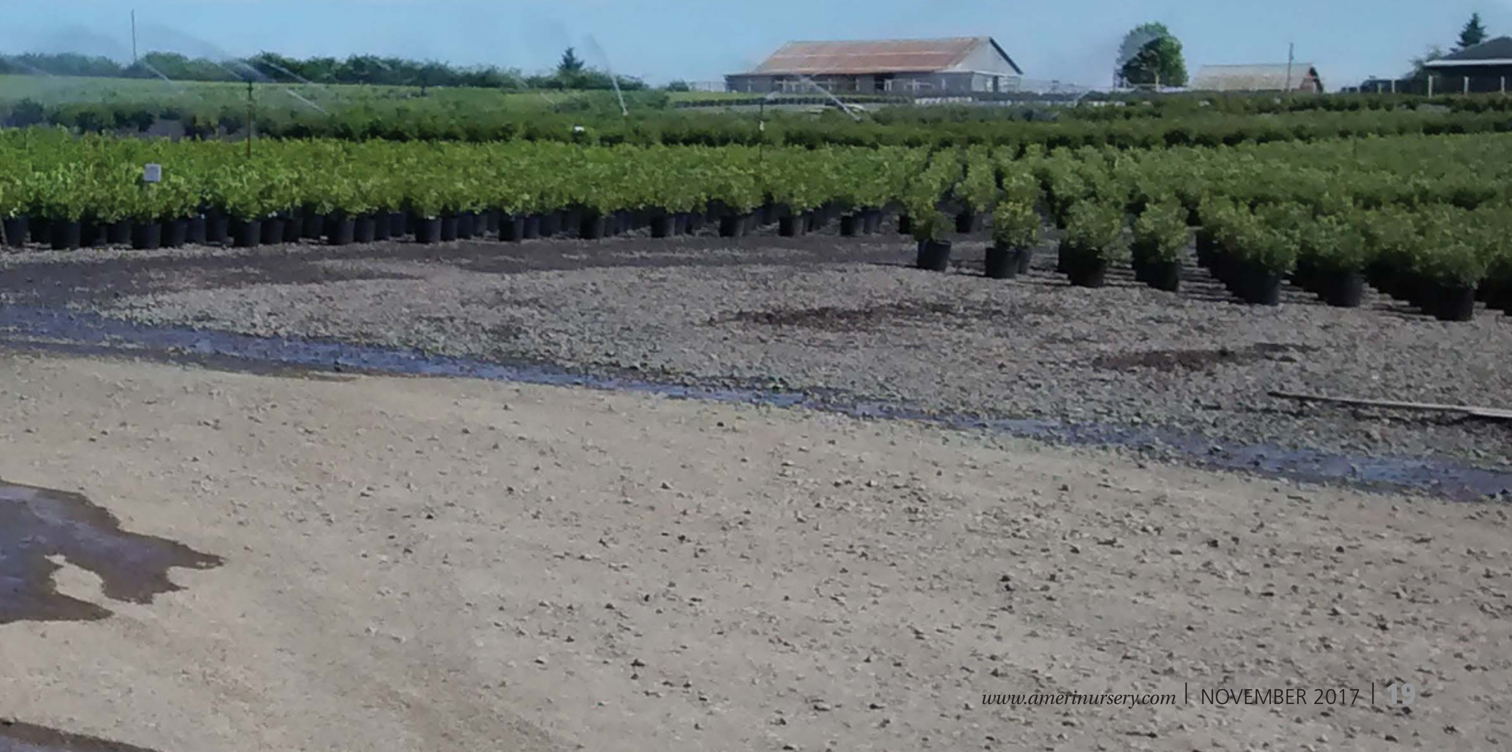
Testing your system

There are two tests that can be performed to determine application uniformity. Both the Lower Quarter Distribution Uniformity Test (DU_{LQ}) and the Christiansen's Uniformity Coefficient (UC) are easy methods to find inefficiencies and correct them.

The DU_{LQ} is a simple test by which "catch cans" or containers are placed strategically around the irrigation block during an irrigation run. Use at least 24 containers placed near sprinklers, halfway in between, and then at other various distances from the sprinklers. Draw a schematic of your test design, numbering each container and mapping where they are placed. Turn the irrigation on for a set amount of time. Collect the water samples, measuring the volume applied in each of the containers. Then, write the volumes down in a list from highest to lowest. Get an average of all the volumes. At the bottom of the list will be the containers with the lowest volumes recorded. Take the lowest 25 percent of the volumes. That is, if you have 24 containers, take the six (25 percent) with the lowest volumes and average those volumes. Divide the average of the lowest volumes by the average of all the volumes. (For further explanation of this calculation, see the sidebar, opposite page.)

For high value container crops, DU_{LQ} values should be greater than 80 percent (90 percent for drip or micro-irrigation), and greater than 70 percent for field crops or landscaping. Uniformities for deep-rooted orchard crops can be as low as 55 percent, as long as chemicals are not injected. Values lower than specified indicate the irrigation system is not functioning as efficiently as it should.

