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# Frost Protection Calibration Quick Check

***Guidelines for Solid Set on Row Crops***



## What is the Frost Protection Quick Check?

The purpose of the Irrigation Calibration Quick Check is to determine the application rate of water applied during frost fighting event and how uniformly the water is distributed.

It is designed so operations managers can do the checking and calculations themselves. As well as this guideline, a worksheet is available to assist.

If your findings are unexpected, or suggest low performance, you should consider getting professional advice.

## Why you should check your system?

**Profitability** – effective frost protection minimises risk of severe loss. A well setup system saves money!

**Sustainability** – efficient frost protection minimises water and energy use and subsequent adverse effects such as soil water logging or leaching. A well setup system saves the environment!

It is essential for irrigation managers to know how much water is being applied as it is the most important factor determining success or failure.

The uniformity of irrigation determines whether all parts of the crop are receiving the same amount of water. As uniformity decreases, some areas will be under-watered and experience freezing injury. Areas that are over-watered may be damaged through water logging.

## What is involved?

The Quick Irrigation Calibration Check method is based on measurements of frost protection water collected in twenty identical buckets. Follow bucket placement instructions carefully and read volumes as accurately as possible to be sure of best results.

Check the application rates in a number of areas. Consider the design and layout, and check areas where differences could be anticipated – high and low parts, close and distant parts. Compare these to determine the overall performance of a system.

There are some extra tests and checks you can do. Record water flow from your water meter and compare with results from the bucket collection results. Record energy usage and determine the energy (and cost) needed for pumping.

## What will the checking tell you?

The main things the Quick Check will tell you are:

**Application Rate** – the rate at which the system is applying water. Compare the measured rate to your target rate as a calibration exercise.

**Distribution Uniformity DU** – describes the evenness with which water is applied. The higher the DU the better the system is performing. And the higher the uniformity, the more confident you can be that your measurements are truly representative of your system's performance.

**Excess Water Use** – EWF The excess water use factor identifies how much extra water is required during a set event because of non-uniformity.

## What do you need to do?

- Gather information about your system – you should be able to do this yourself.
- Record the data on the worksheet.
- Work out the answers using the worksheet calculations.

## When should you do it?

Choose test conditions that are typical for your property. It can be useful to check the operation in different places especially over large areas or varying terrain. Performance may change if another large draw off starts or stops taking water.

It also helps to test in relevant temperature and wind conditions. While frosts typically occur in calm conditions, there is often air flow as cold air drains. Some systems are seriously affected.

## What are the Quick Check's limitations?

The application rate will change as pressure changes or if different nozzles are fitted. Check the right nozzles are installed.

The uniformity will also change with different spacings, topography and wind.

Ensure sprinklers are operating correctly – rotation time is critical if crops are to be adequately protected. Check your design specifications.

The Quick Irrigation Calibration Check will only provide information for the tested area, running at test pressure, on that day with that wind speed and air temperature. As any of these change so will system performance.



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## *Measurement Procedure*

### What equipment will you need?

This Guide and the Worksheet

20 Collectors of the same diameter (>150 mm) 9 Litre plastic buckets with handles are good
1 Measuring cylinder (about 1 Litre)
1 50 m tape
1 Stop watch
1 Pen or pencil

### Field check layout

The calibration check is based on four lines of five collectors set in a grid. This checks that the same application rate is applied near to, and away from, the permanent set sprinklers.

The calculations give an average value for the whole area based on all the measurements. If there are variable row spacings, or variable protection system designs separate testing must be carried out.

### Dealing with larger areas

The base test arranges collector lines in order to assess how evenly application is made between adjacent sprinklers (Diagram 1).

A first "field scale" check can be made by locating the four lines across a large area. If carefully selected the four locations should give a guide to overall performance.

### Testing Layout

1. Observe the proposed test area in operation
2. Choose an area where all sprinklers appear to be operating correctly
3. Select four adjacent rows, starting with a sprinkler row (Diagram 1)
4. Space five collectors (buckets) above or at the cordon, evenly between two adjacent sprinklers on the first row (Diagrams 2a & 2b)
5. Align collectors in the crop row to represent the canopy to be protected. It may be easy to hang them by their handles on trellis wires
6. Space additional sets of five collectors on the three adjacent rows forming a square grid of twenty collectors in total

### Application test

1 Set up the test grid as described
2 Run the system to collect an easily measured amount of water – at least half an hour. Record the run time
3 Measure the volume of water caught in each bucket and record on the Record Sheet, taking care to record each in the correct position
4 Do the calculations as shown in the worksheet

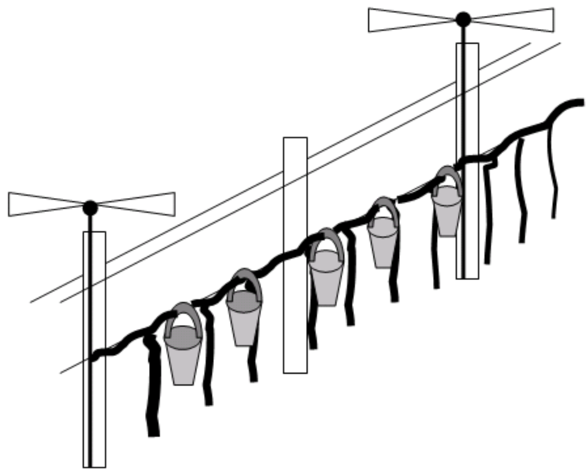
Diagram 2a: Collectors suspended on fruiting wire

