

Fertigation in Perennial Fruit Crops: Major Concerns

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Agriculture has advanced at a rate that should complement the net food requirement for ever growing population either at regional level or global level. Perennial fruits of tropical nature (Citrus, banana, mango, papaya, and guava) have emerged as an alternative source of nutrients to lessen the burden on per capita consumption of cereals crops. Intensive growing of perennial fruit crops under high density and ultra-high density plant population has further put an additional pressure on soil fertility conservation. But, concept of fertigation in perennial crops has given a definite edge over conventionally used basin method of irrigation coupled with basal or top dressing of fertilizers within the perimeter of trees [1,2]. Reports are candidly visible on fruit yield, quality indices soil fertility improvements coupled water use efficiency (WUE) and fertilizer use efficiency (FUE) covering a variety of fruit crops [2,3]. Hence, fertigation has proved beyond doubt about its utility to fruit culture [3,4].

Techniques and managements of perennial fruits production are nowadays directed towards the need to conserve resources, energy and a commitment to the environment. In this sense, fertigation has risen as a valuable tool in recent years spreading around the world in major fruit belts. The million dollar question strikes why does fertigation outperform conventional basin method of irrigation carrying fertilizers. A plant exposed to uniform regime of moisture and nutrient flow within rhizosphere zone has to spend much less energy than the growing conditions constantly changing over time. Fertigation, is thus, energy efficient as well [5]. This has led to an increase in both fertilizer use efficiency (FUE) and water use efficiency (WUE). In the future, fertigation would continue to replace traditional flood irrigation so extensively adopted in water surplus irrigated fruit growing areas [3].

Open hydroponics (OH), a concept synonymous to fertigation is a management practice to address low fertility gravel base soils and saline water. The nutrient uptake is maximised, if the ratio of ions in the solution matches with scion/stock requirements. In Spain, the performance of 'Nova', 'Marisol', and 'Dalite' mandarins at density of 1000 plants/ha under OH system was evaluated [6]. The average yield in sixth year was 60-75 tonnes/ha, which is much higher than many conventionally managed orchards. In Israel the response of 'Shamouti' orange under restricted root zone practices, a sprinkler versus drip irrigation treatment with three fertilizer rates, maintained at high moisture status (8-12 Kpa) as a part of intensive OH program. A significant increase in yield in the restricted root zone drip irrigation compared treatment was observed with the highest rate of fertilizer application, 400 kg N/ha [7]. Similar promising results were obtained in South Africa where OH system increased the yield of 'Valencia' orange and 'Clementine' orange by 19% and 25%, respectively, using 16% less water with 25-31% higher returns compared to micro-irrigation with broadcast method of fertilizer application as control [8]. More information on critical issues like capability of manipulate the soil solution as a restricted root zone versus conventional drip irrigation root zone, buffering capacity of soil manipulating specific nutrient ratios at different physiological stages, evaluating orchard productivity-energy relationship through ionic balanced nutrient solution, planting density etc. are further required before OH system under citrus is adopted on a commercially large scale.

The principles of OH have some potential benefits in conventional production practices like intensive fertigation programs (IFP). IFP is a fertigation program that has similar principles to OH, but is less intensive than OH. Both use a nutrient solution containing various macro- and micronutrients (ionic balance is more important in IFP than OH), proportional injection of the nutrients into the water supply, pH adjustment of the irrigation water, and a high level of irrigation scheduling and monitoring. The most obvious difference is that IFP uses a larger conventional root zone volume and a refill point that is set lower than OH. The practical implication of using a conventional root zone is that the physical and chemical properties of the soil are more utilised. This can lower the application rates of some of the macronutrients, e.g. Ca, Mg, and K. The majority of growers using IFP would irrigate only once a day to maintain soil moisture at a good level (generally not exceeding 50% readily available water), whilst OH would be focussing on maintaining soil moisture levels near field capacity. IFP is an intensive form of fertigation, whilst OH uses fertigation as part of a hydroponic management strategy. Nutrient application rates in majority of OH and IFP in citrus can be about 20% to 50% higher than conventional practices due to higher productivity levels and a lower nutrient bank in the soil. Therefore, OH and IFP use a more intensive nutrition program that may push the trees into a higher level of vigour and productivity requiring higher nutrient application rates to maintain production [9].

Fertigation is considered synonymous to nutrient use efficiency which can further be fine-tuned with nitrification inhibitors (restrict the microbial conversion of ammonium to nitrate that it is mobile in soils) or plant growth-promoting bio-effectors (microorganisms and active natural compounds involved in plant growth). Thus, in addition to all these, precise soil sampling, whether to take samples from below drippers or in between drippers or mixing soil samples from both the sites and finally, drawing a representative soil samples, find a greater intervention while evaluating nutrient-water interaction in citrus [10]. Another prominent concern is often raised with regard to threshold values of leaf nutrient diagnostics [11]. Whether or not, optimum leaf nutrient values hold some application efficacy when compared with basin irrigation coupled with basal fertilizer application. Under two contrasting fertilizer application techniques, due to difference in fertilizer use efficiencies, optimum values could warrant minor adjustments, depending upon mode of fertilizer application [12,13].

Assessment of off-site movement of applied nutrients and their

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implications on temporal changes in ground water quality is still in a inconclusive stage, needs an elaborate study in the larger context of sustainability in quality production in addition to in-situ conservation of applied nutrients. Possibility of integrating liquid biofertilizers (broth using native isolates) as a starter with nutrients in order to further hasten the bioavailability of nutrients within plant rhizosphere needs to be looked afresh. Concept of rhizosphere hybridization triggering the nutrient dynamics across crop phenophases then finds its candid way into the curriculum of fertigation oriented research [14]. However, it remains to be seen that net impact on soil solute fluctuations in both soluble and exchangeable phase of soil if nutrient use efficiency has to be targeted, besides an eye on changes in soil salinity build up [15]. While addressing these concerns, however, the major concern emerges as orchard efficiency vis-a-vis FUE/WUE by adopting variable rate fertilizer application taking into consideration the spatial variability in soil properties in a time domain manner known as automated fertigation.

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