Some plants are being over-irrigated just to provide other plants with



sufficient water since applications are usually managed for the driest plants. Perform this test for each irrigation zone to improve uniformity and reduce over-watering. With the schematic map, problem areas can be found and corrected. And since you have the length of time the valve was on when conducting the test, you can also calculate the precipitation rate (also known as application rate) of the irrigation system. This can then be used to calculate the run time for that valve. There is an Excel spreadsheet available to help you with the DU assessment at: *http://ucanr.edu/sites/UCNFA/files/212297.xlsx*. For further information, the Irrigation Association (*www.irrigation.org*) has resources and guidelines for these audits.

Another uniformity test is the Christiansen's UC. It is an overall examination of the irrigation system. Use the same catch can data from the DU_{LQ}, calculating the overall average, and subtract the average from all the values. Make all the values positive numbers (absolute values). Total these "deviation values" and average them. Follow the formula below.

UC=100 percent × [1 – (Average deviation from the average volume of application / Overall average volume of Application)]

For high-value, shallow rooted or containerized crops, the UC value should be more than 87 percent. For field crops the UC should be higher than 81 percent and for deep rooted orchard crops, the value should be greater than 72 percent.

Controlling hand watering

For hand watering, train employees to irrigate as consistently as possible. Check containers after irrigation to see if the water being applied is thoroughly wetting the substrate in the container. Often, dry root balls are found in a container, even after what seems to be a thorough hand watering. Regardless of application method, try to keep the substrate moist, which may mean several irrigation events a day. This is considered cyclic irrigation, or several short irrigation events, which keeps substrates or soils moist and prevents them from drying to the point of turning hydrophobic (resisting moisture) and being difficult to rewet. A hydrophobic substrate takes more than twice the volume of water for rewetting, most of which channels down the side of the pot or through the substrate, increasing your leaching fraction and wasting fertilizer and water.

Finally, for those applying soluble fertilizers through your irrigation water, be sure that your injector system is working properly and is calibrated. Make sure your fertilizer injector is calibrated, regardless if it is an expensive displacement pump injector or a simple aspirator injector like a Hozon™. Knowing the rate at which fertilizer concentrate is mixed with irrigation water, simply verify that rate by measuring the volume of your irrigation application and the volume being taken up by the injector. The ratio between the two volumes is your rate. If the measured rate is different than what you expected, you'll need to adjust your fertilizer concentrations. For even more precision, use an EC (electrical conductivity) meter to check the total salinity of the irrigation water and compare it to the expected EC.

Above, Dr. Lorence Oki places irrigation catch cans in #5 containers at a CleanWateR^3 cooperator's nursery to measure irrigation system distribution uniformity. Right, the "Aggie Catch Can" designed by researchers at Texas A&M University has volume gradations to make conducting an irrigation uniformity test easier. However, one can use tin cans, plastic cups, or any other standard sized vessel with a graduated cylinder to measure irrigation application volume.

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References

Ross, D. S., 2008. Irrigation System Audits. In: Water and Nutrient Management Learning Modules. J. D. Lea-Cox, D. S. Ross. and C. Zhao. (Eds.). University of Maryland, College Park, Maryland. Published online at *www.waternut.org/moodle/course/view.php?id=26*

Landscape Irrigation Auditor Second Edition. 2011. Irrigation Association. Falls Church, Virginia.

Schwankl, L.J., R.Y. Evans and B. Faber. Irrigation Management Practices. In: Container Nursery Production and Business Management Manual. Publication No. 3540. J.P. Newman (Ed.) University of California. Oakland, California.

Lower Quarter Distribution Uniformity

Example calculating Lower Quarter Distribution Uniformity (DU_{LQ}) using the catch can data below (note that there are only 12 catch cans shown in this example, but you should use at least 24 to capture water samples. Also note that the volumes are in milliliters (mL)).

Step 1. Calculate the average of all of the catch can volumes (Avg_T)
Add up all of the volumes and divide this total (T) by the number of values (n).
$Avg_T = T \div n = 24.5$

Step 2. Rank the catch can volumes from smallest to largest.

Step 3. Select one quarter of the volumes with the smallest values (Lowest ¼).
Since in this example there are 12 volumes, select the smallest 3 values.

Step 4. Calculate the average of these smallest values ($Avg_{LQ} = 16$).

Step 5. Calculate the Distribution Uniformity (DU_{LQ}).
$DU_{LQ} = Avg_{LQ} \div Avg_T = 16 \div 24.5 = 0.65$ or 65%

Catch can volume (mL)	Rank	Lowest ¼
36	11	
28	9	
18	3	18
19	4	
26	8	
33	10	
16	2	16
22	5	
38	12	
22	6	
14	1	14
22	7	
$Avg_T = 24.5$		$AVG_{LQ} = 16$

Irrigation application in container production is typically inefficient because of overhead irrigation and container spacing. This article describes some ways to ensure your irrigation system is operating as efficiently as possible.