



Impacts of Different Irrigation Strategies in Sweet Cherry

Final Report

May 2025

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Summary

Central Otago provides an ideal environment for quality sweet cherry production however, good irrigation practice is critical to maximise fruit quality.

An irrigation literature review followed by practical irrigation trials was conducted in four Central Otago cherry orchards during the 2023-24 season. While the project provided useful insights for growers around good irrigation practice, unfortunately the paired site method used for the trials was not successful.

The irrigation trials were redesigned for the 2024-25 season to ensure the good practice, under and over irrigation treatments could be successfully applied, and the resulting impacts on fruit quality and export pack out comprehensively assessed.

The 2024-25 season trial results clearly demonstrated the benefits of closely monitoring irrigation to achieve good practice. The main findings were:

- The good practice irrigation treatment export pack out increased by >10% in comparison to both the over and under irrigation treatments.
- Under irrigation had a more significant impact than over irrigation when export fruit size was also considered.
- Over irrigation resulted in a slight increase in fruit size but there was less fruit of export grade.
- Under irrigation resulted in firmer fruit of higher brix but there was less fruit of export grade.
- Good practice irrigation slightly improved fruit firmness and brix in relation to over irrigation.

While the projects focused was cherries, it also has applicability to other stonefruit, particularly those are susceptible to cracking such as plums and apricots.

Future knowledge needs for growers raised through the 2024-25 irrigation season trial included:

- Peak evapotranspiration rates (crop coefficients) of the different orchard canopy types, and how to apply these in combination with a soil moisture probe and an evapotranspiration forecast, to support irrigation decision making.
- When and how best to apply fertigation in combination with irrigation, to maximise plant uptake and optimise fruit quality.

Purpose

The Impact of Different Irrigation Strategies in Sweet Cherry project purpose was to provide growers with practical information around the benefits of implementing good irrigation practice. The project involved practical irrigation trials followed by the provision of the findings to growers.

Background

Central Otago provides an ideal environment for growing sweet cherries however, drought conditions and/ or heavy rainfall events can reduce export pack-outs through increased incidence of fruit cracking and reduced fruit firmness. To manage the impacts from drought and/ or rainfall good irrigation management critical.

During the 2023-24 growing season Primary Insight undertook a literature review of good irrigation practice for sweet cherry production. Points of note included:

- Pre-harvest - Maintaining soil moisture at approximately 85% of field capacity and stem water potential above -7 to -8 Bar reduced incidences of cracking and improved overall fruit quality.
- Post harvest – Dropping to soil moisture levels between 55-60% of field capacity and stem water potentials above -15 bar reduced vegetative growth while having no impact on the following seasons crop.
- Crop coefficients for sweet cherries with a grass inter row over the growing season typically start at 0.4 (budburst) and over a 90-day period increase to a maximum of 1.05 depending on the canopy type. From day 150 onwards they then decrease down to 0.4 (leaf fall).
- High frequency irrigation (little and often) provided improved yield over low frequency irrigation.

Paired irrigation trials were also conducted in four different Central Otago cherry orchards during to understand the benefits of adopting the findings of the literature review.

While the 2023-24 season project provided useful insights to growers, unfortunately the paired trial site method was not successful. This was due to growers either adjusting their own irrigation to align with the trial irrigation strategy, or the grower's irrigation control system not practically allowing for a differential approach to irrigation. The project was also unable to assess the impact of the trial irrigation strategy on fruit quality, due to block level production data not being available for three of the trial sites.

For the 2024-25 season the paired trial approach was redesigned to ensure the different irrigation treatments could be successfully applied and the impacts of the treatments on fruit production understood.

Trial Setup

Two orchards were selected for the 2024-25 season irrigation trial. They included a Central Leader (CL) canopy irrigated by offset micro-sprinklers, and an Upright Fruiting Offshoot (UFO) canopy irrigated by double dripline. At each trial site 3 irrigation treatments were applied (good practice, over and under). Details of the trial sites and treatments are provided in table 1.

Each treatment consisting of 6 trees along the same row and had the following monitoring equipment installed:

- A Sentek 90cm Drill and Drop soil moisture probe in the good practice treatment and 60cm Drill and Drop soil moisture probes in the under and over. These measure soil moisture and temperature at 10 cm intervals down the probe every 10 minutes.
- A FloraPulse stem water potential sensor. These measure the negative tension in the tree's xylem (how stressed the tree is) every 10 minutes with the
- A commercial grade rain gauge.

The soil moisture probes were located adjacent to the tree with the stem water potential sensors installed.

All data was collected using the Harvest Electronics telemetry system. Data was then transferred to Sentek's IrriMAX Live website to allow for improved data display, analysis, and decision-making.

Seven-day weather forecasts, including daily evapotranspiration, wind speed, humidity, rainfall, and air temperature were also provided through the Meteoblue service.

From 3 weeks prior to harvest through to harvest weekly fruit quality samples were taken and analysed for size (electronic calliper), brix (digital refractometer) and firmness (fruit penetrometer). A sample size of 100 fruit was used.

At harvest the trial sites were strip picked and 5 buckets of fruit run through the each packhouses automated grading system. The pack out results from each were then recorded (export grade and size, domestic and reject).

Post harvest samples were also taken from the export grade fruit, kept in cold storage (at 1°C) and analysed at 1 week and 4 weeks post-harvest. This was to represent air and sea freight timeframes to market. A sample size of 50 fruit was used for each.

