Drip irrigation variability

- how well is your vineyard drip system performing?

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in a nutshell

- Drip irrigation systems are theoretically very efficient at applying water evenly, with high distribution uniformities claimed by many manufacturers
- In commercial field situations these expectations are not always met
- Non-uniformity in applied water can have a significant impact on yield and berry quality parameters
- Techniques for identifying drip irrigation system performance range from simplistic field-based 'catch cans' to using satellite vegetation measurements for identifying changes in vine growth throughout the vineyard

The increasing pressure being placed on water resources and labour availability within Australia has created a large move to pressurised irrigation systems. Vineyard owners throughout the Murrumbidgee Irrigation Area (MIA) are moving towards drip systems as the irrigation method of choice. Current estimates are that 40–60% of vineyards within the MIA are using surface drip irrigation systems, with the remainder expected to be converted in the near future.

Drip irrigation systems theoretically have high distribution uniformities and application efficiencies. However, in commercial situations, field evaluations of these systems are often overlooked with many simply taking for granted published data on the performance of these systems.

Recent work in vineyards in the Murrumbidgee Irrigation Area, funded through the Grape and Wine Research and Development Corporation's (GWRDC) 'Soil and Water Initiative' program, has provided some interesting figures on drip irrigation system application rate variability and its effect on vine performance in terms of yield and quality parameters.

Measuring drip irrigation performance

The simplest approach to evaluating the performance of drip irrigation systems involves undertaking physical measurement of application rates using 'catch cans' (Figure 1). Catch cans are small containers which can be used to measure the volume of water emitted from a dripper over a given period of time. The volume of water is determined using either a measuring container or by weighing the water (1 kg water = 1 litre). By dividing the volume of water by the measurement time period, the drip system application rate can be determined. A number of these measurements are taken throughout the block of interest. These measurements can then be combined with GPS coordinates which allows for the construction of a drip application distribution uniformity map. This map can be used to see how well a drip system is performing.

This analysis was carried out on a commercial Shiraz block of 12 ha which had a 10 year old drip irrigation system. The drip tape was of the pressure compensated emitter type. The emitter spacing was of 0.6 m and design flow rate of 1.75 L/h at 3 bar. The emitter spacing provides for three emitters per vine thus providing a design flow rate of 5.25 L/h/vine. Maximum recommended design length on flat terrain was 368 m. Maximum length of the installation in the irrigation unit was 300 m. A total of 100 measurement points spread throughout the vineyard were measured with three adjacent emitters being measured at each of the 100 locations. The measurement positions were collected using differential GPS and the information used to construct a drip irrigation rate uniformity map.

Figure 1: Measuring drip emitter rates in a vineyard using a 'catch can'

Results

Figure 2 shows results from the catch can analysis presented as a map of the dripper flow rates. It can be seen that over the block, which is managed as one irrigation unit, there is considerable variation in the amount of applied water. Drip emitter rates varied from a low of 3.5 L/h/vine (red areas) to a high of 5.3 L/h/vine (blue areas), the average was 4.4 L/h/vine.

The calculated Distribution Uniformity for this block is 85%. This means that the average of the lowest quarter flow rates was 3.8 L/h/vine. By comparison the average of the highest quarter flow rates was 5.0 L/h/vine.

In practice, the lowest quarter of the block is receiving on average 25% less water than the highest quarter of the paddock. This corresponds to a 25% difference in the volume of water applied over a season. For example if 4 ML/ha is being applied to the area with the highest emitter rates then only 3 ML/ha is being applied to the area with the lowest emitter rates. This non uniformity also applies to fertiliser, the combined effects of water and fertiliser will have a large impact on vine growth as shown later in this article.

The dripper flow rate map shows a characteristic decrease in application rates moving away from the supply line over the entire block, even though pressure compensated emitters were used. The longer run lengths particularly exhibited poor distribution uniformity. The lower application rates towards the tail ends generally indicate that there is a hydraulic issue, either the system is running at the incorrect pressure or the run length/emitter rate/tape diameter combination are incorrect. Places where the application rate is low towards the supply end of the lines probably indicate emitter blockages, indicated as (A) on Figure 2. Places where a large portion of the line has low application tends to indicate some kind of flow restriction within the line itself indicated as (B) on Figure 2. This could be a hole in the line causing water leakage, or a kinked, pinched or twisted line restricting water flow down the line.

The difference in applied irrigation through the system had, as would be expected, a large influence on the growth of the vines. Figure 3 shows Normalised Difference Vegetation Indexes (NDVI) taken from Landsat satellite images during December of 2004 and 2005 of the same vineyard block. The NDVI is a measurement of the amount of vegetation (biomass) and its 'greenness', which can be used to represent the amount of grapevine canopy present.

It can be seen in Figure 3 that high NDVI areas generally correspond to areas that have high drip application rates at the start of the supply lateral and on the shorter rows. As evidenced by the images it can be seen that there is a clear relationship between drip emitter application rates and the amount of vegetation. It can be seen that the variation in emitter rates has a large effect on the performance of the vines which will in turn affect the yield and quality parameters associated with the vines.

