

IRRIGATION ASSESSMENT REPORT



Date: 10th November 2010

Landholder:

Address:

Irrigation System: Micro-sprinklers

Soil Details

Physical and anecdotal evidence suggests that the soil type across the property is clayey in nature with layers of hard soil approx 30-40cm in depth.



Soil cores were taken in the Crimson Seedless block to a depth of 50cm. The top 10-15cm of the soil was darker in colour. From 15cm, the soil was sticky, plasticine in nature and changed colour to orange hue with darker orange mottles.

Field Texture: Light Clay 0-15cm (Plastic behaviour evident, smooth feel easily worked, moulded and rolled into rod. Rod forms a ring without cracking, 35-40% clay)

There was a colour change at 15-20cm from light brown to light orange colour. **Medium Clay 15-50cm** (Smooth plastic bolus, handles like plasticine, can be moulded into rods without cracking, resistant to shearing)

Soil Readily Available Water (RAW): Light Clay = 45mm/m @ -40kPa tension, Medium Clay = 45mm/m @ -40kPa. -40kPa is how dry the rootzone should get between irrigations. This can only be gauged with tensiometers or gypsum blocks.

Rootzone depth: Soil core and pit evidence indicates the majority of the feeder roots are within 0-40cm layer. 10cm was added to the bottom of the rootzone as a precautionary measure so 50cm has been set for the bottom of the active rootzone.

Rootzone RAW: 45mm/m X 0.5m = **22.5mm of Readily Available Water in the rootzone.**

Irrigation System Details

Lateral Size: 100mm main and submain ranges from 100mm to 80mm to 50mm. Laterals are 25mm LDPE.

Sprinkler Make: Wingfield

Sprinkler Model: Challenger Mk II

Spec Sprinkler Flow: 143L/hr @ 200kPa

Nozzle and Swivel: Blue Nozzle (1.6mm)

Pressure range: 100 to 200kPa (14 to 29bar)

Field pressure: 310kPa (45psi)



Challenger MkII Performance Data

| Product Code | SMB 13 SMB 14 SMB 16 SMB 20 SMB 22 SMB 24 SMB 25 SMB 27 | | | | | | | | | TESTED A93032 A92046 | |
|---------------------|---|------|---------|---------|----------|----------|----------|----------|----------|----------------------------|------|
| | | | White | Maroon | Green | Blue | Grey | Yellow | Olive | | Red |
| Nozzle Orifice (mm) | | | 1.1 | 1.3 | 1.4 | 1.6 | 1.8 | 2.1 | 2.2 | 2.4 | |
| | kPa | bar | | | | | | | | psi* | |
| Flow Rate L/hr | 100 | 1.00 | 46 (12) | 56 (15) | 72 (19) | 101 (27) | 125 (33) | 153 (40) | 167 (44) | 196 (52) | 14.5 |
| Flow Rate L/hr | 125 | 1.25 | 52 | 64 | 81 | 113 | 139 | 172 | 186 | 219 | |
| Flow Rate L/hr | 150 | 1.50 | 55 (14) | 70 (18) | 90 (24) | 125 (33) | 150 (40) | 185 (49) | 200 (53) | 240 (63) | 21.8 |
| Flow Rate L/hr | 175 | 1.75 | 61 | 75 | 95 | 134 | 165 | 202 | 220 | 261 | |
| Flow Rate L/hr | 200 | 2.00 | 65 (17) | 80 (21) | 101 (27) | 143 (38) | 176 (46) | 215 (57) | 235 (62) | 278 (73) | 29.0 |
| Flow Rate L/hr | 225 | 2.25 | - | - | - | - | 187 | 227 | 253 | 295 | |
| Flow Rate L/hr | 250 | 2.50 | - | - | - | - | 197 | 244 | 266 | 311 | |
| Radius (metres) | 100 | 1.00 | 3.4 | 3.4 | 3.8 | 4.0 | 4.8 | 4.8 | 4.9 | 4.9 | |
| Radius (metres) | 150 | 1.50 | 3.5 | 3.7 | 4.3 | 4.6 | 5.0 | 5.4 | 5.5 | 5.5 | |
| Radius (metres) | 200 | 2.00 | 3.5 | 3.8 | 4.4 | 4.8 | 5.3 | 5.7 | 5.7 | 5.7 | |
| Stream Height (m) | 150 | 1.50 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.7 | 0.7 | |

Note: Shaded area denotes recommended operating pressure & discharge.

* psi with US Gallons/hr.

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING FOR OUR COUNTRY

System Performance (audit data)

The method used to check the irrigation performance in the Crimson Seedless block was **grid sprinkler uniformity test**.



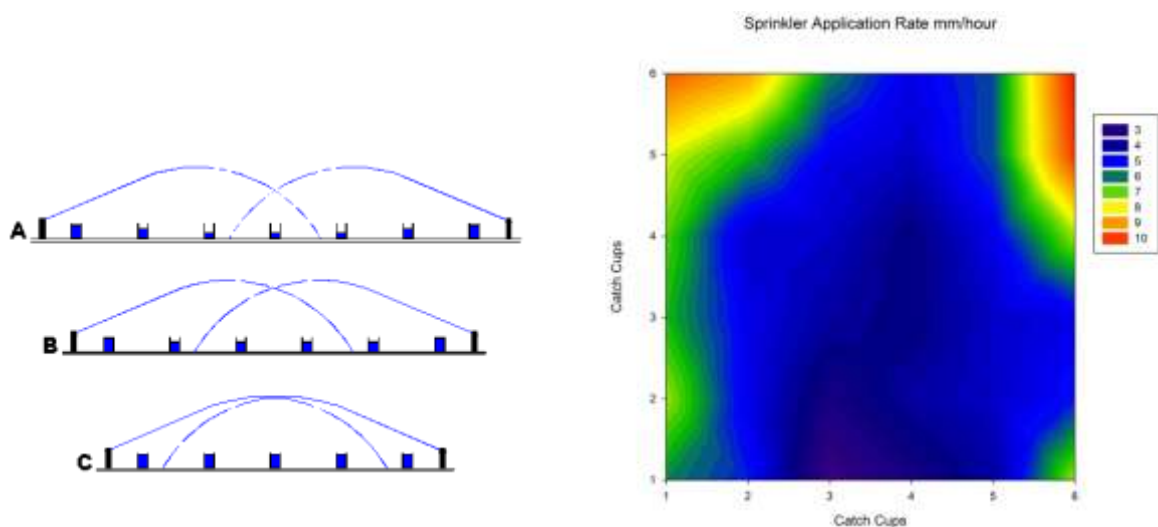
The system was designed to be overlapping between the sprinklers and between the laterals and this was the reasoning behind choosing a grid uniformity test.