Table 1: Trial Site Summary

Site	Location	Rootstock & Variety	Canopy Type	Irrigation Information	Soil Type (S-map)
Site 1	Mount Pisa	Rootstock - Colt Variety – Sentinel	Upright Fruiting Offshoot 3 m row spacings 2.5 m tree spacings	Dripline (40% coverage) 60cm dripper spacings 1.6 l/hr drippers Good Practice (standard 2 driplines) <i>Depth applied = 1.8 mm/ha/hr</i> <i>Wetted zone = 4.4 mm/hr</i> Under Irrigation (1 dripline) <i>Depth applied = 0.9 mm/ha/hr</i> <i>Wetted zone = 2.2 mm/hr</i> Over Irrigation (3 driplines) <i>Depth applied = 2.7 mm/ha/hr</i> <i>Wetted zone = 6.6 mm/hr</i>	Ardgou_9a.1 - Loam with high stone content below 50 cm PAW ₃₀ = 49 mm PAW ₆₀ = 64 mm PAW ₁₀₀ = 64 mm
Site 2	Clyde	Rootstock – Colt Variety – Staccato	Central Leader 5 m row spacings 2.5 m tree spacings	Micro-sprinklers (100% coverage) One sprinkler per two trees Good Practice (97 l/hr sprinkler heads) <i>Depth applied = 3.9 mm/ha/hr</i> Under Irrigation (45 l/hr sprinkler heads) <i>Depth applied = 2.1 mm/ha/hr</i> Over Irrigation (170 l/hr sprinkler heads) <i>Depth applied = 6.8 mm/ha/hr</i>	Clydemot_4a.1 - Silt with high stone content below 40 cm PAW ₃₀ = 61 mm PAW ₆₀ = 90 mm PAW ₁₀₀ = 129 mm

2024-25 Season Climate Summary

Figures 1 and 2 show the rainfall and Potential Evapotranspiration (PET) from the Cromwell weather station for the 2024-25 growing season. They also show the 10-year rolling average values.

Rainfall was significantly above the 10-year rolling average for September and October, above average for December and April, below average for March, and significantly below average for November, January and February.

Potential Evapotranspiration (ET_o) was above the 10-year rolling average in every month apart from October. January and February were notably above average.

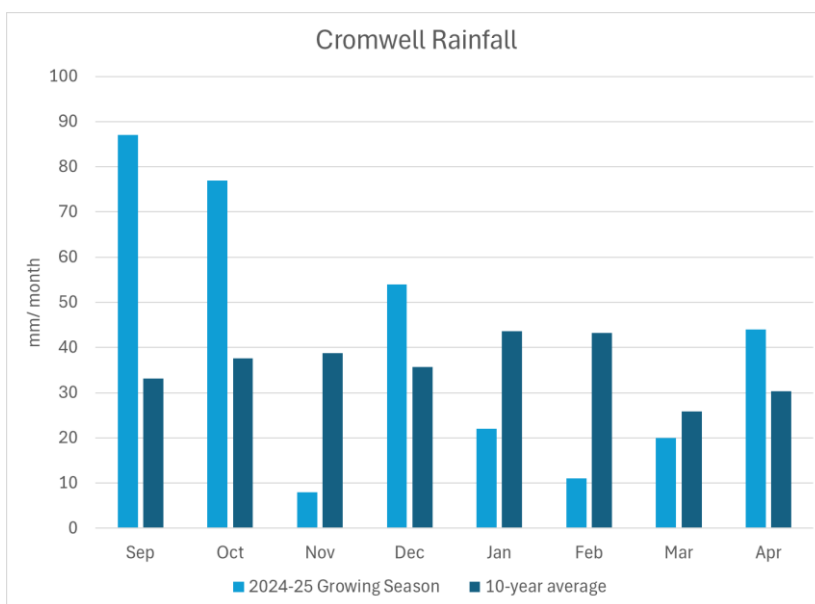


Figure 1: Cromwell 2024-25 Season Rainfall

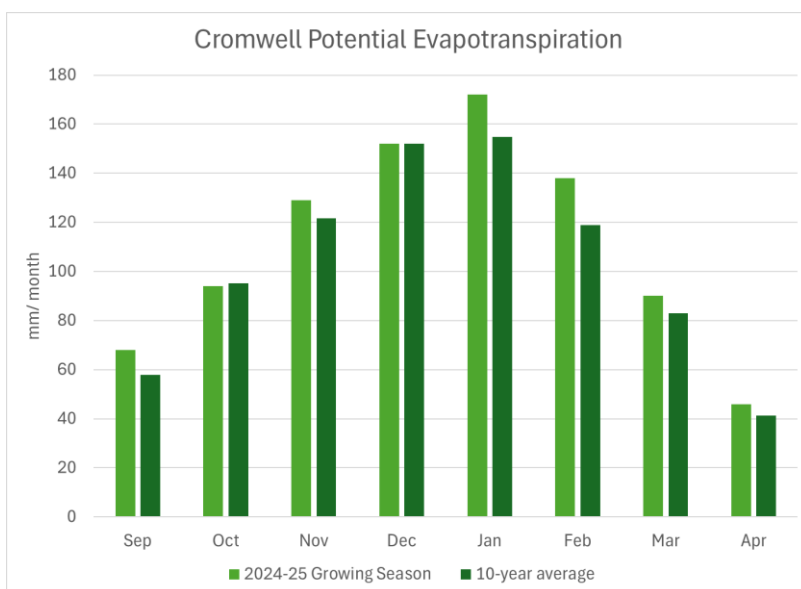


Figure 2: Cromwell 2024-25 Season Potential Evapotranspiration

Trial Findings

Irrigation & Plant Stress

Figures 3 and 4 show the soil moisture and stem potential data for the good practice irrigation pre and post-harvest. The under and over irrigation data is contained in Appendix 1. These demonstrate the differences in soil moisture and plant stress for each of the treatments at each site.

The objective for the soil moisture trace was to maintain irrigation at the bottom of the green zone. For the stem water potential trace the objective was to maintain the lowest daily reading in the green zone pre-harvest and in the yellow zone post-harvest.

The good practice treatments irrigation largely followed the recommended irrigation approach at each site. The over irrigation resulted in reasonably wet soil conditions with no plant stress, and under irrigation resulted in dry soil conditions with the trees experiencing moderate to high stress.

