# Nursery Workshop and Seminar Series
# North Willamette Research & Extension Center

***Practical Nursery Irrigation Workshop***
***Determining the Application Uniformity of an Irrigation System***

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One way to significantly reduce the gallons of water applied by nursery irrigation systems is to make certain that water is spread evenly across the growing area. A result of poor water application uniformity is uneven soil/media moisture replenishment and is often seen in distinct patterns. Wind speed and direction, water pressure, sprinkler spacing and height, nozzle selection, and slope affects the distribution of water from a permanent set irrigation system.

If your system does not apply water uniformly, then the irrigation duration must be increased to avoid localized dry areas that develop. When too much water is applied, then excessive amounts of will cause water-logging, reduced plant vigor, greater disease problems, and increased runoff. Agricultural chemicals applied through irrigation systems will never be more evenly distributed than the water.

The need to test sprinkler application uniformity cannot be overemphasized. This consists of setting up a grid pattern of catch-cans, operating the system for a period of time under normal conditions, and measuring the volume of water collected in each catch-can.

**Select the Test Area**

Select a site that represents both the irrigation system and the crops being grown. Within a grid or along a line of sprinklers or emitters having the same nozzles operating at the same water pressure and on the same slope, a repeating pattern of water distribution will result. Areas that contain the repeating water-distribution pattern are generally rectangular. Areas along the edges of an irrigation system usually won't represent the water distribution found.

| | |
|---|---|
| Full-circle sprinklers with rectangular or triangular spacing. | Use the spacing between sprinklers along lateral lines and the spacing between laterals. |
| A single line of full-circle sprinklers in a Quonset. | Use the spacing between sprinklers along the line and the house width. |
| Partial-circle sprinklers along the perimeter of a growing area. | Use the spacing between sprinklers along lateral lines and the growing area width. |

**Conduct the Test**

*Tools*

- Catch-cans (plastic cups, 3-1/2" diameter x 2-3/4" height).
- Containers (for miro-sprinklers, one gallon milk jug).
- Tape measure.
- 100ml to 2.0l graduated cylinder.
- Pressure gauge, possibly a Pitot tube for nozzle pressures.
- Stop watch or clock to record start and stop times.
- Pencil and paper.

To begin the test, ensure that the system is ready by checking each sprinkler or emitter for plugging, correct or worn nozzles, improper adjustment, or damage. Install a pressure gauge on one of the laterals near the test area or you may prefer to use a Pitot tube to take pressure readings directly at a sprinkler nozzle. If wind speed is greater than 3 MPH, test results will be different and are often unrepeatable. Several tests are often required to characterize an irrigation system because many factors work separately or in combination to affect how uniformly water is applied. When water pressure or wind speed changes, the water distribution pattern will most likely change.

To test a overhead sprinkler system, set the catch-cans up in a square grid pattern that covers the sample site. As a rule of thumb, the spacing of the catch-cans should be no greater than 10 percent of the sprinkler throw radius. The most common spacing used for uniformity tests is 5 feet by 5 feet but closer spacing is recommended for small areas. You should use at least 30 catch-cans in your test and for large areas use at least 60. Placing a metal washer in the catch-can will help to from tipping over. If you are testing a drip or micro-irrigation system a larger container might be needed. Place micro-sprinklers directly in the container and make sure that all of the water is collected. You can randomly select 16 to 24 emitters that are distributed throughout the field.

Start your test by turning on all necessary valve(s) and record the start time using a stop watch. The duration of a test is generally the duration you would use for your irrigation set. If you shorten this time to conduct more tests, make certain the lowest volume catch-can contains at least 30ml of water. Constantly check that your irrigation system is operating properly during the test and remember to record the water pressure. Stop the test by turning off the valve(s) and record the finish time.

The water in each catch-can or container is measured to the nearest 1.0ml with a graduated cylinder and recorded in a table. If graph paper is used, the location of sprinklers should be included for future reference. Remember to read each cylinder volume at the bottom of the meniscus. It is advisable to record additional information about the test such as: type of sprinkler and nozzle size, sprinkler spacing, catch-can spacing, and height from sprinkler nozzle to the top of catch-can.

## Calculating the Uniformity

*Christiansen's Coefficient of Uniformity (CCU)*

This is one of the most commonly used statistical method for evaluating sprinkler system uniformity. Both the wettest and driest areas in a distribution area are considered.

**CCU = [1.0 - (x / mn)] x 100**

**x** = sum of the deviations of each catch-can volume from the average volume
**m** = mean value of all catch-can volumes.
**n** = number of catch-cans

Example

Measurements from 15 catch-cans: 16, 38, 32, 22, 35, 23, 32, 35, 19, 28, 26, 34, 24, 18, 23.

CCU = [1.0 - (x / mn)] x 100
m = 405 / 15 = 27
n = 15
x = 90

CCU = [1.0 - ( 90 / 27x15)] x 100 = 77.8%

*Distribution Uniformity (DU)*

With this coefficient, the wettest areas in a distribution are not considered. This coefficient is often used for drip emitter, micro-sprinkler, and spray stake irrigation systems.

**DU= (q/m) x 100**

**q** = average volume of 25% of the lowest catch-can volumes
**m** = mean value of all catch-can volumes

Example

Measurements from 16 catch-cans: 45, 34, 43, 47, 49, 35, 45, 46, 47, 52, 45, 38, 39, 45, 56, 45.

DU = (q/m) x 100
q = (34+35+38+39)/4 = 36.5
m = 44.4

DU = (36.5/44.4) x 100 = 82%

Note: All deviations from the mean are positive numbers. Therefore, any negative number is changed to a positive number. A mean of 35ml and a catch-can volume of 31ml would have a deviation of 4 (31-35 = -4 = 4).

**Interpreting the Results**

The irrigation industry has established coefficient guidelines to help evaluate water distribution uniformity. These values were determined by individuals who understand the application uniformity requirements of systems designed to irrigate plants in containers. Improving the application uniformity of a sprinkler system can reduce the water supply necessary to irrigate a given area by as much as 40%. This savings in water will lower pumping and operating costs, and allow for more land to be irrigated. Consider application uniformity a necessary design parameter before installing a new irrigation system. Also, regular sprinkler maintenance and repair are important aspects to good irrigation practices.

If the coefficient value is lower than acceptable, steps should be taken to redesign or modify the irrigation system. Major adjustments are usually accomplished by the addition of sprinklers or changing sprinkler spacing. However, this type of change is very difficult and can significantly influence the performance of irrigation pumps, and improper modifications may cause other problems such as over-watering. Since the operating pressure of the irrigation system was determined when it was designed, increasing or decreasing the pressure to improve uniformity is useful only when it has deviated from the design. Changing the nozzle size is useful when making only minor adjustments to the system.

| **Coefficient** | **Application Uniformity Rating** | | | |
|---|---|---|---|---|
| | **Very Poor** | **Poor** | **Acceptable** | **Excellent** |
| Christiansen's Coefficient of Uniformity | < 77 % | 77 - 82 % | 83 - 90 % | > 90 % |
| Distribution Uniformity | < 73 % | 73 - 78 % | 79 - 85 % | > 85 % |

*Acknowledgment*

This handout was prepared using several references, including detailed information presented by:

Bruce Lane, Hines Horticulture. June 22, 1999, 2nd Annual Nursery Growers Water Short Course, Oregon State University, Wilsonville, Oregon.