Optimizing Water and Nitrogen Use Efficiency (WUE & NUE) with Airjection® Irrigation

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Abstract

Injection of air into the root zone environment has shown to enhanced crop productivity. Using a high efficiency venturi to inject air into water delivered through subsurface drip irrigation, commonly referred to as AirJection® Irrigation, has been shown to result in increased yields for a variety of crops. In the current study, we assessed an economic analysis and techniques for assessing Airjection to optimize water and Nitrogen use efficiency in vegetable production. Overall, Airjection improved the economic returns for various crops favored the dominance of bacteria that enhance plant nitrate uptake with a potential reduction in nitrate leaching.

Keywords: Airjection, Oxygation, Nitrogen Use Efficiency, Water Use Efficiency

1. Background

Evaluating the addition of ambient air via subsurface drip irrigation system, referred to as AirJection® Irrigation, and "Oxygation" by researchers in Australia, has been the focus of our research over the past decade (Goorahoo et al., 2008; Bhattari etal., 2005). During this period, we have conducted both basic and applied research aimed at evaluating the water (W) and nitrogen (N) use efficiency (WUE and NUE) of implementing Airjection in vegetable production systems. In this presentation we review the basic concepts of AirJection Irrigation and describe the protocol used to assess the practice at the field scale with commercial farmers.

2. Basic and Applied Research

First, we compared the "agronomic" WUE and NUE, calculated as the ratio of crop yields to water and N inputs, for various vegetables. We have therefore conducted and economic analysis of adopting the technology at the commercial scale. Thirdly, by measuring the rates of photosynthesis, transpiration, and stomatal conductance, we determine the "leaf scale" and "intrinsic" WUE and NUE we examined the potential of this system to enhance Nitrogen (N) and crop water use efficiency (WUE). In the most recent phase our research, we are assessing methods for quantitatively determining (1) the proportion of nitrifying and denitrifying of bacteria in soils, and (2) the oxidative stress in plants, subjected to AirJection Irrigation.

3. Concluding Remarks

At the commercial scale, over an eight- year period reviewed, Cantaloupes equated to approximately 47% of the total acreage (1061 ha) and consistently produced the best results with yields anywhere between 12%-34% above the farm average. In the case of sweet corn, the five- year average increase was approximately 8 boxes per ha. The net increase in yield using the same amount of water per ha would be an equivalent cantaloupe production to farming approximately 405 ha less over 8-year period. This crop yield increase would theoretically allow farmers to farm more "crop per drop of water and per kg of N fertilizer. AirJection Irrigation had a clear selective impact on the distribution of the tested genes among the soil microbial population. While AirJection did not impact N fixation or ammonia oxidation, it did significantly change the denitrification genes population in manner that can positively affect NUE. Furthermore, with judicious water management within the root zone, AirJection Irrigation can

favor the dominance of bacteria that enhance plant nitrate uptake with a potential reduction in nitrate leaching. Finally, determination of the relative proportions of total Glutathione (GLU), an antioxidant, and the reduced (GSH) and oxidized (GSSG) forms appears to be a sound indicator of oxidative stress in vegetables subjected to aerated and non-aerated irrigation systems.

4. References

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