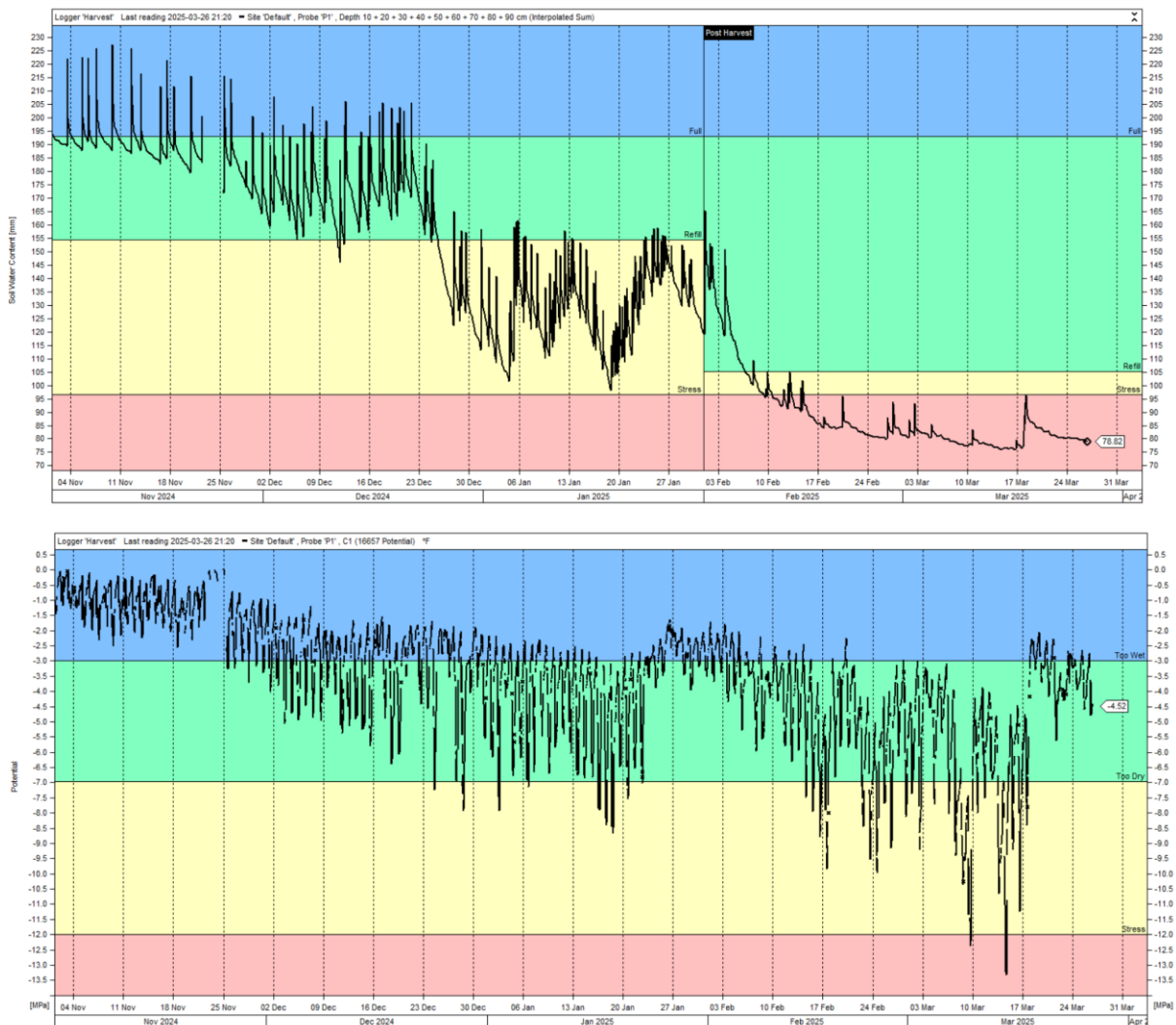


Figure: 3 Trial Site 1 Good Practice Soil Moisture (Top) and Stem Water Potential (Bottom)

