Plasma Activated Water in USDA-organic fertilization

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In nature, around 10% of available nitrate is produced by lightning flashes. VitalFluid has taken this natural process to a reactor, for disinfection of water and fixation of nitrogen, so called Natural Nitrogen. A lightning flash is produced with electricity, creating a plasma from air (78% N_2, 21% O_2). In this plasma, nitrogen and oxygen are turned into reactive components and led through water. The reactive components that occur give the water temporary disinfecting properties, after these reactions nitric acid (HNO_3) will be fixed in the water. The nitric acid can be used for fertigation of greenhouse crops.

Final results

General findings

In a cultivation cycle of tomato (July – December 2021) it was shown that Natural Nitrogen (HNO_3) could be applied in a complete nutrient solution in organic cultivation. HNO_3 was neutralised by lime ($CaCO_3$), creating $Ca(NO_3)_2$, before supply into the nutrient solution. This nitrogen form is readily available for uptake by the crop, so plant requirements can be followed closely. The input concentration of NO_3 in the nutrient solution was determined by the Ca concentration, which adds 0.5 mmol/L Ca for each mmol/L of NO_3. To keep the ratio of K:Ca at the right level, on average 10 mmol/L of NO_3^- was suppled from Natural Nitrogen. The biggest challenge was to manage the micro-biological activity that was initiated by some of the organic fertiliser inputs in the B-stock solution. This caused strong pH rise and some changes in the nutrient composition.

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Yield and crop performance

We have seen a good crop in the Natural Nitrogen treatment throughout the cultivation season. The organic reference suffered from a lack of available N, after we supplemented sodium nitrate (5 mmol/L) to the reference treatment, the performance of the crop improved seriously. This shows that control of available nitrogen is difficult in organic cultivation, and can be improved seriously by using Natural Nitrogen. The difficult start in the reference treatment makes a comparison of productivity and average fruit weight (Figure 1) not very useful.

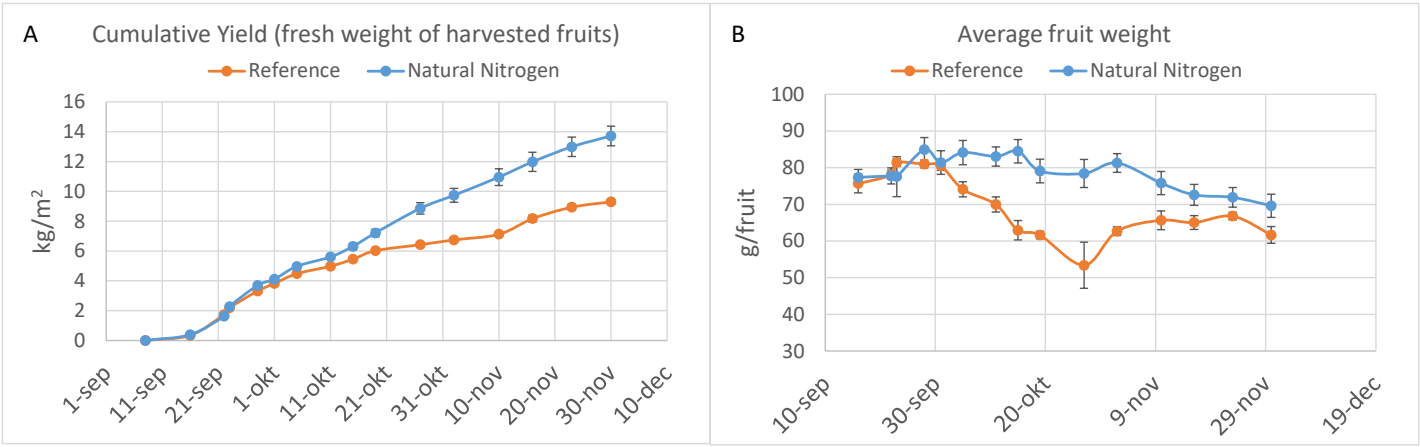

Figure 1. A. Cumulative yield (fresh weight) and B. Average fruit weight during the cropping cycle

Water Use Efficiency

It was shown that implementation of Natural Nitrogen as main source for nitrogen in USDA organic cultivation of tomato opens opportunities for saving water and nutrients by reusing drain water. This could improve the resource use efficiency (RUE) of USDA-

organic cultivation tremendously. In Figure 2 it can be seen that the concentration of sodium remained very low during the whole trial, while the addition of sodium nitrate in the reference, required a high discharge after some weeks and made it in fact impossible to recirculate the nutrient solution in the reference treatment.

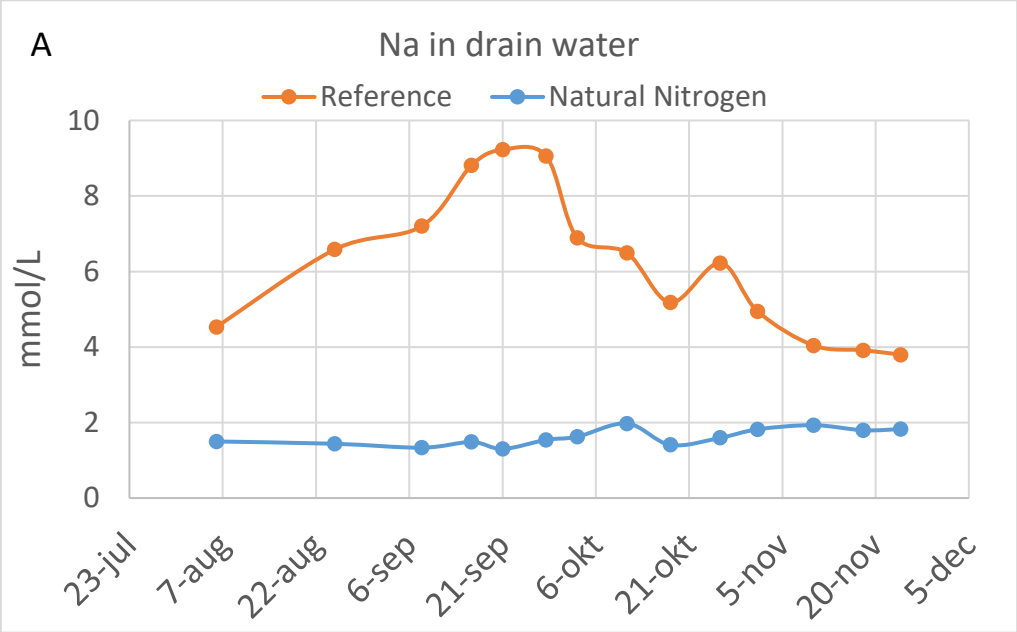

Figure 2. Sodium concentration in drain water of reference and Natural Nitrogen treatment