Grid sprinkler uniformity test: 36 catch cans were placed in a grid pattern between the pine posts and between the laterals.

Over the 15min test, the average amount in the catch cups was 1.4mm of irrigation. The Mean Application Rate for the grid test was 5.5mm per hour with a Distribution Uniformity of 65% and a Coefficient of Uniformity of 73%.

A DU of 65% indicates that there is a difference between the average of the lowest 16 catch cups (3.6mm/hr) compared to the average amount collected over the entire catch cup area (5.5mm/hr). See Sprinkler Application Rate graph for a detailed look at sprinkler wetting patterns.

Important note: The Wingfield Challenger sprinklers have a max throw radius of 4.8m. Lateral Spacing is 6.8m. The sprinkler wetting patterns overlap as per diagram A. To be fully overlapping (which is the ideal situation), the system should resemble C. Your system is operating between A and B, depending on sprinkler pressure and throw radius (see image below).



Sprinkler Flow Tests

Results:

1. 162L/hr
2. 162L/hr
3. 144L/hr
4. 162L/hr
5. 180L/hr
6. 158L/hr

Average: 161L/hr

The Wingfield Challenger sprinklers are designed to deliver a flow of 143L/hr at 200kPa pressure. Sprinkler pressure during the test was 310kPa. Higher pressure is the reason for higher sprinkler flows. This would be a major issue for irrigation efficiency as the sprinklers are operating above recommended range but anecdotal evidence has indicated that head pressure reduces considerably as the growing season progresses. 100-200kPa is the recommended operating pressure for these sprinklers.

Calculating Application Rates (mm/hour)

Application rates can be calculated from the grid catch cup test, performed in the field and taken from the wetted area of the sprinkler (as we conducted in the vineyard) or they can be calculated from sprinkler output, spacing and lateral spacing. The calculated application rate from the catch cup data was **5.5mm/hour**. The MAR calculation is the average volume taken from the 36 catch cups.

The application rate calculated from sprinkler output, sprinkler spacing and lateral spacing is:

$$161\text{L} \div (3.4\text{m} \times 6.8\text{m}) = 7.0 \text{ mm/hour.}$$

The catch cup application rate is more accurate as it is calculated over the entire wetted area of the sprinklers between the two laterals and the sprinkler output assumes that 7.0mm is spread evenly over the 23m². From the system performance data, you can see that water is not distributed over the area evenly.

Irrigation Scheduling

There are several ways to schedule irrigations. There are soil based methods, tree based methods and weather based methods which can be used as a guide as to when and how much irrigation to apply.

Soil based method - Using the Rootzone RAW of 22.5mm and the mean application rate of 5.5mm/hr, you can calculate how long it would take to fill the rootzone **if the soil reached -40kPa tension**. $22.5\text{mm} \div 5.5\text{mm/hr} \times 60\text{mins} = 245\text{mins}$ of irrigation need to fill the rootzone (approx 4 hours).

Soil Water Reserves: Based on the wetted area of the sprinklers (23m²) and Rootzone RAW, you have a soil water reserve of 517L (if the soil was at -40kPa). This is calculated: 23m² (sprinkler spacing x lateral spacing) multiplied by 22.5mm RAW = 517L. This figure is the volume of water that the soil can hold in the top 0.5m soil profile (field capacity).

Weather based method – There is a good correlation between plant water requirement and daily evaporation. The percentage of evaporation that needs to be replaced is called a crop factor and this depends on the vines growth stage. Irrigations should be scheduled using daily or monthly evaporation figures and crop factors in conjunction with soil moisture monitoring devices (tensiometers/gypsum blocks/capacitance probes). The calculation for table grape irrigation requirement is:

$$\text{Irrigation requirement} = \text{Daily Evaporation (mm)} \times \text{crop factor}$$

$$\text{Irrigation requirement (Feb)} = 9.6\text{mm} \times 0.4 = 4.3\text{mm per day}$$

Irrigation runtime can be calculated with the following formula:

$$\text{Irrigation Runtime (mins)} = \text{Daily evaporation (mm)} \times \text{crop factor} \div \text{application rate} \times 60 \text{ mins}$$

$$\text{Irrigation runtime (March)} = 9.6\text{mm} \times 0.45 \div 5.5\text{mm/hour} \times 60\text{mins} = 46\text{mins/day (this method is recommended)}$$

Using micro-sprinklers to irrigate the vines, add an extra 10% to the crop factor to adjust for higher evaporative losses and having a large wetted area. Example: the crop factor in March is 0.4, add 10%, this increases the crop factor up to 0.44

Important note: At verasion (colour change) in all table grape varieties, moisture stress should be avoided. Take Crimson Seedless for example. Verasion is around early/mid January and the crop factor for January is approx 0.4. On some soils, a 0.4 crop factor may not be enough irrigation to get water down to the bottom of the rootzone. Soil moisture monitoring (tensiometers) should be used at this time to ensure there is adequate moisture in the rootzone.

