

Micro-Sprinkler orchard irrigation performance

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Clean your filters, check your pressures, check your sprinklers. Know what pressures and flows should be.

Two suspended mini-sprinkler irrigation systems on pip and stone fruit orchards have just been evaluated. The results were variable, and highlight a few issues that warrant attention. The evaluations indicate that with some simple changes these systems could irrigate crops effectively and efficiently.

The evaluations are part of a series being 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. Reports from other system types will follow in coming months. The findings are likely to be relevant to other regions where orchards are using similar irrigation systems.

Why evaluate?

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.



Picture 1. Inside a filter clogged with sand and iron. Cleaning this blocked ring filter slashed pressure losses, increasing irrigation performance and reducing energy consumption.

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.

Adequacy of watering considers whether each plant gets enough water, and if enough of the potential root volume is irrigated. If the system can apply water evenly, adequacy depends mainly on scheduling decisions and the system's capacity to 'get around' the whole area fast enough.

Efficient water use is determined through estimation of losses. These are predominantly related to uneven watering and excessive irrigation run times. Minor losses result from system leakages or off-target applications.

Energy efficiency is dependent firstly on watering efficiency – there is no benefit from pumping water that is not used by the crop. The second factor relates largely to system design issues – are the pipelines correctly sized to minimise friction losses at reasonable capital cost? And thirdly, has the right pump and motor combination been selected to drive the whole system? Sadly, many studies have shown this is not the case – oversized pump units are common.

What did we find?

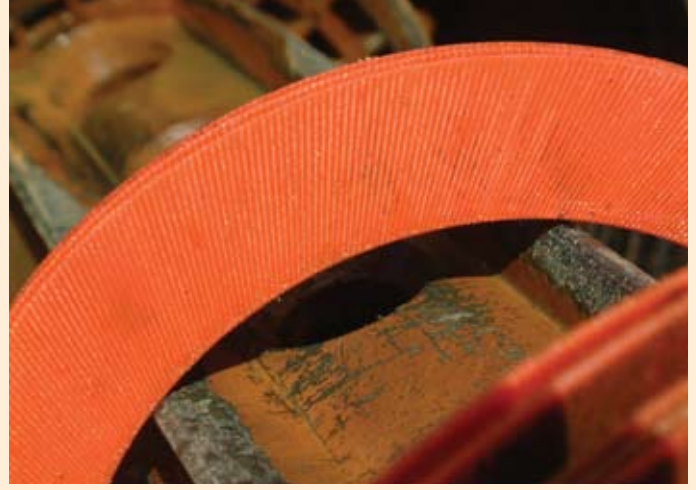
The potential application efficiency was lower than can be achieved by such systems. It is reasonable to expect over 85% of water applied to be available to the crop when using micro-irrigation. On the day we tested, the potential application efficiency of these systems was about 60%.

The main reason for lack of performance was lack of uniformity, i.e. uneven application. As noted, evenness depends on several factors, so what was going on here?

Orchard 1's irrigation system is nine years old. The water supply is reasonably clean, and a tubular screen filter is cleaned regularly.

The Orchard 2 irrigation system is similar in age and water quality to Orchard 1. A disk ring filter is installed, but as shown in Pictures 1 and 2, was not clean when we checked the system.

Picture 3 shows the filter rings after a quick clean. The difference reduced pressure losses from 195kPa loss to 60kPa loss. This represents a very significant energy saving, and is likely to be affecting system performance as well. Better cleaning would reduce this still further.



Picture 2. Close up of filter rings, cleaning desperately needed.

Picture 3. Close up of filter rings, after cleaning. Photos by Dan Bloomer

Sprinkler performance

Sprinkler performance was responsible for about a quarter of the watering variation in Orchard 1 and over half the variation in Orchard 2.

Chart 1 shows the measured flows in three different parts of Orchard 1. We selected areas we thought likely to be the cleanest, dirtiest and somewhere in between.

The chart shows the clean area had very even flows, with a little more variation creeping into the average area. By contrast, the dirty area shows a lot of variation, with some sprinklers obviously blocked, and the whole area running at a lower output rate. The reason for the overall low output is mainly a lack of

pressure getting into that area.

Orchard 1 has 'flow regulated' sprinklers. These are designed to keep a steady flow so long as the pressure is within a certain band. We tested the flows of a group of sprinklers at different pressures and found flow changed considerably. It is possible that the diaphragms have aged and no longer have the flexibility needed to regulate flow.

Chart 2 shows the measured flows in the three different parts of Orchard 2. The clean area has more variability than Orchard 1 but is still within acceptable levels. The dirty area shows more variation, and the flows are much higher than in the clean area. The flows in the average area show two quite different flow

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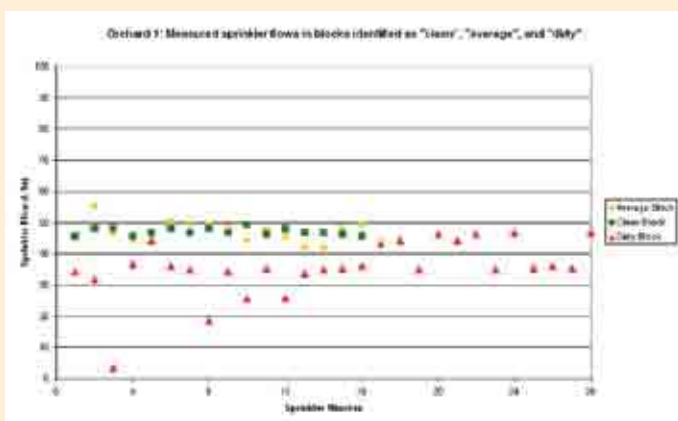


Chart 1: Showing sprinkler flows measured in clean, average and dirty areas of Orchard 1.