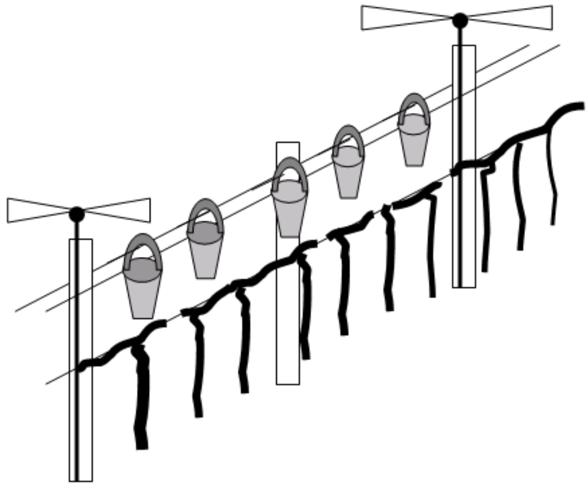
Diagram 2b: Collectors suspended on tuck wires

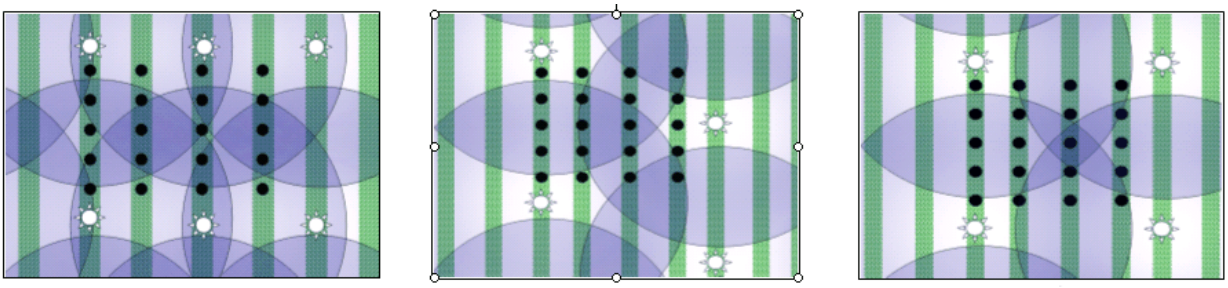
Diagram 1. Example collector bucket positions ● relative to rows and sprinklers



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## What is acceptable?

### Application Rate

You should expect your measured application rate to be within 10% of your target rate. A result within 5% is better. Rate is critical for frost protection.

### Distribution Uniformity

DU > 0.9 Uniformity is excellent - the system is performing very well. You can be confident of this result.

0.9 – 0.8 Uniformity is good - performance better than average. You can be confident of this result.

0.8 – 0.7 Uniformity is adequate - performance could still be improved. The result is likely to be a good indication of system performance.

0.7 – 0.6 Uniformity is fair - system should be investigated. Results may be less reliable – redo the testing to check.

DU < 0.6 Uniformity is poor - system must be investigated. Results are less reliable – redo the testing to check.

## Why does performance change?

The factors driving application rate are *sprinkler flow and sprinkler spacing.*

Spacing is set at installation. Changing spacing has very significant effects on uniformity and average application rate.

Flow rate is pressure dependent, so check pressures are correct. Low pressure will reduce flow and reduce uniformity.

Wetting patterns vary with pressure, wind direction and speed. Sprinkler angle and nozzle size and wear can also make a considerable difference to results.

Check the correct nozzles are fitted and are clean. Check sprinklers are properly aligned and turning correctly.

Make additional checks to ensure satisfactory application rates are achieved across the system as a whole.

**TIP:**

Use extra Worksheets to record and process system performance in more areas

## Example Worksheet for Row Crop Frost Protection Calibration

Use the Sheet to record details from the field and to complete some extra calculations. Take care to enter information using the same measurement units (e.g. millimetres or metres) as specified in the Recording Sheet. This will ensure your calculated answers have the correct units too.

| | | |
|---|---|---|
| | Property Name | Oak Wines |
| | Area 1 Test Date | 2/08/2009 |
| | Area 1 Block | Old Merlot |
| | Area 1 Rows | B 13 - 16 |
| | Wind conditions | Light North |
| | Temperature | 11°C |
| ***a*** | Test Pressure at pump [kPa] | 750 |
| ***b*** | Water Meter Flow Rate [m³/hr] | 640.55 |
| ***c*** | Target Application Rate [mm/hr] | 4.00 |
| ***d*** | Actual Application Rate [mm/hr] | 4.38 |
| ***e*** | Variance ( **d** / **c** x 100) [%] | 109.5 |
| ***f*** | Row width wetted [m] | 2.50 |
| ***g*** | Length of rows operating [m] | 57,500 |
| ***h*** | Area wetted (**f** x **g** / 10,000) [ha] | 14.38 |
| ***i*** | *Field Flow Rate (**d**x **h**x10) [m³/hr] | 629.63 |
| ***j*** | Variance ( **i** / **b** x 100) [%] | 98.3 |