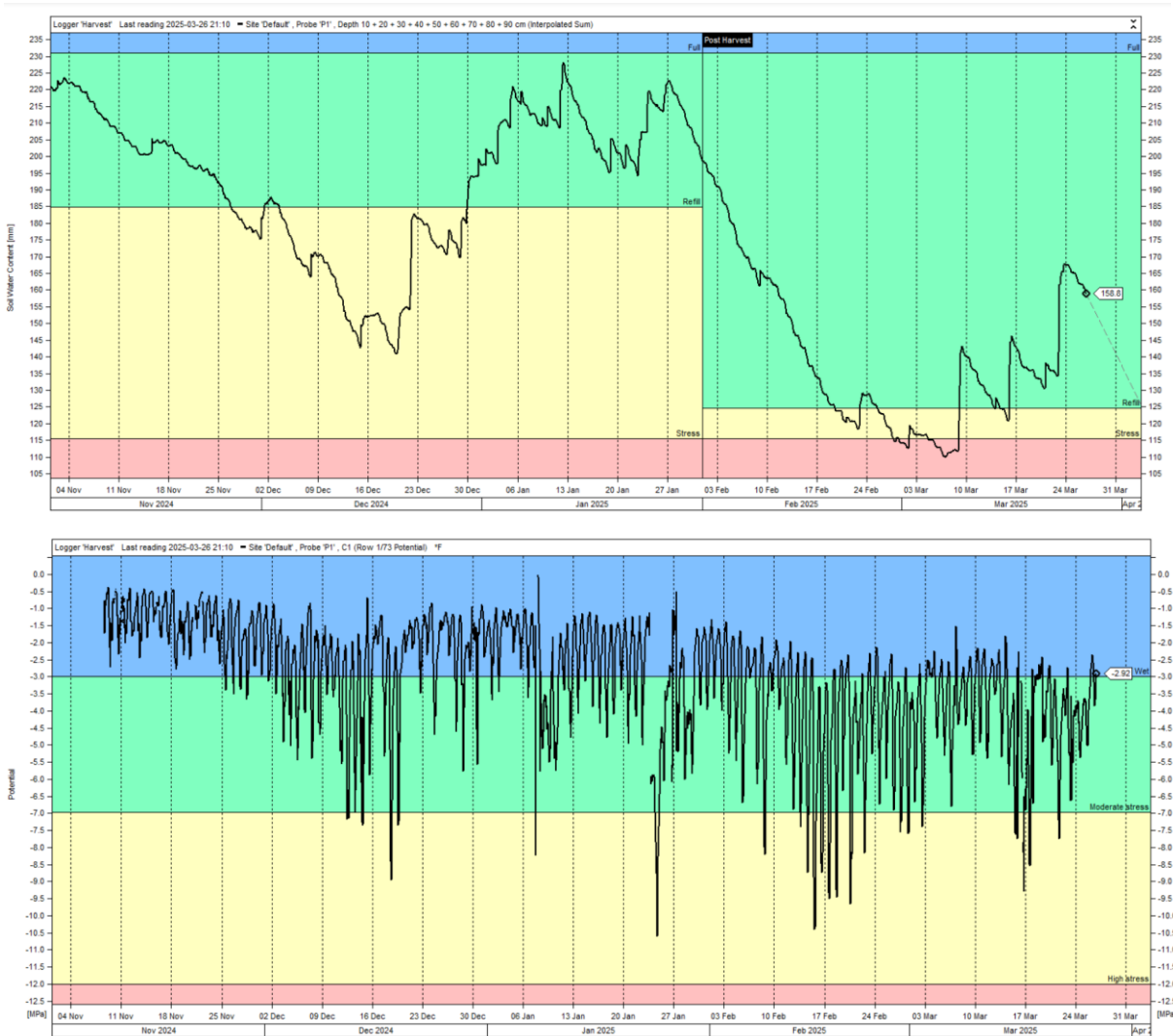


Figure: 4 Trial Site 2 Good Practice Soil Moisture (top) and Stem Water Potential (bottom)

Export Packout

Figure 5 shows there were notable differences in the export pack out percentage between the good irrigation and under and over irrigation treatments. In comparison with good irrigation, under irrigation resulted in a 17% reduction for site 1 and 8% for site 2, and over irrigation resulted in a 10% reduction for both sites.

Figure 6 shows there was also a difference in the distribution of fruit size for the export pack out. Under irrigation had a higher percentage of smaller sizes. Good practice and over irrigation had a similar distribution, noting for site 2 good practice had a slightly higher percentage of larger sizes and for site 1 over irrigation had the higher percentage.



Figure 5: Packout Percentages

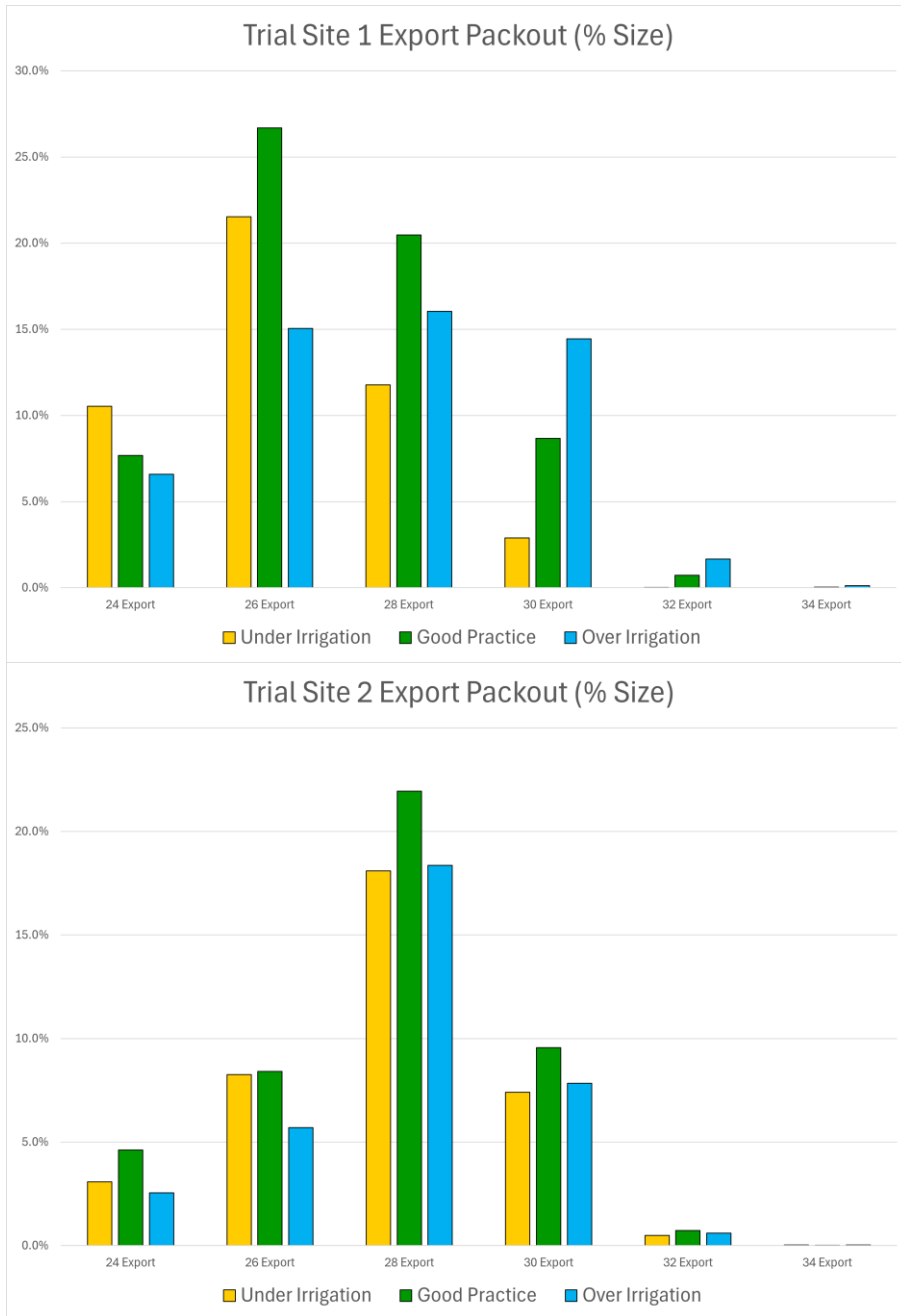


Figure 6: Export Packout Size Distribution

Fruit Quality

Figure 7 shows fruit firmness was typically greatest for the under-irrigation treatment, and the least firm for the over-irrigation treatment. This trend was consistently observed in all samples. However, it should be noted there was a relatively large range in the measured data.

