Oxygation – an option for drip irrigated vineyards in Sunraysia

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Recent studies have found that rootzone conditions in vineyards on finer textured soils in the Murray Valley are universally poor; only 4% of the subsoils studied being sufficiently aerated to allow root growth and function (Murray 2011).

These difficult soil conditions are likely to be exacerbated with the adoption of drip irrigation, and the increasingly popular practice of frequent daily drip irrigations. Drip irrigation applies water immediately under the emitter at an application rate equivalent to 160-300mm per hour (assuming a 10 x 10cm infiltration area). This high localised application rate, along with highly frequent irrigation applications can result in sustained wetting fronts around the emitters, impeding root respiration and resulting in sub-optimal plant performance.

As water exits an emitter, it purges soil pores of air with water that typically contains less than 10 mg oxygen/L, a quantity quickly consumed by roots and soil microbes (Midmore 2013). Higher temperatures, salinity and soil compaction exacerbate this effect, as do soil diseases such as phytophthora. The increasing desire of viticulturists to increase the microbiological activity in soil can also be expected to increase oxygen demand.

What is Oxygation?

'Oxygation' is the term used to describe the aeration of irrigation water. It is a relatively new innovation but simply involves the injection of atmospheric air into the irrigation water at an appropriate location such as a pump or valve. The result is the simultaneous application of water and air directly to the rootzone through an existing drip irrigation system. The added air is likely to improve growing conditions, increase root respiration and microbial activity, thereby potentially improving crop performance. Bhattarai et al (2004) have observed higher yields in crops irrigated with oxygen-enriched water or aerated water compared to crops irrigated with untreated water.

Figure 1 Mazzei Venturi air injection system[i]

A local experience

Justin Kassulke is a winegrape grower in Curlwaa, NSW. Soils in the Curlwaa irrigation area are generally fine textured, with light to heavy clay within 30cm of the surface. These soils require mounding and ongoing organic matter inputs to maintain a structure conducive to irrigation. Given the shallow nature of these soils frequent irrigation is required in summer, and sustained wetting fronts develop in the rootzone as a result. Following heavy summer rainfall in 2010/11, some low lying areas were flooded and the performance of vines in these areas has since been poor. As a result alternative options to improve root health were investigated, including oxygation.

A relatively inexpensive venturi system to improve soil aeration appeared to be a good option. A 25mm poly Mazzei Venturi (MI 1078) was installed in November 2013 on a 1.4 Ha valve of own rooted Shiraz, irrigated with Netafim 2025 dripline. Emitters are spaced every 0.5 m discharging 1.2 l/hr. The treated valve has a flow rate of approximately 4.6 l/s. This valve is located in the middle of a 90 m submain, with 30 laterals spaced 3.0 m apart. Row lengths range from 140 to 170 m.

A neighbouring valve with the same winegrape variety and irrigation system acted as a control. This area is comprised of 25 rows ranging from 110 to 160 m in length and make up approximately 1.0 Ha with a flow rate of 3.3 l/s. The dripline in both valves is located on the soil surface, run along the vine row.

Throughout the summer of 2013/14 dissolved oxygen (mg O_2/L) measurements were taken in the treated and untreated valve by collecting water exiting emitters at fixed locations throughout both valves. For the treated valve readings were taken throughout the summer on five occasions when irrigation was available.

Dissolved oxygen (mg O_2/L) and temperature in the water was measured using a Horiba water quality meter. Water was caught in open containers under emitters located strategically throughout the trial site; approximately 0.5 l of water proved to be an adequate sample size. The probe was inserted into the containers and 'swirled' - encouraging water to pass across the sensor membrane- for several minutes until the readings were stable, at which time readings were recorded.

