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Aerated subsurface irrigation water gives growth and yield benefits to zucchini, vegetable soybean and cotton in heavy clay soils

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Abstract:

Inadequate oxygen concentration in the root zone is a constraint to plant performance particularly in heavy, compacted and/or saline soils. Sub-surface drip irrigation (SDI) offers a means of increasing oxygen to plant roots in such soils, provided irrigation water can be hyper-aerated or oxygenated. Hydrogen peroxide (HP) at the rate of 5 litre ha⁻¹ at the end of each irrigation cycle was injected through SDI tape to a field-grown zucchini (courgette) crop (*Cucurbita pepo*) on a saturated heavy clay soil in Queensland, Australia. Fruit yield, number and shoot weight increased by 25%, 29% and 24% respectively due to HP treatment compared to the control. Two pot experiments with vegetable soybean (*Glycine max*) and cotton (*Gossypium hirsutum*) compared the effectiveness of HP and air injection using a Mazzei™ air injector (a venturi), throughout the irrigation cycle in raising crop yield in a heavy clay soil kept at saturation or just under field capacity. Fresh pod yield of vegetable soybean increased by 82-96% in aeration treatments compared with the control. The yield increase was associated with more pods per plant and greater mean pod weight. Significantly higher above ground biomass and light interception were evident with aeration, irrespective of soil water treatment. Similarly cotton lint yield increased by 14-28% in aeration treatments compared with the control. The higher lint yield was associated with more squares and bolls per plant which accompanied greater above ground biomass and an increase in root mass, root length and soil respiration. Air injection and HP effected greater water use, but also brought about an enhancement of water use efficiency (WUE) for pod and lint yield, and increased leaf photosynthetic rate in both species but had no effect on transpiration rate and stomatal conductance per unit leaf area. Aeration-induced enhanced root function was arguably responsible for greater fruit set and yield in all three crops, while in vegetable soybean greater canopy cover, radiation interception and total vegetative biomass were responsible for additional yield benefit. Increased aeration of the root zone in heavy clay soils employing either air injection or HP proved beneficial to SDI irrigated crops, irrespective of the soil water conditions, and can add value to grower investments in SDI.

Key-words: Air injection, hydrogen peroxide, subsurface drip irrigation, water use efficiency, soil respiration, leaf photosynthesis, root mass