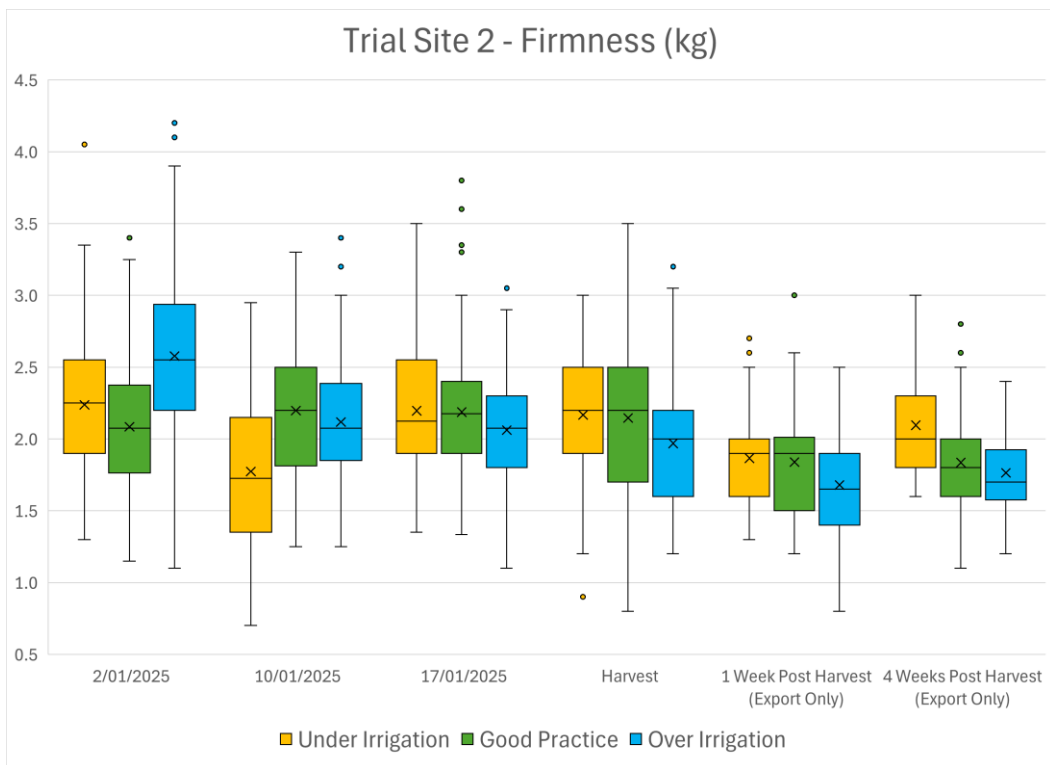


Figure 7: Fruit Firmness

Appendix 2 shows fruit brix levels were typically highest for the under-irrigation treatment, and lowest for the over-irrigation treatment. This trend was consistently observed in all samples. However, again there was a large range in the measured data for each.

Appendix 3 shows fruit size was typically largest for the over-irrigation treatment, and smallest for the under-irrigation treatment. This trend was consistently observed in all samples and is also consistent with the pack-out data.

General Observations

Fruit position in the canopy

The pre-harvest and harvest samples were divided into top and bottom of the canopy (50 from each). It was noted that the fruit at the top of the canopy was typically of slightly greater size and higher brix, however there appeared to be little difference in fruit firmness.

Little and often versus deep irrigations

One of the sites adopted a high frequency irrigation approach whereas the other used deeper irrigations. The less frequent deep irrigations had a greater incidence of cracking in its reject data set, although it should be noted this orchard was not netted.

Location of soil moisture sensors under drip micro-sprinkler systems

For offset micro-sprinkler systems with 1 sprinkler per 2 trees distribution uniformity is often poor, unmanaged weed strips and low hanging branches can also impact uniformity. Locating sensors in an area that represents the average irrigation applied is key if under and over irrigation is to be avoided. For sandy soil types with high stone content this becomes even more critical.

Use of 60cm versus 90cm soil moisture probes in orchards

While 60cm soil moisture probes can be successfully used for orchard irrigation scheduling, a 90cm probe provides a much better understanding of the available moisture in the plant root zone.

Stem water potential sensor installations

Stem water potential sensor installations appear to provide robust information for 2 seasons before they will need to be re-installed.

Conclusion

The 2024-25 season irrigation trial was successful in demonstrating the benefits of closely monitoring irrigation to achieve good practice irrigation.

- The good practice irrigation export packout was around 10% greater in comparison to over and under irrigation.
- Under irrigation has a more significant impact than over irrigation when export fruit size was also considered.
- While over irrigation resulted in a slight increase fruit size as there were fewer fruit of export grade adopting good irrigation practice is of greater benefit.
- Under irrigation results in firmer fruit of higher brix but there are fewer fruit of export grade.
- Fruit firmness and brix were slightly improved by good practice irrigation in relation to over irrigation.

