

SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA17133

STSM title: Application of probiotics for improving the circularity of aquaponic food production

STSM start and end date: 08/05/2021 to 07/07/2021

Grantee name: Leonardo Bruni

PURPOSE OF THE STSM:

The overall aim of my STSM stay at the Zürich University of Applied Sciences, Switzerland (ZHAW) was to give me an insight into hydroponics (HP) and aquaponics (AP), so that I were able to build and manage small experimental HP and AP plants. The detailed aims were: (i) To train in setting up and day-to-day management of an AP system, focusing on complementary knowledge acquisition (horticulture-hydroponics); (ii) To revise the plans for the new AP at the University of Florence; (iii) To prepare an SOP for the operation of AP at the University of Florence; (iv) To perform an experiment on the influence of probiotics on nutrient use, crop quantity and quality in AP and HP. In addition to fulfilling these goals, the stay at ZHAW allows me to strengthen my academic network.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

I investigated following research questions:

- Can the addition of commercial probiotics developed for the soil-bound production or bacterial communities from sludge support the growth of lettuce in soilless systems?
- Does water origin (aquaculture effluent or hydroponic) play a role in fighting against the pathogen *Pythium*?
- Can bacterial inoculation help soilless lettuce fight against the pathogen *Pythium*?

To answer these questions, a set up with 10 trials in duplicate was done.

- 1) An aquaponic control (AP) consisting of water from an aquaculture farm rearing pikeperch (*Sander lucioperca*) of different sizes (from 300 to 1000 g/fish) at a mean stocking density of 37 kg m⁻³ in a total rearing volume of 75 m³ resulting in a total fish biomass of 2000 kg, situated in Steinibach-Flühli (LU), Switzerland;
- 2) A hydroponic control (HP) consisting of freshwater supplemented with nutrients to mimic the nutrient levels present in the AP control;
- 3) Eight experimental treatments combining either HP or AP water with either: RhizoVital42 (Andermatt Biocontrol AG, Switzerland), which contains *Bacillus velezensis* (synonym *B. amyloliquefaciens* ssp. *plantarum*), administered at the concentration of 0.04% v/v (T1); sludge from the drum filter of the aquaculture farm, administered at the concentration of 1% v/v, collected at the beginning of the experiment and stored at +8 °C (T2); sludge from wastewater treatment plant (Abwasserreinigungsanlagen, Alte Landstrasse 8, Au/ZH), administered at the concentration of 1% v/v, collected at the beginning of the experiment and stored at +8 °C (T3); activated effective microorganisms BodenFIT (EM Schweiz AG, Switzerland), administered at the concentration of 1% v/v (T4). The 10 nutrient solutions were collected/produced at the beginning of the experiment and stored at +8 °C during the experiment.

The experiment took place in a climate chamber with the following conditions: 23-15 °C day/night, 65% RH, 16-8h day/night, full-spectrum light with 250 photosynthetic photon flux density (PPFD), 120 ppm CO₂ concentration.

The lettuce seedling were produced according to the SOP of ZHAW. 20 plastic boxes containing the nutrient solutions were planted with 6 seedling each and were filled with 15 L of solutions prepared as described above. Each box was equipped with an air stone to ensure good oxygenation of the water.

Evapotranspiration was monitored weekly and “missing” solution was topped up with the equivalent amount water; besides, half of the solution of each treatment was replaced weekly. Dissolved oxygen (DO), electrical conductivity (EC), pH and temperature of the water were monitored twice per week with a Hach-Lange Multimeter. For each treatment, two 15 mL and three 50 mL tubes were weekly filled with weekly and stored at -20 °C for downward compositional analysis.

Challenge test with Pythium

After two weeks from transfer to the nutrient solutions a challenge test was run inoculating 0.25 g *Pythium* grown on millet on six rockwools of one of the two replicate boxes of each treatment.

Further microbiological analysis and data evaluation

Further microbiological analysis (gene target sequencing and phenotype microarray) and data evaluation will be performed withing the next two months. A paper will be written and submitted by the end of 2021.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Training in the management of HP and AP and on laboratory analyses to monitor water parameters.

Experiment on *in vivo* effect of potential probiotics on horticulture crops, complete with dataset of environmental parameters and crop growth & quality monitoring.

Further microbiological analysis (gene target sequencing and phenotype microarray) and data evaluation will be performed withing the next two months. A paper will be written and submitted by the end of 2021.

FUTURE COLLABORATIONS (if applicable)

Preparation of designs and SOP for the planned Aquaponics in Italy.

Biochemical tests on the bacteria present in the systems of the above-mentioned experiment.

Sample set for metagenomics from selected system components (solution, biofilm, roots...).

The STSM stay will result in COST publication in an international peer-reviewed journal on the trial performed with bacterial administration: Bruni, L., Junge, R., Parisi, G., Skar, S., Smits, T.H.M., Schmutz, Z. (2021) Influence of beneficial bacteria on growth and quality of leafy greens in aquaponics and hydroponics.

Another publication will be written on the metagenomics results. The title is to be defined later.