You may be able to delay the first irrigation for the season if soil moisture is adequate at 40-50cm. Use soil moisture monitoring devices to assist you with decision making at this time.

Monthly Crop Factors Table – Micro-Sprinkler Irrigation

| Month | Early Variety | Mid Variety | Late Variety |
|-------|---------------|-------------|--------------|
| Sept | 0.11 | 0.11 | 0.11 |
| Oct | 0.22 | 0.22 | 0.16 |
| Nov | 0.38 | 0.38 | 0.27 |
| Dec | 0.44 | 0.38 | 0.33 |

| | | | |
|-------|------|------|------|
| Jan | 0.44 | 0.44 | 0.38 |
| Feb | 0.38 | 0.44 | 0.44 |
| March | 0.38 | 0.38 | 0.44 |
| April | 0.22 | 0.22 | 0.33 |

Please see attached Irrigation Schedule for monthly irrigation figures.

Water Budget

The water budget was produced based on full vineyard floor irrigation where all of the vineyard is irrigated. The water budget has been broken up into Early, Mid and Late varieties.

Local evaporation and rainfall figures were sourced from the Bureau of Meteorology, Perth Airport weather station.

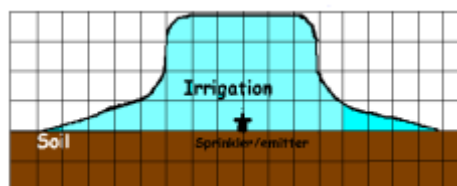
With a wetted area of 100% (sprinklers cover all the vineyard floor), the Crop Water Requirement is 16,160 kL for Early season grape varieties (Midnight Beauty, Flame Seedless, Dawn Seedless), 2,906kL for Mid season grape varieties (Red Globe, Ruby Seedless) and 3,537kL for Late season grapes (Crimson seedless). Your irrigation requirement for the total 4.33ha, would be approximately 22,603kL/year during an average rainfall year. The 10 rows of Calmeria were grouped with Dawn Seedless and were included in the early season varieties. Department of Water (licensing and allocation) has allocated 5000kl/ha for the production of table grapes in the Swan Groundwater Area.

With a decile 1 rainfall year (e.g. 2010), your total irrigation requirement would be approximately 26,053kL/year.

Water use during Jan, Feb and March may be higher than the recommended 0.44 crop factor. Soil moisture monitoring equipment (e.g. tensiometers) should be used to guide irrigation scheduling during late summer months to ensure that wetting fronts reach the bottom of the rootzone. Tensiometers can be purchased for approx \$250 each (various depths – 150, 300, 450mm etc).

Notes

Sprinkler Pressure and Flow – in field pressure was recorded at 310kPa or 45psi. The Wingfield Challenger sprinkler is designed to operate within a pressure range of 100-200kPa. Flow from the sprinkler was recorded at 161L/hr (avg) but they are designed to deliver 143L/hr @ 200kPa. The sprinkler may not be operating efficiently at higher pressures. It is recommended to run the sprinkler within designed operating pressure.



If the bore head pressure reduces over the

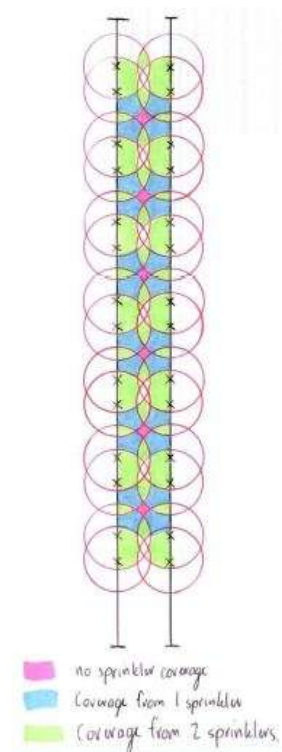
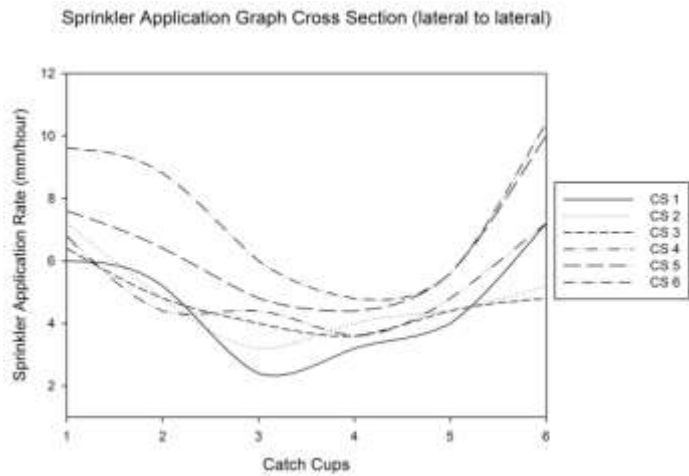
growing season, you should check sprinkler flow each month as you may need to apply more irrigation if sprinkler flow decreases.

Sprinkler wetting patterns – From the catch can analysis and sprinkler spacing, the sprinkler wetting patterns appear to be concentrating water close to the sprinkler. There is good overlap between the sprinklers along the lateral line which are spaced at 3.4m apart but there are significant areas between the sprinklers under the influence of only 1 sprinkler which will affect

application rates in the area. Sprinklers should be spaced for maximum water distribution uniformity. The minimum DU% standard for sprinkler systems is 75% and CU% should be 85%.

If the sprinklers distribute the water unevenly, some areas will receive too little water and others too much. Under watered areas may lead to crop water stress, and in the overwatered areas large amounts of water will be wasted and nutrients leached. Similarly, plant nutrients will be unevenly distributed if fertigation is used.