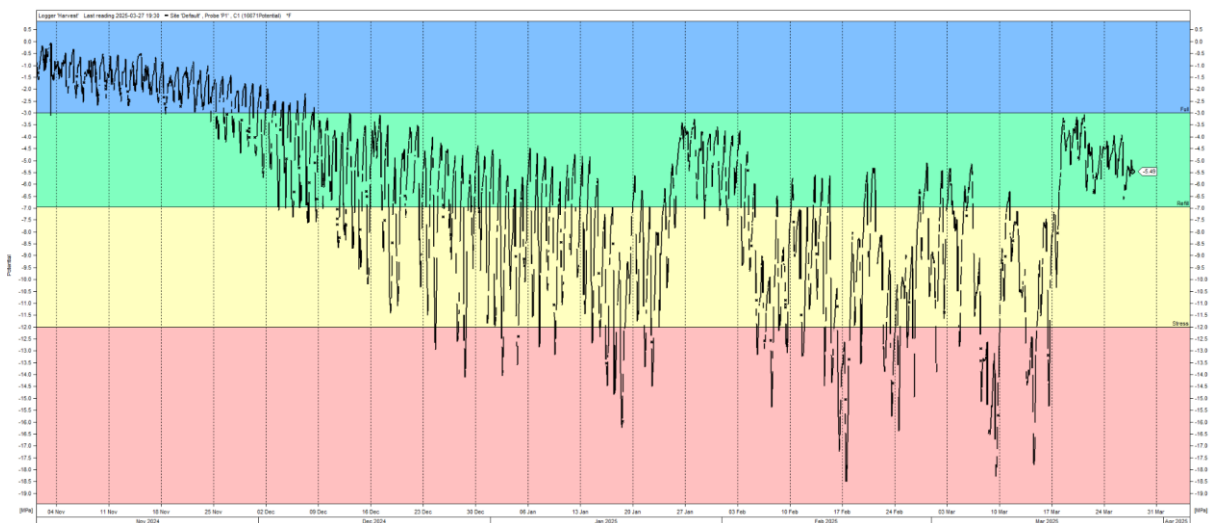
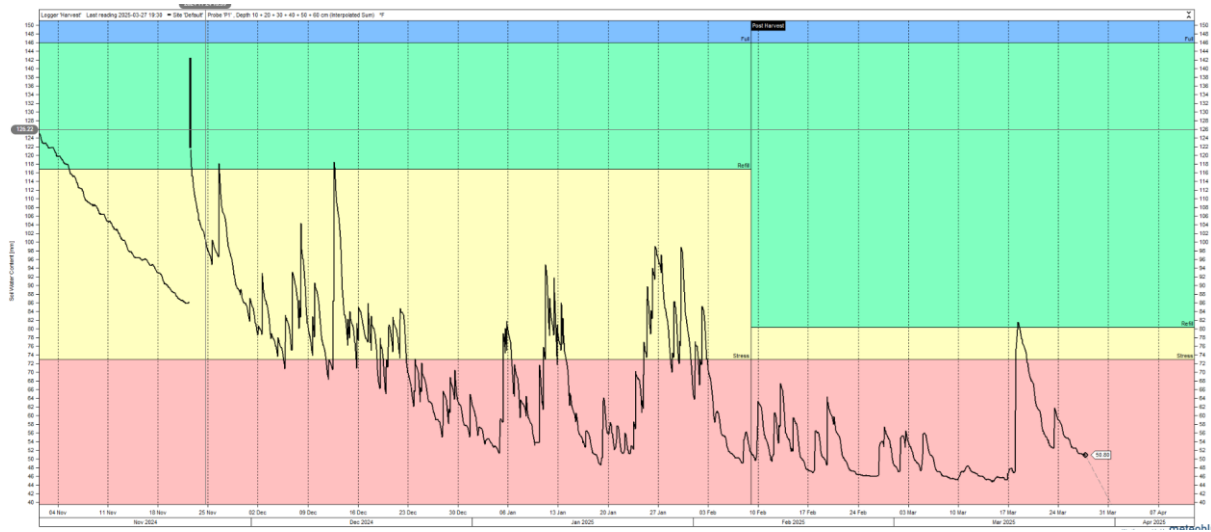
Future Investigations

Two areas were identified through the 2024-25 season irrigation trials that may warrant further investigation:

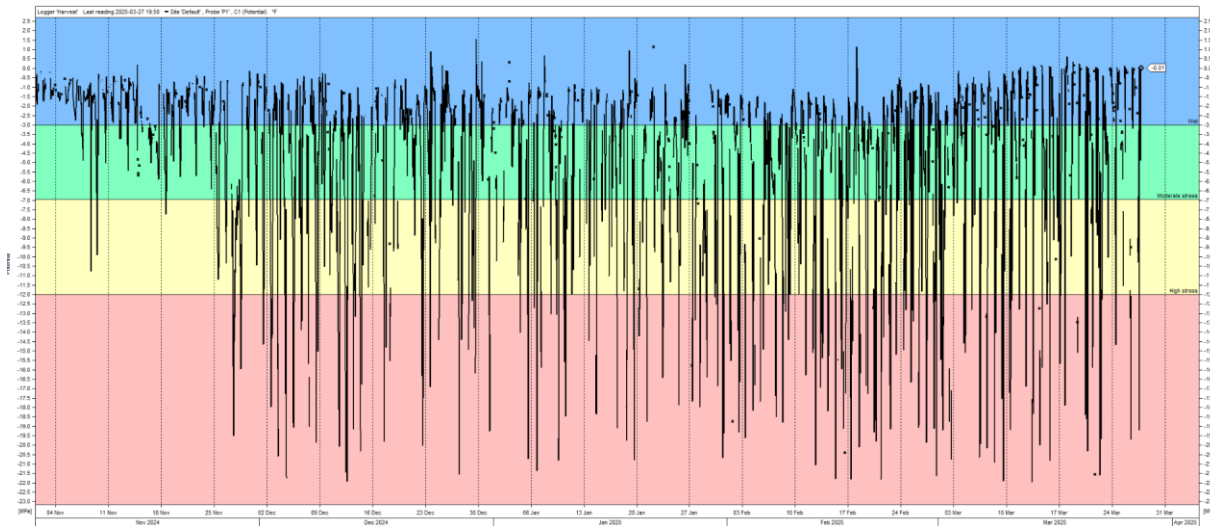
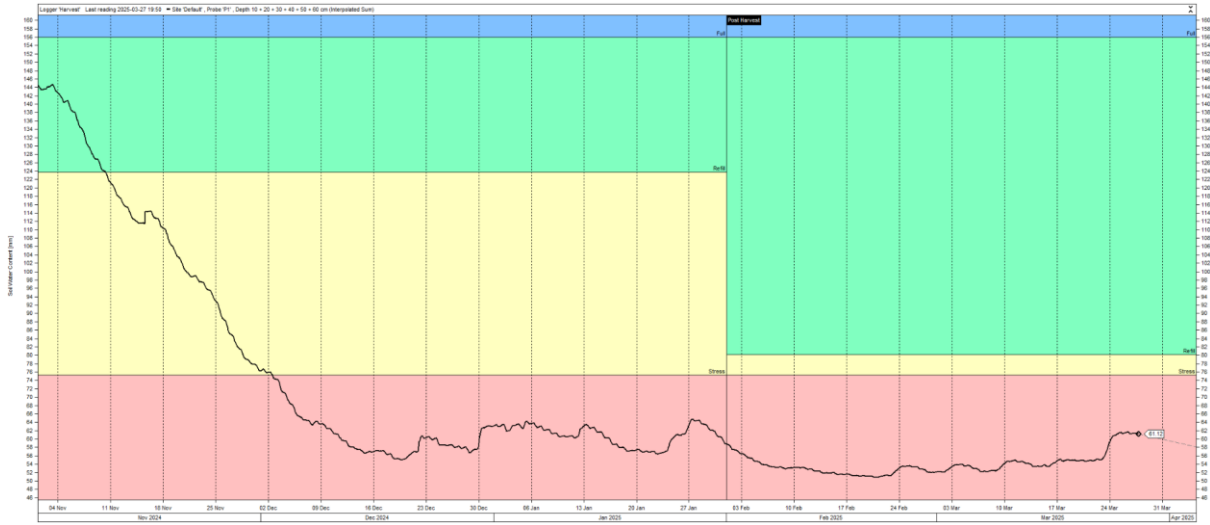
1. There is a lack of knowledge around the evapotranspiration rates for the different orchard canopy types at peak. Better quantifying this could help growers more easily achieve good irrigation practice. When used in combination with a soil moisture probe and an evapotranspiration forecast, this knowledge would allow growers to refine daily irrigation depths to more easily maintain specific soil moisture levels.
2. Many growers are now using fertigation, and there are questions around when and how best to apply it in conjunction with irrigation to optimise plant uptake and ultimately fruit quality.