Figure 2 Justin Kassulke measuring dissolved oxygen December 2013

Results and Discussion

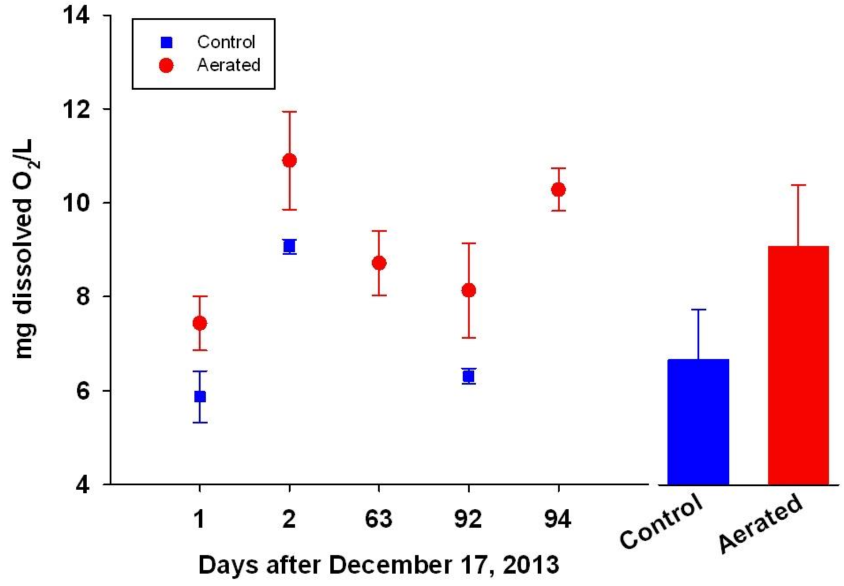

Figure 3 Dissolved oxygen in the irrigation water of control and aerated valves

The treated air injection valve was sampled on five occasions, and the untreated control on three occasions. Figure 3 shows that water exiting the emitters in the treated valve was higher in dissolved oxygen than the control on the common sampling occasions. Overall, average dissolved oxygen for irrigation water of the aerated valve was 9.1 mg O_2/L, compared to 6.7 mg O_2/L in the control valve.

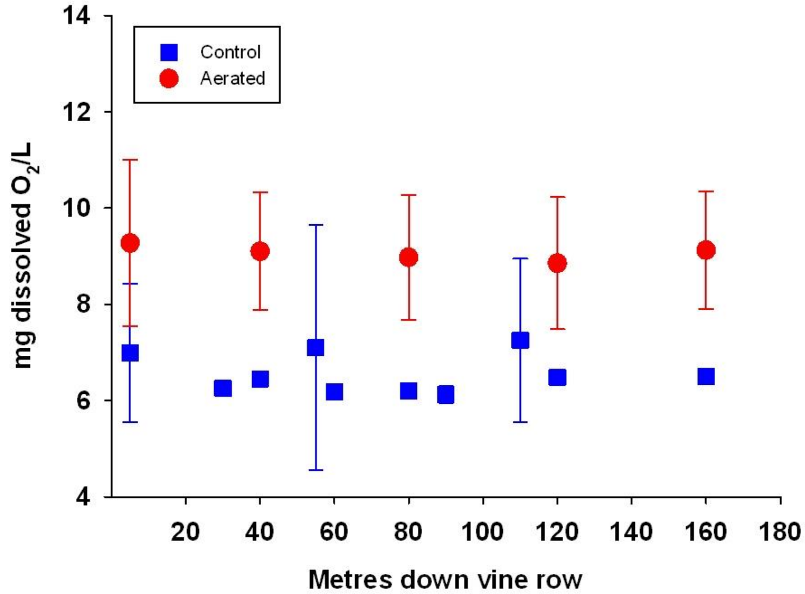

Figure 4 Spatial variation of dissolved oxygen with control and aerated valves

Accounting for the location of sampling sites within both areas demonstrates that there is very little spatial variation in dissolved oxygen levels within either treatment. The relatively even distribution determined in this trial provides confidence that standard, well designed drip irrigation systems can be used for oxygation. Midmore and Bhattarai (2012) describe system requirements for oxygation as being a water flow of 3.8 l per min to 30.3 l per min per drip line and the terrain being level to moderately sloped. This is the case with this trial site, with the 160 m length of dripline having a flow of approximately 6.4 l per min, with a very slight (<1%) downhill slope only.

Where to from here?

This preliminary investigation into oxygation in the Murray Valley has determined that a relatively cheap, simple and easy to install Venturi system can increase the dissolved oxygen level of irrigation water. This would ultimately be expected to have beneficial effects for winegrape growers.

The Venturi system at this trial site has only been installed for less than one season and any production benefit is expected to take time. No obvious measurable beneficial effect on production has been observed, or attempted to be measured to date. Midmore and Bhattarai (2012) found a lint yield increase of 14% in cotton, 26% total yield increase in pineapple (and suppression of phytophthora), and yield increases of 4-10% in capsicum, strawberry and grapes. Obviously potential exists for improved production or crop health at this trial site, and it is hoped future studies can take place to identify and quantify those benefits.

Beneficial effects on soil health are also yet to be determined, and this may be possible in future seasons with a measure of biological activity, air filled porosity and water penetration within the soil. These measures are more complex and costly than could be undertaken within the scope of this preliminary study.

Oxygation would potentially be highly beneficial for crops sensitive to waterlogging, in soils prone to waterlogging, or in extremely wet seasons where waterlogging is more likely. Water supplies low in dissolved oxygen (such as re-used waste water, water from covered storages, black water events) may also be rendered more horticulturally useful by aeration.

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