I have attached a hand drawn image of what the wetting pattern of the sprinklers looks like from above, based on the vine spacing and sprinkler throw. The colours indicate the amount of overlap in the wetted area.



****This audit was conducted at one location on the property and is representative of the system in the general area. System performance can change over irrigation blocks / stations so it is recommended that more than one system check be performed.*



Irrigation System Performance Evaluation

Fixed overhead/undercanopy (overlapping)

Program developed to support the delivery of the Waterwise on the Farm Program



CONTACT INFORMATION

| | | | |
|-------------------|----------|---------|--|
| Business: | | Email: | |
| Contact: | | Mobile: | |
| Property Address: | | Phone: | |
| Mailing Address: | as above | Fax: | |

SYSTEM SPECIFICATIONS

| | |
|--------------------|--------------------------------|
| System Type: | Undercanopy Micro |
| Sprinkler Make: | Wingfield |
| Sprinkler Model: | Challenger |
| Nominal Flow: | 143 L/min (specification) |
| Nominal Pressure: | 200 kPa (specification) |
| Nozzle (Front): | 1.6 mm |
| Nozzle (Rear): | mm |
| Throw Radius: | 4.4 metres (at above pressure) |
| Lateral Spacing: | 6 metres (between laterals) |
| Sprinkler Spacing: | 3.4 metres (along laterals) |

ADDITIONAL DETAILS

| | |
|--------------------------------|------------------|
| Test Location: | |
| Crop/s Grown: | Crimson Seedless |
| Crop Water Allocation: | 5,000 kL/ha/year |
| Total Irrigated Area: | 1 hectares |
| Theoretical Water Entitlement: | 5,000 kL/year |
| Wind Direction: | NW |
| Approx. Wind Speed: | 5 km/h |

Notes/Comments

Sprinkler spacing at 3.6m and 4.1m

TEST PARAMETERS * Denotes required fields

| | |
|--------------------|------------------|
| Test Date: | 10 November 2010 |
| Test Start Time: | 9:00 |
| Test Runtime: | 15 minutes |
| No. Cans Used *: | 36 |
| Low Quarter Cans: | 9 |
| Can Spacing: | metres |
| Can Diameter*: | 113 mm |
| Conversion Factor: | 10.0 |

PRESSURE

FLOW

| LOCATION | p (kPa) | LOCATION | Q (L/min) |
|----------------|---------|-----------------|-----------|
| 1 near inlet | 310 | 1 | 2.7 |
| 2 | | 2 | 2.7 |
| 3 | | 3 | 2.4 |
| 4 | | 4 | 3 |
| 5 | | 5 | 2.64 |
| Test Average | 310 | Test Average | 2.7 |
| Test Midpoint | 310 | Test Midpoint | 2.7 |
| Variation (±%) | 0.0 | Variations (±%) | 11.1 |

TEST DATA

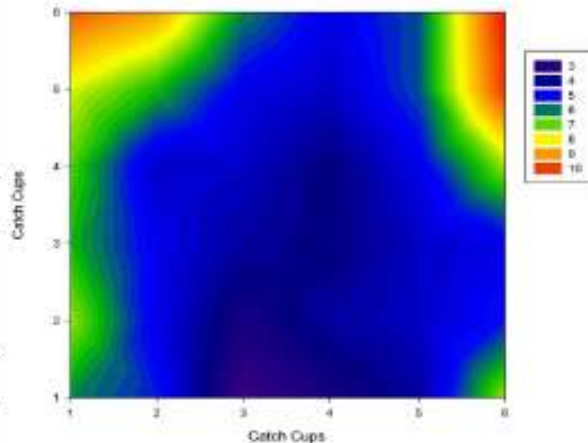
* S = Sprinkler location

| | | | | | | | |
|---|----|----|----|----|----|----|---|
| X | | | | | | | X |
| | 26 | 25 | 18 | 12 | 13 | 18 | |
| | 14 | 14 | 12 | 11 | 11 | 10 | |
| | 12 | 11 | 9 | 9 | 10 | 8 | |
| | 15 | 12 | 11 | 10 | 8 | 6 | |
| | 22 | 16 | 11 | 12 | 12 | 13 | |
| | 24 | 19 | 17 | 16 | 18 | 15 | |
| X | | | | | | | X |

DISTRIBUTION & SCHEDULING SUMMARY

| | |
|--|-------------|
| Average Test Catch Depth | 1.4 mm |
| DU _{25%} (average catch depth) | 0.9 mm |
| Average Deviation (catch depth) | 0.4 mm |
| Mean Application Rate (MAR) | 5.5 mm/hour |
| DU _{25%} (average application rate) | 3.6 mm/hour |
| Distribution Uniformity (DU) | 64.8% |
| Coefficient of Uniformity (CU) | 72.5% |
| Scheduling Coefficient (SC _{25%}) | 1.5 |

Sprinkler Application Rate mm/hour



RUNTIME CALCULATOR

| | | |
|-------------------------------------|------------------|----------|
| Soil Readily Available Water (RAW)* | 45 mm/metre | |
| Effective Rooting Depth* | 0.50 metres | |
| Rootzone Readily Available Water | 22.5 millimetres | |
| Runtime to Refill Depleted RZ RAW | 244 minutes | |
| Rootzone RAW Refill (DU% adjusted) | 376 minutes | |
| EVAPORATION (mm/period) | CROP FACTOR | CWR (mm) |
| 10.0 | 0.5 | 5.0 |
| Approx. System Runtime | 54 minutes | |
| DU% Adjusted Runtime | 84 minutes | |
| Irrigation (ie CWR) Spill Over | 1 Shift/s | |

Disclaimer: These results are representative of the system's operating characteristics at the time and location of testing. The results do not necessarily reflect the performance of the system across other installations. It is recommended that system routines are validated in-field using appropriate soil moisture monitoring equipment.