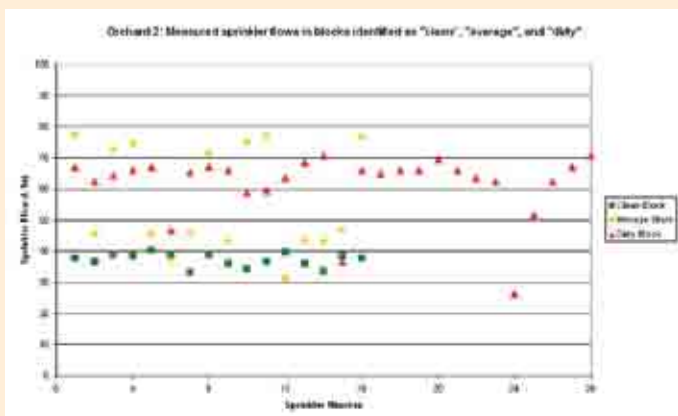


Chart 2: Showing sprinkler flows measured in clean, average and dirty areas of Orchard 2.

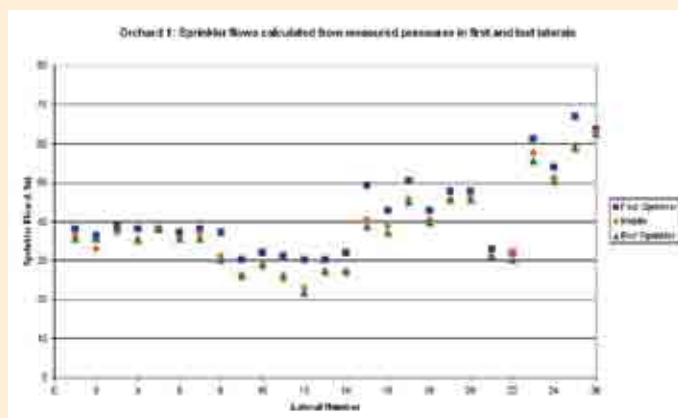


Chart 3: Showing sprinkler flows calculated from lateral line pressures measured in Orchard 2.

regimes. Some are similar to the clean area, and others similar to the dirty area.

The system design (apparently) specified ‘anti-misting’ bases on the sprinklers. These use pressure reducing plates whose small orifice causes a reduction in flow. The bigger orifices in the sprinkler nozzles produce larger droplets at the lower pressure.

Somewhat typically, over time many of the anti-mist bases have been lost. The results in Chart 2 reflect two different nozzle combinations – all in the clean area have the anti-mist, none do in the dirty area and about half still do in the average area.

Pressure performance

We tested the pressures in laterals at six points in a number of sub-blocks on each orchard. And we measured how flow varies as pressure varies to determine sprinkler pressure:flow characteristics. By combining these we were able to calculate what flows should be at each sample point.

Pressure variation was the cause of about two fifths of the variation found in Orchard 1, and one sixth in Orchard 2.

In thirteen sub-blocks on Orchard 1 we found inlet pressures ranged from 95 – 360 kPa. Within blocks, some points having pressures as low as 55kPa. It seems certain that pressure is available, but probable that pressure regulation at block take-offs needs some maintenance.

Chart 3 shows the flows that we calculated based on our pressure readings in Orchard 1. Each column of three dots represents the flow at the first sprinkler on the lateral, in the middle and at the end. Odd numbered laterals are closest to the block off-take valves. Even numbered laterals are the last laterals on each sub-main.

Chart 3 shows the inlet pressures in different blocks cause significant variation in sprinkler flow (the blue squares). Some blocks have double the flow of others as a result of these pressure differences.

Big differences between the first and last sprinklers on a lateral (the blue squares and green triangles in any column) indicate high pressure losses along a lateral. This can be due to elevation changes, blockages or leaks, or undersized lateral tubing.

Unequal plant spacing

The third contributor to uneven watering is variable plant and sprinkler spacing. The water use from an orchard with full canopy is pretty much the same, regardless of the number of plants.

One hectare of closely planted small trees will use very much the same volume of water as a hectare of larger trees planted

further apart. In both cases, around 50m³/ha of irrigation will replace 5mm of evapo-transpiration losses.

It is common for orchard tree and row spacings to vary between varieties and rootstocks. If the system is set up with one sprinkler per tree, there will be different numbers of sprinklers in a hectare of irrigation. If all the sprinklers are the same, the flow per hour going on to the different areas will also be different.

To avoid some plants getting too much irrigation, and others not enough, the areas with different spacings should be irrigated for different durations.

In both orchards, different spacings would cause almost one third of the non-uniformity of watering if all blocks were irrigated for the same length of time. But by adjusting the irrigation duration appropriately, this can virtually be eliminated.

Conclusions

The irrigation performance on both orchards can be significantly increased quite easily. A few simple adjustments to systems and their management will make a big difference.

In the case of Orchard 1, the first task is to set the pressures going into each block to the same level. With pressures corrected, the flow from individual sprinklers should be within acceptable limits. The second thing to do is schedule irrigation for each



block according to its sprinkler spacings and flows.

On Orchard 2, the first tasks are to clean the filter and to ensure the sprinklers have the correct bases. It may not matter too much if they have anti-misters or not – so long as they are all the same in any particular block. The second task is to set block pressures to be even. While the irrigation system does not have pressure regulators, it is possible to adjust the pressure at the solenoids on the block off-takes. The third task is to adjust the watering time in each block to take account of the different sprinkler spacings.

In all cases, it is essential to know what the system and block pressures and flows should be when the system is operating correctly. 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. 🌿

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