Department of Primary Industries
primefact

# Checking above-canopy sprinkler performance

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Agriculture NSW Water Unit

The efficiency of above canopy sprinklers has a major influence on potential crop yields and quality. For these systems to be efficient they firstly need to be performing to specifications. There are three basic measures available which managers can carry-out themselves when checking above-canopy sprinkler systems. These include:

- Sprinkler operating pressure
- Sprinkler discharge
- Sprinkler distribution uniformity (DU%)

**Figure 1. Measuring sprinkler operating pressure with a pitot tube**

## Sprinkler operating pressure

To assess the performance of each irrigation section in the field, measure and record pressure and discharge from at least nine sprinklers. Test sprinklers that are at the extremities of the submain and laterals, as well as any high and low points, and any areas showing poor crop health.

To test above-canopy sprinklers, you need a good quality pressure gauge (0 to 400 kPa) with a pitot tube attached

While the system is operating, point the pitot tube into and parallel with the stream of water, about 3 mm from the jet (see Figure 1). The needle will fluctuate but the maximum value obtained is the reading to record. Write down the sprinkler position and pressure for future reference.

- If the pressure is too low, droplets break up poorly, giving large droplets which in turn create a doughnut pattern of distribution and insufficient coverage.
- If the pressure is too high, the droplets break up excessively and misting occurs. Fine droplets fall close to the sprinkler causing poor overlap and increase losses from wind and evaporation.

*If the variation across the irrigation shift is greater than plus or minus (±) 10%, discuss the problem with a designer.*

## Sprinkler discharge

Measure sprinkler discharge using the following equipment:

- a length of plastic tube large enough to fit over the sprinkler jet
- a large bucket or container
- a measuring jug and
- a stop watch.

**Figure 2. measuring sprinkler discharge**

To measure the sprinkler discharge, place the plastic tubing over the nozzle and direct the water into a bucket for 30 seconds, or, if the bucket fills in less than 30 seconds, record the time taken in seconds (Figure 2).

For double-jet sprinklers, measure the two nozzles separately (using the same time period for each nozzle) and then add the discharges to get the total sprinkler discharge.

Measure sprinkler discharge in the same location as described for checking sprinkler pressures.

*Discharge should not vary by more than ± 5% of the design discharge.*

Compare the results of the pressure and discharge test with your design description and appropriate sprinkler specification sheet.

### Converting discharge to litres per hour (L/h)

Discharge is usually displayed as ‘L/h’ on irrigation designs and specification sheets. To allow appropriate comparisons, convert the discharge of the sprinkler you measured into litres per hour using the following equation:

***Discharge (L/h) = water collected (L) ÷ time of collection (s) × 3600***

### Sample discharge calculation:

If 17.4 litres was collected from a sprinkler in 30 seconds.

***Discharge (L/h) = 17.4 (L) ÷ 30 (s) × 3600 = 2088 L/h***

The following worksheet can be used to record pressure and discharge, and calculate the variation that exists within the sample.

## Worksheet for calculating sprinkler pressure and discharge

| **Sprinkler** | **Pressure (kPa)** | **Discharge (L/h)**<br>**[volume (L) ÷ time (s) x 3600]** |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| Firstly add up all the pressures and flows | Total pressure = | Total discharge = |
| To calculate the average pressure and flow rate divide the totals by the number of sprinklers measured | Average =<br>total pressure ÷ no. of sprinklers<br>= kPa | Average =<br>total discharge ÷ no. of sprinklers<br>= L/h |
| To calculate the midpoint, select and add together the max and min and divide the result by two. | Midpoint = (max + min) ÷ 2<br>= kPa | Midpoint = (max + min) ÷ 2<br>= L/h |
| To calculate variation subtract the min from the midpoint, divide this by the midpoint and multiply by 100 to get a percentage. | Variation = (mid – min) ÷ mid x 100<br>= %<br>Acceptable = ± 10% | Variation = (mid – min) ÷ mid x 100<br>= %<br>Acceptable = ± 5% |

