Orchard irrigation performance: Permanent under-tree sprinklers

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Previously we reported on our observations of two suspended sprinkler irrigation systems operating on pip and stone fruit orchards. We stressed the need to keep filters and sprinklers in good condition, and to ensure correct pressures at all points in the system.

This month we are presenting results from another evaluation of orchard irrigation that uses bigger sprinklers, each covering a number of trees. This was a permanent under-tree system with sprinklers every third tree in every second row. Our jargon term for these is "spraylines".

For such systems, we measure the evenness of application using a grid of collectors, then consider the effects of pressure or flow variation between sprinklers in different parts of the orchard or irrigation block.

The evaluation is one of a series conducted under a Sustainable Farming Fund Project. Supported by Hawke's Bay Regional Council, Pipfruit NZ and Summerfruit NZ, it is investigating the performance of a range of irrigation system types used on apple and stonefruit orchards in Hawke's Bay.

The purpose of an on-orchard evaluation is to assess current performance, identify issues detracting from best performance, and to propose actions that can improve performance. Performance includes evenness of watering, adequacy of watering, and efficiency of water and energy use.

Evenness of watering is important if each plant is to receive the same (correct) amount of irrigation. It depends on having the correct combination of sprinkler or emitter performance, spacing and run times.

Permanent under-tree sprinkler systems

The permanent under-tree system is different to a typical micro-irrigation system because each sprinkler covers an area equivalent to six trees. There is some overlap between adjacent sprinklers which are on a semi-triangular layout.

The system evaluated was well designed and properly installed. It has good maintenance and good scheduling. The capacity of the system is sufficient and allows for irrigation as required.

There is no water meter fitted to this irrigation system, so management relies on assumed application rates and run times to target certain applied depths. On this orchard, an independent soil moisture monitoring consultant provides checks and works with the manager to optimise irrigation applications.

Determining uniformity

To assess this system we set up a grid of 48 collectors between six adjacent sprinklers and ran the irrigation for two hours.

View of orchard row with grid of collectors in place.

We had to use low collectors because the trajectory of water from the low sprinklers was only just about the ground. Their opening is 65mm in diameter, which is the smallest we consider usable.

View of collector used to measure irrigation uniformity.

We measured the depth of water in the collectors and divided by the area of the collector opening to determine the depth of irrigation applied.

We used the information about collected depths to create a map of irrigation uniformity. This is shown in Figure 1. The graph is like a contour map showing how much water landed at points across the measured area.

Results

Based solely on the grid collectors, the system has a Distribution Uniformity of DU_{GRID} = 0.43 which is very poor indeed and highlights a risk of some areas being over-wetted and losing water through deep drainage. What limited performance?

One of the main factors affecting this system was sprinkler interference by weeds, low branches and the tree trunks near the sprinklers. Compounding this were sprinklers that were not set horizontally. The resulting 'rain shadows' and distorted spray

Measuring the volume of irrigation collected.

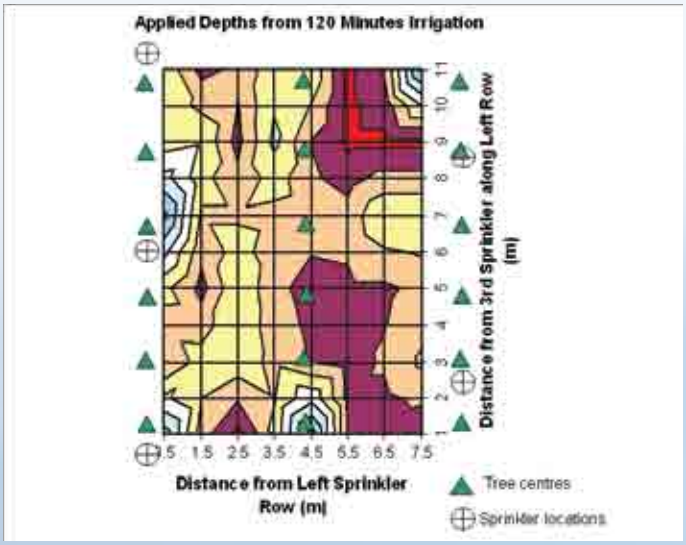

Fig 1: Contour map of irrigation depth applied.

patterns meant some areas received a lot of extra water while others received little or none.

The big question is, "What effect does this have on tree performance?" If we were looking at a field crop with many small plants, we could assume that some would be missing out and would be stressed.

However, in this case we are looking at big trees, whose roots will be extending at least as much as the canopy above. So it is important to consider the amount of water being received by each plant, not just by each collector.

We estimated the average ***applied*** depth of irrigation reaching individual trees by adding data collected in $8m^2$ blocks. The resulting values are shown in Table 1.

Table 1: Average Applied Depth in Tree Root Areas		
Dist (m) from Sprinkler #3	**Side Rows Depth (mm)**	**Middle Row Depth (mm)**
11	7.4	5.3
9	4.4	4.3
7	9.0	5.2
5	4.5	4.8
3	5.3	5.0
1	5.9	6.6

The mean *(average)* of all the ***applied depth*** values is 5.65 mm, and the mean of the lowest quarter (three) values is 4.43 mm. ***So*** the distribution uniformity on this whole tree basis is DU_{TREE} = 0.78. This is generally considered a fair result.

The "tree by tree" assessment used a very limited number of sample points per tree and allowed for no cross over of roots between adjacent trees. Overall, we think the uniformity on an individual tree basis could be as high as DU_{TREE} = 0.85.

Of course, all this is based on measurements in one small part of a large orchard. We repeated the measurements in another position and the pattern was very similar. Because the sprinklers in both test areas were working correctly (flows were the same, no blockages etc) we believe it is a fair representation.

But we were still interested in assessing variability across the many blocks. We did this by checking the pressure at the beginning, middle and end of the first and last spraylines in each block. We found these were generally very even, reflecting if anything 'over design', or using pipes a bit bigger than may have been necessary.

In summary we think this system is working satisfactorily. It has the capacity to get the correct amount of water on to each block as required. Within the blocks, the trees are receiving reasonably similar amounts of water. The bigger sprinklers have larger nozzle orifices than micro-irrigation systems, so they are less likely to block.

With good scheduling, which appears to be the case on this orchard, about 75% of the water pumped is likely to be stored in the soil and used by the trees. Removing under-storey interference and checking sprinklers are set horizontal would raise this further – perhaps to about 80%.

Conclusions

The irrigation performance on this orchard is generally good. Distribution uniformity could be increased by removing under storey weeds and low branches that are affecting the distribution pattern.

We also noted that the application rates we measured (2.8mm/hr) were lower than the orchardist indicated (3.3mm/hr). However, the soil moisture monitoring was used to ensure levels were kept within target bands, so this does not appear to compromise production.

It is essential to know the system is operating correctly. To easily check this you need to know what the system and block pressures and flows should be. Any deviation indicates something is not right and needs to be investigated. Get a water meter, get pressure points and gauges, and get a logbook to record your results.