This program has been developed with funding provided by the Australian Governments Caring for our Country: Landcare - Sustainable Practices Grant.





IRRIGATION SCHEDULE

Mean Application Rate (mm/hr) 5.5
 Distribution Uniformity 65%



CARING
FOR
OUR
COUNTRY

Crop Factor 1 0.11
 Crop Factor 2 0.22
 Crop Factor 3 0.38
 Crop Factor 4 0.44

Average Irrigation Requirement Per Month

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------------------|------|------|-----|-----|-----|------------------------|------------------------|------------------------|-----|-----|-----|-----|
| Avg Daily Evap (mm) | 10.1 | 10.6 | 7.8 | 5.0 | 3.0 | 2.2 | 2.1 | 2.6 | 3.6 | 6.1 | 7.4 | 9.0 |
| Required irrigation (mm) | 4.4 | 4.0 | 3.0 | 1.1 | 0.3 | no irrigation required | no irrigation required | no irrigation required | 0.4 | 1.3 | 2.8 | 4.0 |
| Runtime per station (mins) | 48 | 44 | 32 | 12 | 4 | no irrigation required | no irrigation required | no irrigation required | 4 | 15 | 31 | 43 |
| DU% runtime (mins) | 75 | 68 | 50 | 18 | 6 | no irrigation required | no irrigation required | no irrigation required | 7 | 23 | 47 | 66 |

What your runtime means in mm/hour

| | | | | | | | | | | | | |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Run Time (mins) | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| Equivalent in mm/hr | 0.5 | 0.9 | 1.4 | 1.8 | 2.3 | 2.8 | 3.2 | 3.7 | 4.1 | 4.6 | 5.0 | 5.5 |

What to apply when local evaporation changes (0.44 crop factor)

| | | | | | | | | | | | | | |
|--------------------------------------|------|------|------|------|-----|------|------|------|------|-----|------|------|------|
| mm of Evap per day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Irrigation required per day | 0.44 | 0.88 | 1.32 | 1.76 | 2.2 | 2.64 | 3.08 | 3.52 | 3.96 | 4.4 | 4.84 | 5.28 | 5.72 |
| Equivalent irrigation runtime (mins) | 5 | 10 | 14 | 19 | 24 | 29 | 34 | 38 | 43 | 48 | 53 | 58 | 62 |

Notes: Early Table Grape Varieties

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING
FOR
OUR
COUNTRY



IRRIGATION SCHEDULE

Mean Application Rate (mm/hr) 5.5
Distribution Uniformity 65%



CARING
FOR
OUR
COUNTRY

Crop Factor 1 0.11
Crop Factor 2 0.22
Crop Factor 3 0.33
Crop Factor 4 0.38
Crop Factor 5 0.44

Average Irrigation Requirement Per Month

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------------------|------|------|-----|-----|-----|------------------------|------------------------|------------------------|-----|-----|-----|-----|
| Avg Daily Evap (mm) | 10.1 | 10.6 | 7.8 | 5.0 | 3.0 | 2.2 | 2.1 | 2.6 | 3.6 | 6.1 | 7.4 | 9.0 |
| Required irrigation (mm) | 4.4 | 4.7 | 3.0 | 1.1 | 0.3 | no irrigation required | no irrigation required | no irrigation required | 0.4 | 1.3 | 2.4 | 3.4 |
| Runtime per station (mins) | 48 | 51 | 32 | 12 | 4 | no irrigation required | no irrigation required | no irrigation required | 4 | 15 | 27 | 37 |
| DU% runtime (mins) | 75 | 78 | 50 | 18 | 6 | no irrigation required | no irrigation required | no irrigation required | 7 | 23 | 41 | 57 |

What your runtime means in mm/hour

| | | | | | | | | | | | | |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Run Time (mins) | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| Equivalent in mm/hr | 0.5 | 0.9 | 1.4 | 1.8 | 2.3 | 2.8 | 3.2 | 3.7 | 4.1 | 4.6 | 5.0 | 5.5 |

What to apply when local evaporation changes (0.44 crop factor)

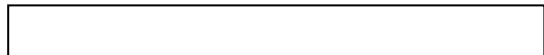
| | | | | | | | | | | | | | |
|--------------------------------------|------|------|------|------|-----|------|------|------|------|-----|------|------|------|
| mm of Evap per day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Irrigation required per day | 0.44 | 0.88 | 1.32 | 1.76 | 2.2 | 2.64 | 3.08 | 3.52 | 3.96 | 4.4 | 4.84 | 5.28 | 5.72 |
| Equivalent irrigation runtime (mins) | 5 | 10 | 14 | 19 | 24 | 29 | 34 | 38 | 43 | 48 | 53 | 58 | 62 |

Notes: Mid Season Table Grape Varieties

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING
FOR
OUR
COUNTRY



IRRIGATION SCHEDULE



CARING FOR OUR COUNTRY

Mean Application Rate (mm/hr) 5.5
Distribution Uniformity 65%

Crop Factor 1 0.11
Crop Factor 2 0.16
Crop Factor 3 0.27
Crop Factor 4 0.33
Crop Factor 5 0.38
Crop Factor 6 0.44