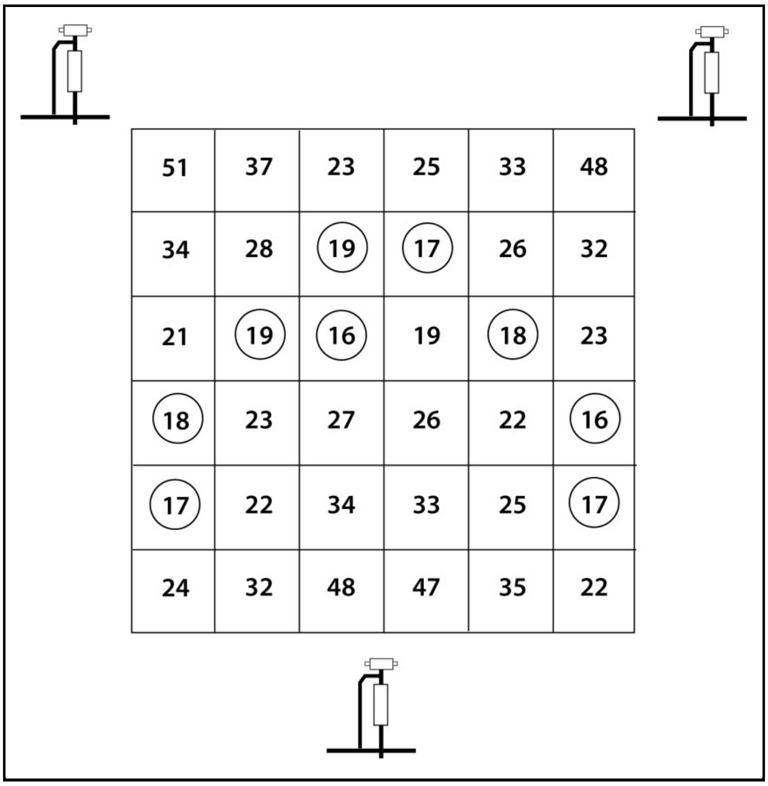
## Distribution Uniformity (DU%)

Measuring distribution uniformity determines the evenness of coverage of a sprinkler system. A series of cans of uniform size are placed in a grid pattern between three or four sprinklers, depending if the sprinklers are spaced in a square or triangular arrangement. The sprinklers are run for a period of time (a normal length shift is ideal as long as cans do not overflow) and the depth of water in each can, or volume, is then recorded.

The position of each can in the grid, and the depth of water are important in providing information about the evenness of application of the sprinklers.

Using a graduated jug or measuring cylinder, the volume of water collected in each can is determined, and each reading is recorded at the correct site on a plan (Figure 3).

**Figure 3. Distribution Uniformity can pattern for sprinklers**



| | | | | | |
|---|---|---|---|---|---|
| 51 | 37 | 23 | 25 | 33 | 48 |
| 34 | 28 | 19 | 17 | 26 | 32 |
| 21 | 19 | 16 | 19 | 18 | 23 |
| 18 | 23 | 27 | 26 | 22 | 16 |
| 17 | 22 | 34 | 33 | 25 | 17 |
| 24 | 32 | 48 | 47 | 35 | 22 |

### Calculating the DU

To calculate the distribution uniformity:

1. Add up all the values recorded on the site plan (Figure 3), and then get the average by dividing the total water caught with the number of tins used.
2. Circle the lowest value, second lowest value and so on, until you have circled a quarter of the values on your plan. Average this "Lowest Quarter" of the readings.
3. Calculate the distribution uniformity by dividing the low quarter average by the average of all the collectors, and multiply by 100.

### Example

$$\text{DU \%} = \frac{b}{a} \times 100$$

Where

$b$ = Low Quarter Average

$a$ = Average of all collectors

1. average all the cans

$$a = \frac{sum\ of\ all\ the\ readings}{number\ of\ cans} = \frac{977}{36} = 27.1$$

2. average the lowest quarter

$$b = \frac{19+17+19+16+18+18+16+17+17}{9} = \frac{157}{9} = 17.4$$

3. calculating the DU %

$$DU\ \% = \frac{17.4}{27.1} \times 100 = 64\%$$

The DU% figure is the preferred measure of uniformity for overlapping sprinklers, particularly if salinity is an issue. It represents the ratio of the average irrigation volume applied to the driest quarter of the field (or grid) and the average volume applied across the whole field (or grid). The higher the value, the more even the distribution of water is. A commonly accepted value for DU in permanent horticultural crops is equal to or greater than 75%, with values less than 67% considered unacceptable.

In the example provided, the DU% is low, and the system should be investigated to determine the problem. It appears from the can measurements that most of the water is being distributed close to the sprinklers, which may indicate that the sprinklers were installed too far apart, or they may be old or worn.

Other measures of uniformity which are applicable in certain situations (such as non-overlapping sprinkler or in container grown nurseries) are Christiansen's Coefficient of Uniformity (CU) and Scheduling Coefficient (SC). These are generally more complex to calculate but may be determined when specialised irrigation audits are carried out.

Manufacturers also provide information on jet sizes and pressure combinations and how they affect sprinkler performance. Additional information on distribution and spacing for different pressures can be obtained from consultants, irrigation retailers and your local Irrigation Officer.

## More information

NSW Agriculture. 2002. *Irrigation for Horticulture in the Mallee*.

## Acknowledgments

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