WAGENINGEN
UNIVERSITY & RESEARCH

Innovation
& Demo Centre Water

Plasma Activated Water in USDA-organic fertilization

Update 20/10/2021; number 2

In nature, around 10% of fixed nitrogen 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.

Cultivation update

Additional lighting

As the available amount of daylight is already strongly decreasing, SON-T lights are switched on to elongate the days and increase the total amount of light. This option is not possible in USDA-organic cultivation, but was inevitable in this trial due to the starting date of the cultivation.

Available nitrogen and other nutrients

The crop in the VitalFluid treatment looks healthy and clearly has enough nitrogen available for uptake (left side of Figure 1), as it is readily supplied by the technology. The fruits showed some potassium deficiency, but by increasing the dosage of potassium this was restored.

In the drain of the reference treatment no nitrate was measured. This indicates that the conversion of organic nitrogen into mineral N (NH_4^+ and NO_3^-) was relatively slow and

VitalFluid

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likely all mineral N is taken up by the plants which resulted in complete depletion of the root zone. The total quantity of N being available is not sufficient to cover the demand , which is shown in the crop as N-shortage symptoms. The plants have smaller and less leaves, and the leaves are paler green (right side of Figure 1). To avoid a complete stand-still of the plants in the reference, chilean nitrate ($NaNO_3$) was added in addition to the organic nitrogen fertilizers, to compensate for the lack of microbial production of nitrate. The lack of microbial conversion of nitrate is possibly due to at one hand a lack of oxygen in the rootzone. It was observed that the substrate is relatively wet and likely the O_2 consumption by the roots and in addition of the microbiology depleted the oxygen concentration completely. In addition, it might also be possible that the required microbial community could not have settled properly, which is a general problem of substrates. All by all the too low activity or presence of the microbiology in the rootzone, caused suboptimal conditions and too low productivity of the crop.

Figure 1. Tomato crop (Roterno) for the VitalFluid (left) and reference treatment (right) at 13-10-2021

Recirculation of nutrient solution
Complete recirculation of drain water (no discharge) is achieved in the VitalFluid treatment. The addition of chili nitrate in the reference treatment, containing high amounts of sodium, causes the sodium concentration to increase rapidly. This forces us to discharge the drain water of the reference treatment, so no recirculation is applied.

Results

The first harvest was on September 8. The yield of the VitalFluid (VF) and the reference (BIO) treatments are shown in Figure 2. Yields were equal for both treatments until September 23, but crop development was quite different. The VitalFluid crop clearly had enough nitrate available for growth, whereas the reference crop was affected by the shortage of nitrogen, which resulted in a decrease in productivity for this treatment.

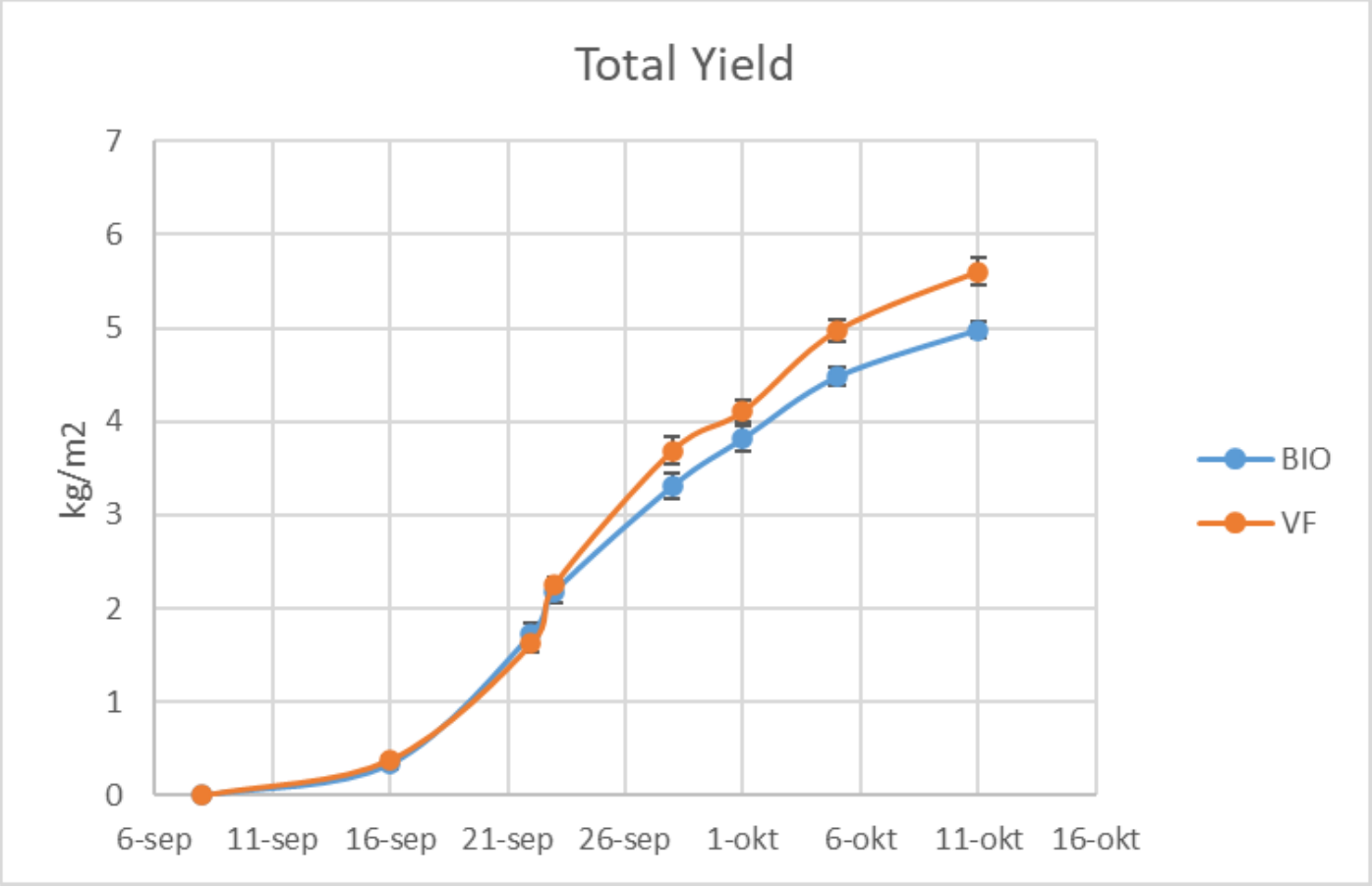

Figure 2. Cumulative yield (kg/m²) for the VitalFluid (VF) and the reference (BIO) treatment.