Average Irrigation Requirement Per Month

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------------------|------|------|-----|-----|-----|------------------------|------------------------|------------------------|-----|-----|-----|-----|
| Avg Daily Evap (mm) | 10.1 | 10.6 | 7.8 | 5.0 | 3.0 | 2.2 | 2.1 | 2.6 | 3.6 | 6.1 | 7.4 | 9.0 |
| Required irrigation (mm) | 4.4 | 4.7 | 3.4 | 1.7 | 0.5 | no irrigation required | no irrigation required | no irrigation required | 0.4 | 1.0 | 2.0 | 3.0 |
| Runtime per station (mins) | 48 | 51 | 37 | 18 | 5 | no irrigation required | no irrigation required | no irrigation required | 4 | 11 | 22 | 32 |
| DU% runtime (mins) | 75 | 78 | 58 | 28 | 8 | no irrigation required | no irrigation required | no irrigation required | 7 | 16 | 34 | 50 |

What your runtime means in mm/hour

| | | | | | | | | | | | | |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Run Time (mins) | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| Equivalent in mm/hr | 0.5 | 0.9 | 1.4 | 1.8 | 2.3 | 2.8 | 3.2 | 3.7 | 4.1 | 4.6 | 5.0 | 5.5 |

What to apply when local evaporation changes (0.44 crop factor)

| | | | | | | | | | | | | | |
|--------------------------------------|------|------|------|------|-----|------|------|------|------|-----|------|------|------|
| mm of Evap per day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Irrigation required per day | 0.44 | 0.88 | 1.32 | 1.76 | 2.2 | 2.64 | 3.08 | 3.52 | 3.96 | 4.4 | 4.84 | 5.28 | 5.72 |
| Equivalent irrigation runtime (mins) | 5 | 10 | 14 | 19 | 24 | 29 | 34 | 38 | 43 | 48 | 53 | 58 | 62 |

Notes: Late Season Table Grape Varieties

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING FOR OUR COUNTRY



WATER BUDGET CALCULATOR

Crop: **Table Grape - Early**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|------|------|------|------|-------|-------|-------|-------|------|------|------|------|
| Average Monthly Evaporation (mm) | 314 | 297 | 242 | 150 | 93 | 66 | 65 | 81 | 108 | 189 | 221 | 279 |
| Average Daily Evaporation (mm) | 10.1 | 10.6 | 7.8 | 5.0 | 3.0 | 2.2 | 2.1 | 2.6 | 3.6 | 6.1 | 7.4 | 9.0 |
| Average (mean) Rainfall (mm/month) | 8.9 | 14.8 | 16.2 | 41.7 | 100.7 | 164.4 | 159.3 | 118.0 | 72.0 | 44.8 | 26.1 | 10.3 |
| Aver. Rainfall - Decile 1 (mm/month) | 0.0 | 0.0 | 0.6 | 5.4 | 38.7 | 79.0 | 85.4 | 61.6 | 34.8 | 18.4 | 5.3 | 0.2 |
| Effective Rainfall Fraction | 0.6 | | | | | | | | | | | |
| Effective Rainfall - Average Year (mm) | 5.3 | 8.9 | 9.7 | 25.0 | 60.4 | 98.6 | 95.6 | 70.8 | 43.2 | 26.9 | 15.7 | 6.2 |
| Effective Rainfall - Decile 1 Year (mm) | 0.0 | 0.0 | 0.4 | 3.2 | 23.2 | 47.4 | 51.2 | 37.0 | 20.9 | 11.0 | 3.2 | 0.1 |

CROP WATER REQUIREMENT & IRRIGATION SUMMARY

| | | | | | | | | | | | | |
|-----------------------------------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| Crop Factor | 0.44 | 0.38 | 0.38 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.22 | 0.38 | 0.44 |
| Crop Water Requirement (mm/month) | 138.2 | 112.9 | 91.9 | 33.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.9 | 41.6 | 84.0 | 122.8 |
| Irrigation Requirement (mm) | | | | | | | | | | | | |
| Average Rainfall Month (mm) | 132.8 | 104.0 | 82.2 | 8.0 | 0 | 0 | 0 | 0 | 0 | 14.7 | 68.3 | 116.6 |
| Decile 1 Rainfall Month (mm) | 138.2 | 112.9 | 91.5 | 29.8 | 0 | 0 | 0 | 0 | 0 | 30.5 | 80.8 | 122.6 |
| Irrigation Requirement (kL) | | | | | | | | | | | | |
| Average Rainfall Month (kL) | 4076 | 3191 | 2522 | 245 | 0 | 0 | 0 | 0 | 0 | 451 | 2097 | 3578 |
| Decile 1 Rainfall Month (kL) | 4240 | 3464 | 2809 | 913 | 0 | 0 | 0 | 0 | 0 | 937 | 2480 | 3764 |

| | | |
|-------------------------------|-------------|-----------|
| Average Annual Evaporation | 2104 | mm |
| Average Annual Rainfall | 777 | mm |
| Annual Crop Water Requirement | 636 | mm |

| | |
|--|---------------|
| Current Crop Allocation (kL/ha/yr) | 5,000 |
| Crop Area or Property size (ha) | 3.069 |
| Licensed Allocation (kL/yr) | 15,346 |
| System Efficiency (DU ₂₅ %) | 0.65 |

ALLOCATION SUMMARY

| | | | |
|---|---------------|--------------|--|
| Theoretical Irrigation Requirement | | | |
| Average Rainfall Year | 16,160 | kL/yr | |
| Decile 1 Rainfall Year | 18,607 | kL/yr | |
| Calculated Crop Allocation (DU% Adjusted) | | | |
| Average Rainfall Year | 24,862 | kL/yr | |
| Decile 1 Rainfall Year | 28,627 | kL/yr | |
| Potential Crop Area - Current Allocation (DU% Adjusted) | | | |
| Average Rainfall Year | 1.9 | ha | |
| Decile 1 Rainfall Year | 1.6 | ha | |

Additional Comments: Irrigation Requirement (mm) = Crop Water Requirement - Effective Rainfall (avg year). Irrigation Requirement (kL) = Water Deficit (average) X Crop Area (ha) x 10,000 ÷ 1000.