| | | |
|---|---|---|
| | Property Name | Oak Wines |
| | Area 2 Test Date | 4/08/2009 |
| | Area 2 Block | Pinot Gris |
| | Area 2 Rows | H 65 - 68 |
| | Wind conditions | Still |
| | Temperature | 8°C |
| ***a*** | Test Pressure at pump [kPa] | 745 |
| ***b*** | Water Meter Flow Rate [m³/hr] | 325.04 |
| ***c*** | Target Application Rate [mm/hr] | 4.00 |
| ***d*** | Actual Application Rate [mm/hr] | 4.38 |
| ***e*** | Variance ( **d** / **c** x 100) [%] | 109.5 |
| ***f*** | Row width wetted [m] | 1.25 |
| ***g*** | Length of rows operating [m] | 57,500 |
| ***h*** | Area wetted (**f** x **g** / 10,000) [ha] | 7.19 |
| ***i*** | *Field Flow Rate (**d**x **h**x10) [m³/hr] | 314.81 |
| ***j*** | Variance ( **i** / **b** x 100) [%] | 96.9 |

* Calculating Field Flow Rate is difficult if there are varying row or sprinkler set ups in different areas within one system



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# Example Worksheet for Row Crop Frost Protection Calibration

Enter your field measurements from Area 1 collectors by Row (R1 – R4)
Complete the calculations as shown
Repeat for Area 2
Use additional Worksheets for extra test areas

## Area 1

| Collected Volumes (mL) | | Enter lowest five volumes in boxes 1 – 5 | |
|---|---|---|---|
| R1/1 | 100 | 1 | 65 |
| R1/2 | 90 | 2 | 75 |
| R1/3 | 85 | 3 | 75 |
| R1/4 | 105 | 4 | 80 |
| R1/5 | 80 | 5 | 80 |
| SUM R1 | 460 | SUM Lo5 | 375 |
| R2/1 | 75 | AVG Lo5 | 75 |
| R2/2 | 95 | SUM ALL | 1735 |
| R2/3 | 80 | AVG ALL | 86.75 |
| R2/4 | 80 | Calculate DU AVG Lo5 / AVG ALL | |
| R2/5 | 90 | DU | 0.86 |
| SUM R2 | 420 | Calculate Ave Applied Depth | |
| R3/1 | 120 | Collector Area = $(MouthDiam/2)^2$ x 3.14 | |
| R3/2 | 80 | Mouth Diam m | 0.160 |
| R3/3 | 90 | Area $m^2$ | 0.020 |
| R3/4 | 75 | Depth = AVG Vol ÷ Collector Area ÷ 1000 | |
| R3/5 | 80 | Depth mm | 4.34 |
| SUM R3 | 445 | Calculate Application Rate: | |
| R4/1 | 90 | Depth / Test Time | |
| R4/2 | 70 | Test Time hr | 1 |
| R4/3 | 65 | App Rate mm/h | 4.34 |
| R4/4 | 80 | Calc. Excess Water Factor EWF% | |
| R4/5 | 105 | = ( (Rate ÷ DU) – Rate ) ÷ Rate x 100 | |
| SUM R4 | 410 | EWF % | 15.7 |
| SUM ALL | 1735 | | |

## Area 2

| Collected Volumes (mL) | | Enter lowest five volumes in boxes 1 – 5 | |
|---|---|---|---|
| 1 | 100 | 1 | 60 |
| 2 | 95 | 2 | 65 |
| 3 | 80 | 3 | 70 |
| 4 | 80 | 4 | 75 |
| 5 | 80 | 5 | 75 |
| SUM R1 | 435 | SUM Lo5 | 345 |
| 1 | 75 | AVG Lo5 | 69 |
| 2 | 70 | SUM ALL | 1670 |
| 3 | 65 | AVG ALL | 83.5 |
| 4 | 80 | Calculate DU AVG Lo5 / AVG ALL | |
| 5 | 90 | DU | 0.83 |
| SUM R2 | 380 | Calculate Ave Applied Depth | |
| 1 | 80 | Collector Area = $(MouthDiam/2)^2$ x 3.14 | |
| 2 | 60 | Mouth Diam m | 0.160 |
| 3 | 75 | Area m2 | 0.020 |
| 4 | 75 | Depth = AVG Vol ÷ Collector Area ÷ 1000 | |
| 5 | 80 | Depth mm | 4.18 |
| SUM R3 | 370 | Calculate Application Rate: | |
| 1 | 90 | Depth / Test Time | |
| 2 | 120 | Test Time hr | 1 |
| 3 | 80 | App Rate mm/h | 4.18 |
| 4 | 90 | Calculate Excess Water Factor EWF% | |
| 5 | 105 | = ((Rate ÷ DU) –Rate ) ÷ Rate x 100 | |
| SUM R4 | 485 | EWF % | 21.0 |
| SUM ALL | 1670 | | |



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