NDVI satellite images can also be used to quickly and easily identify irrigation management units which may have problems associated with poor application uniformities before more detailed and manually intensive on-ground sampling with catch cans takes place.

NDVI satellite images can be purchased from a range of local consultants for approximately $4–10/ha. This allows irrigation management units to be assessed for their uniformity and also to target specific sampling areas. Once problems due to poor distribution uniformities in drip systems have been identified then mitigation measures can be undertaken to try and overcome any associated

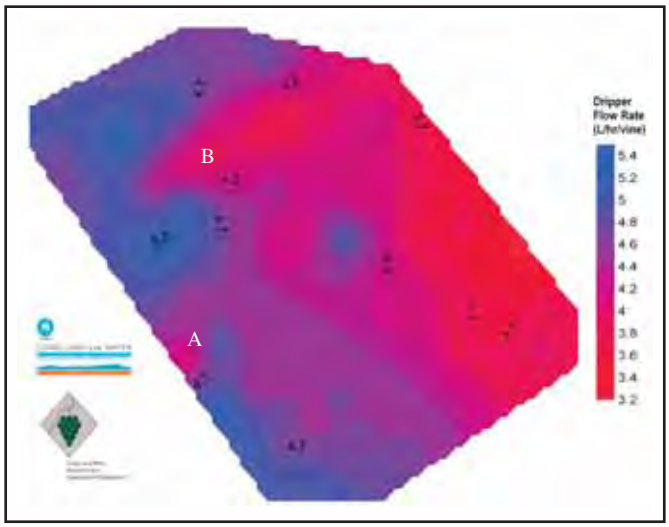

Figure 2: Measured dripper flow rates across a 12 ha Shiraz block

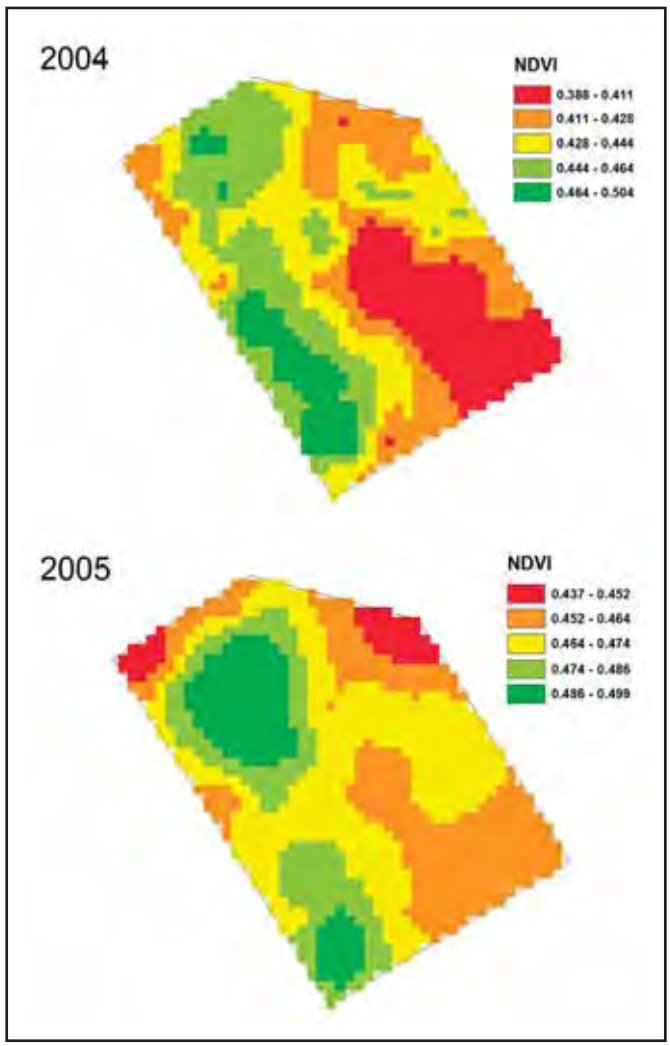

Figure 3: NDVI satellite images taken from the vineyard in December of 2004 and 2005

problems. Possible interventions include thorough flushing and cleaning of the system, running the system at higher/lower operating pressures or redesigning parts of the system to overcome limitations with run lengths.

Conclusions

Whilst converting from surface irrigation systems to pressurised systems can improve application efficiencies, assumptions are often made about the performance of these systems with few checks being undertaken on their actual field performance. While theoretical distribution uniformities of drip irrigation systems are high, there is also the potential for poor uniformity if they are not designed and operated correctly as evidenced by the field data presented. Use of easy to acquire satellite NDVI images and simple catch cans will go a long way to identifying possible problems in vineyards. Further research is being undertaken in the area to identify and quantify the impacts this irrigation variability has on a range of vine quality parameters.

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