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING FOR OUR COUNTRY



WATER BUDGET CALCULATOR

Crop: **Table Grape - Mid**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|------|------|------|------|-------|-------|-------|-------|------|------|------|------|
| Average Monthly Evaporation (mm) | 314 | 297 | 242 | 150 | 93 | 66 | 65 | 81 | 108 | 189 | 221 | 279 |
| Average Daily Evaporation (mm) | 10.1 | 10.6 | 7.8 | 5.0 | 3.0 | 2.2 | 2.1 | 2.6 | 3.6 | 6.1 | 7.4 | 9.0 |
| Average (mean) Rainfall (mm/month) | 8.9 | 14.8 | 16.2 | 41.7 | 100.7 | 164.4 | 159.3 | 118.0 | 72.0 | 44.8 | 26.1 | 10.3 |
| Aver. Rainfall - Decile 1 (mm/month) | 0.0 | 0.0 | 0.6 | 5.4 | 38.7 | 79.0 | 85.4 | 61.6 | 34.8 | 18.4 | 5.3 | 0.2 |
| Effective Rainfall Fraction | 0.6 | | | | | | | | | | | |
| Effective Rainfall - Average Year (mm) | 5.3 | 8.9 | 9.7 | 25.0 | 60.4 | 98.6 | 95.6 | 70.8 | 43.2 | 26.9 | 15.7 | 6.2 |
| Effective Rainfall - Decile 1 Year (mm) | 0.0 | 0.0 | 0.4 | 3.2 | 23.2 | 47.4 | 51.2 | 37.0 | 20.9 | 11.0 | 3.2 | 0.1 |

CROP WATER REQUIREMENT & IRRIGATION SUMMARY

| | | | | | | | | | | | | |
|-------------------------------------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| Crop Factor | 0.44 | 0.44 | 0.38 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.22 | 0.33 | 0.38 |
| Crop Water Requirement (mm/month) | 138.2 | 130.7 | 91.9 | 33.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.9 | 41.6 | 72.9 | 106.0 |
| Irrigation Requirement (mm) | | | | | | | | | | | | |
| <i>Average Rainfall Month (mm)</i> | 132.8 | 121.8 | 82.2 | 8.0 | 0 | 0 | 0 | 0 | 0 | 14.7 | 57.3 | 99.8 |
| <i>Decile 1 Rainfall Month (mm)</i> | 138.2 | 130.7 | 91.5 | 29.8 | 0 | 0 | 0 | 0 | 0 | 30.5 | 69.8 | 105.9 |
| Irrigation Requirement (kL) | | | | | | | | | | | | |
| <i>Average Rainfall Month (kL)</i> | 747 | 685 | 462 | 45 | 0 | 0 | 0 | 0 | 0 | 83 | 322 | 562 |
| <i>Decile 1 Rainfall Month (kL)</i> | 777 | 735 | 515 | 167 | 0 | 0 | 0 | 0 | 0 | 172 | 392 | 596 |

Average Annual Evaporation **2104 mm**
 Average Annual Rainfall **777 mm**
 Annual Crop Water Requirement **626 mm**

Current Crop Allocation (kL/ha/yr) **5,000**
 Crop Area or Property size (ha) **0.563**
 Licensed Allocation (kL/yr) **2,813**
 System Efficiency (DU₂₅%) **0.65**

ALLOCATION SUMMARY

Theoretical Irrigation Requirement

| | | |
|-------------------------------|--------------|--------------|
| <i>Average Rainfall Year</i> | 2,906 | kL/yr |
| <i>Decile 1 Rainfall Year</i> | 3,355 | kL/yr |

Calculated Crop Allocation (DU% Adjusted)

| | | |
|-------------------------------|--------------|--------------|
| <i>Average Rainfall Year</i> | 4,471 | kL/yr |
| <i>Decile 1 Rainfall Year</i> | 5,161 | kL/yr |

Potential Crop Area - Current Allocation (DU% Adjusted)

| | | |
|-------------------------------|------------|-----------|
| <i>Average Rainfall Year</i> | 0.4 | ha |
| <i>Decile 1 Rainfall Year</i> | 0.3 | ha |

Additional Comments: Irrigation Requirement (mm) = Crop Water Requirement - Effective Rainfall (avg year). Irrigation Requirement (kL) = Water Deficit (average) X Crop Area (ha) x 10,000 ÷ 1000.

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.





WATER BUDGET CALCULATOR

Crop: **Table Grape - Late**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|------|------|------|------|-------|-------|-------|-------|------|------|------|------|
| Average Monthly Evaporation (mm) | 314 | 297 | 242 | 150 | 93 | 66 | 65 | 81 | 108 | 189 | 221 | 279 |
| Average Daily Evaporation (mm) | 10.1 | 10.6 | 7.8 | 5.0 | 3.0 | 2.2 | 2.1 | 2.6 | 3.6 | 6.1 | 7.4 | 9.0 |
| Average (mean) Rainfall (mm/month) | 8.9 | 14.8 | 16.2 | 41.7 | 100.7 | 164.4 | 159.3 | 118.0 | 72.0 | 44.8 | 26.1 | 10.3 |
| Aver. Rainfall - Decile 1 (mm/month) | 0.0 | 0.0 | 0.6 | 5.4 | 38.7 | 79.0 | 85.4 | 61.6 | 34.8 | 18.4 | 5.3 | 0.2 |
| Effective Rainfall Fraction | 0.6 | | | | | | | | | | | |
| Effective Rainfall - Average Year (mm) | 5.3 | 8.9 | 9.7 | 25.0 | 60.4 | 98.6 | 95.6 | 70.8 | 43.2 | 26.9 | 15.7 | 6.2 |
| Effective Rainfall - Decile 1 Year (mm) | 0.0 | 0.0 | 0.4 | 3.2 | 23.2 | 47.4 | 51.2 | 37.0 | 20.9 | 11.0 | 3.2 | 0.1 |