Appendix 1: Trial Site Soil Moisture and Stem Potential Data

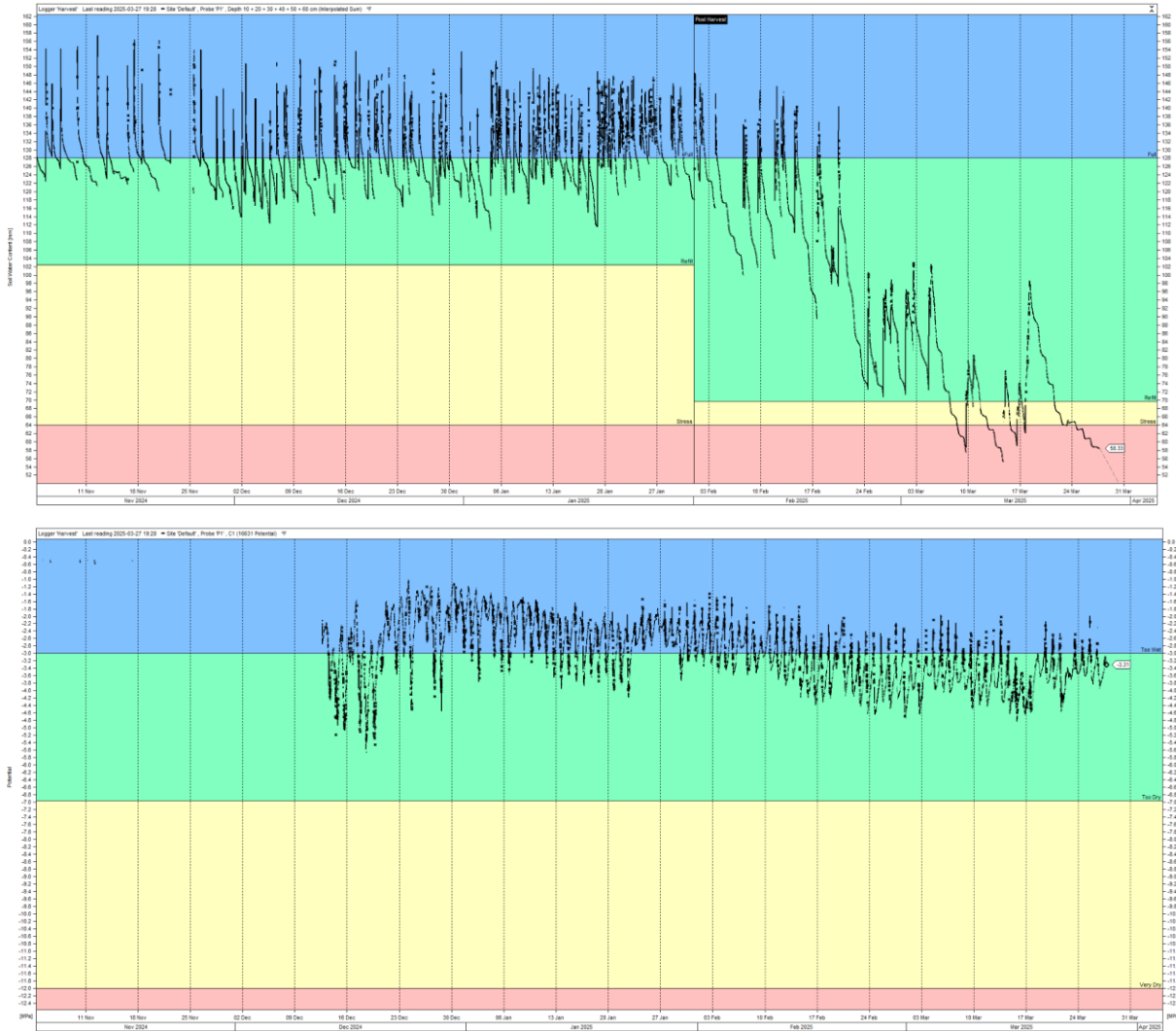
Trial Site 1 Under Irrigation Soil Moisture and Stem Water Potential



