The importance of oxygen in drip irrigation systems for optimising crop production

To date growers have been careful to optimize nutrients and irrigation inputs, but have overlooked water aeration as a factor constraining yield.

There are two things in life that we cannot live without for any length of time: water & oxygen.

Generally we require them independently, but how about plants and plants roots? Is there a benefit to you as a grower in using aerated water compared to oxygen depleted or poorly aerated water? Or doesn't it really make a difference?

Well to start with, the Dissolved Oxygen Concentration (DOC) level in water is an important – and seriously underestimated – irrigation water parameter than can have a significant impact on intensive crops systems. For instance a low DOC in irrigation water will cause root oxygen deficiency, limiting nutrient uptake, thereby reducing growth, production and thereby also lowering plant resistance to disease.

Greenhouse growers use a lot of water, preferably rainwater as they will all admit that plants like it better than bore water, town water or osmosis treated water. Bore water, mains water and osmosis water are oxygen depleted which is one of the reasons that plants don't perform as well as with rainwater.

Many growers (unfortunately) still dose chlorine into their irrigation water to try to curb bacterial populations. However, this is often done in combination with fertilisers and when it comes to mixing fertilisers, chlorine and oxygen there may be some unwanted combinations such as the fact that sulphur based chemicals will neutralise chlorine (wasted money besides the fact that micro-organisms rapidly become resistant to chlorine) but also that Sulphur based chemicals are oxygen scavengers and they will reduce oxygen levels in water.

Root systems of crops irrigated with drip irrigation are unique in that they concentrate around the emitter (Machado et al., 2003; Oliveira et al., 1996). As most of the root mass in drip irrigation systems is close to emitters, each time you irrigate the root zone is temporally saturated, whereby the benefits of oxygenation are evident.

Aerating drip irrigation water offers the potential of improving water efficiency in irrigated crops simply because plants roots require oxygen for a whole host of functions. In fact, poor water aeration reduces active uptake of plant nutrients. For example, uptake rates of N, P, K, Ca, and Mg decreased with reduced aeration (*McLaren and Cameron, 1986*) and irrigating with oxygen poor water will cause asphyxiation of the roots every time plants are watered – temporal hypoxia. Analysis of the plant mineral concentrations demonstrate that oxygenation enhanced K and P uptake (Bhattarai et al., 2005a

It has also been shown that water aeration increases leaf function. Leaf chlorophyll concentration increases with oxygenation, reduces heat stress on the canopy, maintaining a more positive leaf water potential and a smaller crop water stress index (Bhattarai et al., 2004).

Due to the number of salts present in some fertilisers which is further increase when chlorine is used as a water treatment biocide, salt levels around the plant roots can increase. Aeration promotes root development and root respiration in saline conditions. Water Oxygenation reduces plant accumulation of sodium (Letey, 1961). Oxygenation also reduced direct damage of mesophyll cells and of the epidermal cells of root tissues due to salt.

Hyper-oxygenation is the process of aerating irrigation water and using the existing drip irrigation systems to deliver it to the root zone. Aerating irrigation water to increase the oxygen concentration is accomplished by either mixing air or by mixing Loxyde - a stabilised hydrogen peroxide - into irrigation water before it is distributed through the irrigation lines. Oxygenation offers plant roots extra oxygen with water during each irrigation cycle

Large irrigation systems have driplines up to 800 m in length or longer, and uniform distribution of aerated water to the extremities represent a problem, as air tends to escape via drippers and other leaks in the system. Aerating irrigation water with specially conceived highly stabilised hydrogen peroxide (e.g. R-EAU) dosed at 20-50 ml/m^3 water will be able to uniformly supply oxygen along any length of drip pipe. Furthermore as it is extremely stable it will slowly release its oxygen over the length of the distribution system while also dealing with other important plant health issues and nutrient uptake. On the other hand air injection into the irrigation system via a venturi system or standard hydrogen peroxide suffer from a loss of uniformity of application. Field data (*Goorahoo et al., 2002, G. Jones 2012*) demonstrates that the increase in production due to venturi and standard hydrogen peroxide aeration only extended to the first 15 m from the aeration source. Yield then declined rapidly equalling the yield of non-aerated plots. Furthermore it does not provide any further benefits such as biofilm or microbial control of the water distribution system.

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50 ml of R-EAU contains 6.6 litres of oxygen

Monetary benefits have shown that oxygenation can contribute to a significant increase in yield. Figures are not available for all types of crops but some tomato growers have seen an increase of 12% and strawberry growers even achieved a peak of 50%, though on average this was around 15%.

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