The importance of dissolved oxygen in irrigation water

Dissolved oxygen (DO) in irrigation water is often completely neglected. It's a parameter that is completely ignored and yet it can have a significant impact on plant health, root development, fertiliser & water uptake as well as yield. Even some of the most advanced farms who pay attention to just about every parameter which influences plant growth and yield completely ignore water DO requirements.

by Mike de Jong

The typical origins of water used on crops is rainwater - high in O_2 (unless stored for too long in a tank), ground water – oxygen deprived, (reverse) Osmosis water – oxygen deprived, and town water which is purposefully oxygen poor to prevent oxidation of the water delivery system. In some cases river/canal/lake water is used and those waters are generally well oxygenated unless affected by eutrophication.

As irrigation water enters the soil, whether overhead, flood or drip it purges the soil pores of air which can result in anoxic conditions – heavy soils are more prone to this - to the detriment of plant growth and water use efficiency.

Water poor in DO will take away oxygen from plants through the root system as well as deplete soil oxygen, both of which are needed for a healthy plant and a heathy soil bacterial flora. Water does this in order to return to a balanced oxygen state.

Insufficient water DO can lead to other problems as well. For instance Nematodes prefer oxygen poor soils and irrigating plants with water poor in DO will allow them to come near the surface where they can easily damage plant roots.

Past research has shown that reducing the concentration of DO in the root zone of plants will compromise the plants' ability to absorb nitrate and water[1]. Research has also demonstrated that roots are injured by O_2 deficiency and that plant metabolism changes during acclimation to low concentrations of O_2[2]. Oxygen deprivation in plants is called internal anoxia and one of its results is sucrose degradation whereby

the plant goes into an energy-conserving pathway[3] to compensate for the lack of oxygen. So basically the lack of soil DO is a problem that keeps compounding the longer it lasts.

The good news is that it is very simple and cheap to fix the problem and that oxygenating or even better hyper-oxygenating irrigation water should actually become standard practice in all irrigation water.

Hyper-oxygenation of irrigation water has many benefits

Hyper-oxygenating irrigation water significantly improves plants resistance to stress & diseases. Research has clearly shown that tomato plants inoculated with Pythium F. remained healthy when irrigated with hyper-oxygenated water and showed a significant decrease in root colonisation by the pathogen, in comparison plants treated with normal water perished[4].

Hyper-oxygenation also increases plants tolerance to salt[5, 6]. Hyper-oxygenating water increases nutrient uptake and conversion efficiency which enhances the growth and development of roots, vegetative and flowering characteristics. For instance, oxygen will oxidise organic phosphate into inorganic phosphate which can then be readily used by plants. The benefits apply to the cultivation of all plants, be it vegetables, herbs, bulbs, ornamentals, cut flowers, grass and arboriculture. Nematodes will also be less of a problem as they will avoid all areas where hyper-oxygenated water is present.

Hyper-oxygenating irrigation water can lead to yield increase varying between 5-96% depending on crop type and soil type. It can also significantly increase water efficiency with savings of up to 27% compared to non-oxygenated water[7].

The problem of oxygenating water

There is one major problem when oxygenating irrigating water and that is the amount of dissolved oxygen water will hold as the solubility of oxygen decreases as water temperature increases. But irrigation water DO levels are not only dependent on water temperature but also on how many other “ingredients” are in the water. So water heavily laden with fertilisers will also have a lower DO level which is further influenced by the type of fertiliser used. Water can only hold so much and once you reach the saturation level, well full is full!

So because of the above it is impossible to hyper-oxygenate water using water’s own storing capacity as this is limited. To hyper oxygenate water we need to use a different method.

Using highly stabilised Hydrogen peroxide to hyper-oxygenate irrigation water

For the last 25 years I have been an advocate of stabilised peroxide, mainly because of its versatility. Furthermore as plants produce it, plants are familiar with it and know how to deal with it. It is environmentally friendly and effective against just about every micro-organism. But when hyper-stabilised and dosed at low levels (10 – 100 ppm range), it is pretty ineffective as a disinfectant but excellent as a source of oxygen for water, soil, compost, etc.

There are different types of stabilised peroxides on the market. There is silver peroxide – which in all cases uses silver-nitrate and as this is a poison in the same way as arsenic or mercury and has – in my opinion - no place in horticulture. There are stabilised and activated peroxides, which are used for the shock treatment of irrigation systems to remove biofilm, and there is highly stabilised peroxide which is not activated and whose sole purpose is to be an oxygen delivery source.

For hyper-oxygenating water, I use a special formulation (Loxyde Green) which hyper-stabilises hydrogen peroxide – it creates a very mild but highly stable peroxide. This slow release oxygen delivery system can remain available in water for ±170 hours and in soil and soil media for a couple of days. Dosed at low rates it has absolutely no disinfectant effect so you don't need to worry that it will affect soil micro-organisms – in fact low levels of Loxyde green will actually benefit soil microbial activity and the oxygen is easily available to the plant root system.

It is a simple system, not dependant on the oxygen holding capacity of the water or the amount of fertiliser dosed in the water. It is easy to dose and to measure using peroxide test strips. Advantage is that you can easily increase or decrease dosage dependant on temperature, water usage, crop stage, etc. Loxyde green will also neutralise any chlorine in water.

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