Trial Site 2 Under Irrigation Soil Moisture and Stem Water Potential



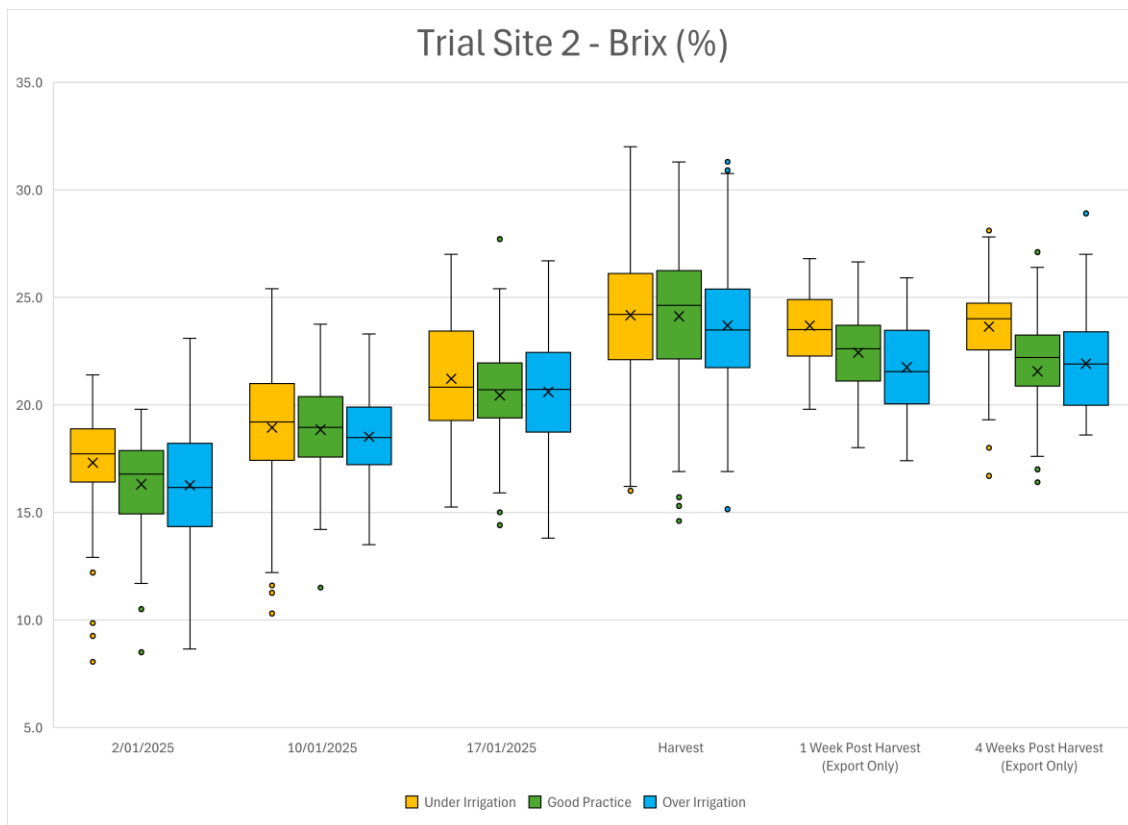
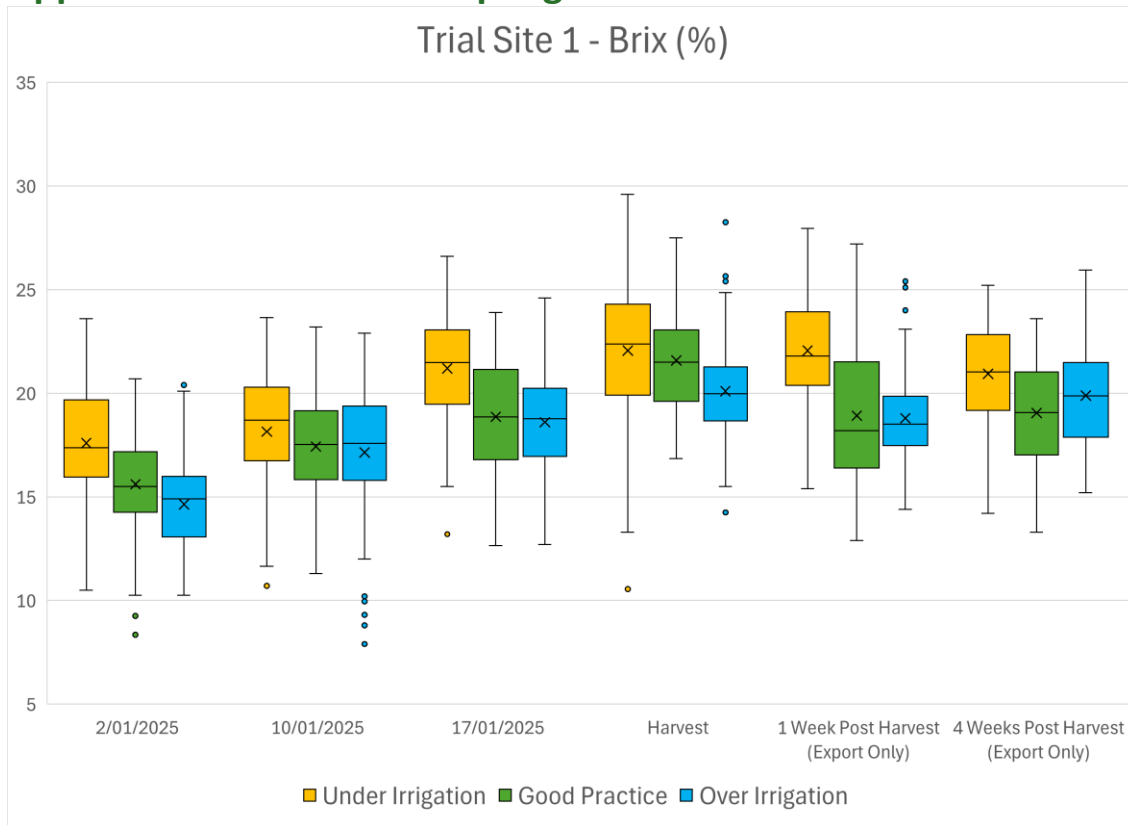
Trial Site 1 Over Irrigation Soil Moisture and Stem Water Potential



Trial Site 2 Under Irrigation Soil Moisture and Stem Water Potential



Appendix 2: Fruit Brix Sampling Data



Appendix 3: Fruit Size Sampling Data