CROP WATER REQUIREMENT & IRRIGATION SUMMARY

| | | | | | | | | | | | | |
|-----------------------------------|-------|-------|-------|------|------|------|------|------|------|------|------|------|
| Crop Factor | 0.44 | 0.44 | 0.44 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.16 | 0.27 | 0.33 |
| Crop Water Requirement (mm/month) | 138.2 | 130.7 | 106.4 | 49.5 | 0.0 | 0.0 | 0.0 | 0.0 | 11.9 | 30.2 | 59.7 | 92.1 |
| Irrigation Requirement (mm) | | | | | | | | | | | | |
| Average Rainfall Month (mm) | 132.8 | 121.8 | 96.7 | 24.5 | 0 | 0 | 0 | 0 | 0 | 3.4 | 44.0 | 85.9 |
| Decile 1 Rainfall Month (mm) | 138.2 | 130.7 | 106.0 | 46.3 | 0 | 0 | 0 | 0 | 0 | 19.2 | 56.5 | 92.0 |
| Irrigation Requirement (kL) | | | | | | | | | | | | |
| Average Rainfall Month (kL) | 923 | 846 | 672 | 170 | 0 | 0 | 0 | 0 | 0 | 23 | 306 | 597 |
| Decile 1 Rainfall Month (kL) | 960 | 908 | 737 | 321 | 0 | 0 | 0 | 0 | 0 | 133 | 392 | 639 |

| | |
|-------------------------------|----------------|
| Average Annual Evaporation | 2104 mm |
| Average Annual Rainfall | 777 mm |
| Annual Crop Water Requirement | 619 mm |

| | |
|------------------------------------|--------------|
| Current Crop Allocation (kL/ha/yr) | 5,000 |
| Crop Area or Property size (ha) | 0.695 |
| Licensed Allocation (kL/yr) | 3,474 |

| | |
|--|-------------|
| System Efficiency (DU ₂₅ %) | 0.65 |
|--|-------------|

ALLOCATION SUMMARY

| | | |
|---|--------------|-------|
| Theoretical Irrigation Requirement | | |
| Average Rainfall Year | 3,537 | kL/yr |
| Decile 1 Rainfall Year | 4,091 | kL/yr |
| Calculated Crop Allocation (DU% Adjusted) | | |
| Average Rainfall Year | 5,441 | kL/yr |
| Decile 1 Rainfall Year | 6,294 | kL/yr |
| Potential Crop Area - Current Allocation (DU% Adjusted) | | |
| Average Rainfall Year | 0.4 | ha |
| Decile 1 Rainfall Year | 0.4 | ha |

Additional Comments: Irrigation Requirement (mm) = Crop Water Requirement - Effective Rainfall (avg year). Irrigation Requirement (kL) = Water Deficit (average) X Crop Area (ha) x 10,000 ÷ 1000.

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING FOR OUR COUNTRY

Challenger MkII Performance Data



| Product Code | | | SMB 13 | SMB 14 | SMB 16 | SMB 20 | SMB 22 | SMB 24 | SMB 25 | SMB 27 | TESTED |
|---------------------|-----|------|---------|---------|----------|----------|----------|----------|----------|----------|------------------|
| Nozzle Colour | | | White | Maroon | Green | Blue | Grey | Yellow | Olive | Red | A93032 A92046 |
| Nozzle Orifice (mm) | | | 1.1 | 1.3 | 1.4 | 1.6 | 1.8 | 2.1 | 2.2 | 2.4 | |
| | kPa | bar | | | | | | | | | psi* |
| Flow Rate L/hr | 100 | 1.00 | 46 (12) | 56 (15) | 72 (19) | 101 (27) | 125 (33) | 153 (40) | 167 (44) | 196 (52) | 14.5 |
| Flow Rate L/hr | 125 | 1.25 | 52 | 64 | 81 | 113 | 139 | 172 | 186 | 219 | |
| Flow Rate L/hr | 150 | 1.50 | 55 (14) | 70 (18) | 90 (24) | 125 (33) | 150 (40) | 185 (49) | 200 (53) | 240 (63) | 21.8 |
| Flow Rate L/hr | 175 | 1.75 | 61 | 75 | 95 | 134 | 165 | 202 | 220 | 261 | |
| Flow Rate L/hr | 200 | 2.00 | 65 (17) | 80 (21) | 101 (27) | 143 (38) | 176 (46) | 215 (57) | 235 (62) | 278 (73) | 29.0 |
| Flow Rate L/hr | 225 | 2.25 | - | - | - | - | 187 | 227 | 253 | 295 | |
| Flow Rate L/hr | 250 | 2.50 | - | - | - | - | 197 | 244 | 266 | 311 | |
| Radius (metres) | 100 | 1.00 | 3.4 | 3.4 | 3.8 | 4.0 | 4.8 | 4.8 | 4.9 | 4.9 | |
| Radius (metres) | 150 | 1.50 | 3.5 | 3.7 | 4.3 | 4.6 | 5.0 | 5.4 | 5.5 | 5.5 | |
| Radius (metres) | 200 | 2.00 | 3.5 | 3.8 | 4.4 | 4.8 | 5.3 | 5.7 | 5.7 | 5.7 | |
| Stream Height (m) | 150 | 1.50 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.7 | 0.7 | |

Note: Shaded area denotes recommended operating pressure & discharge.

* psi with US Gallons/hr.

This project is supported by Perth Region NRM, through funding from the Australian Government's Caring for our Country.



CARING
FOR
OUR
COUNTRY