UNIVERSITY OF HOHENHEIM

HYPOWAVE

Cleaning water with hydroponic plant production

Introduction

Climate change and the growing world population are challenging traditional crop production. In particular, the decline in available freshwater poses a threat, as agriculture is the sector with the highest water demand (FAO, 2012). Hydroponic crop production has the potential to achieve high yields with very low resource inputs. For example, Sharma et al. (2018) show that hydroponics requires less than 30% of water and nutrients than traditional agriculture. To further increase sustainability, treated municipal wastewater can be used as a source of water and nutrients in hydroponic systems. The challenge is to remove nutrients from the water and still achieve consistently high yields.

Therefore, the dynamics of N and P uptake by vegetable plant species from low-concentrated nutrient solutions (treated wastewater) is being investigated as a function of abiotic factors such as air and water temperature, humidity and photosynthetic photon flux density.

Materials & Methods

Two hydroponic experiments were conducted in humidity controlled growth chambers at Phytotechnikum research greenhouse at the University of Hohenheim (Stuttgart, Germany) from 29th February to 30th March and from 3rd to 30th November 2022 (Fig. 1).

Experimental Design

- **24 Hydroponic sets** (Fig. 2a) of 6 plants each (Fig. 2b)
- **101.8 l** of nutrient solution circulating at 1 l/min
- **Photoperiod:** 14 h, **PAR**: 350 - 450 µmol /m²/s
- **Relative air humidities:** Dry < 40 % (high vapor pressure deficit [VPD], Humid 70 – 80 % (low VPD).

Experiment 1

Analysis of the nutrient uptake dynamics, plant growth, and root and shoot morphology of four tomato varieties growing in low concentrated nutrient solution at high and low VPD.
Low concentrated nutrient solution with 20 mg/l N_{tot}, 5 mg/l PO_4-P.
Exchange of nutrient solution at N_{tot} <5 mg/l.

Experiment 2

To investigate the effects of four constant ammonium-nitrate ratios on biomass production, nutrient use efficiency and enzyme activities of tomato plants under high and low VPD.
Initial nutrient solution with 100 mg NO_3-N/l. Depletion to 22 mg NO_3-N/l at the lowest and to 50 mg NO_3-N/l highest ammonium rate.

Fig. 1: View of a chamber half with low VPD (left) and a chamber half with high VPD (right) with four hydroponic sets each

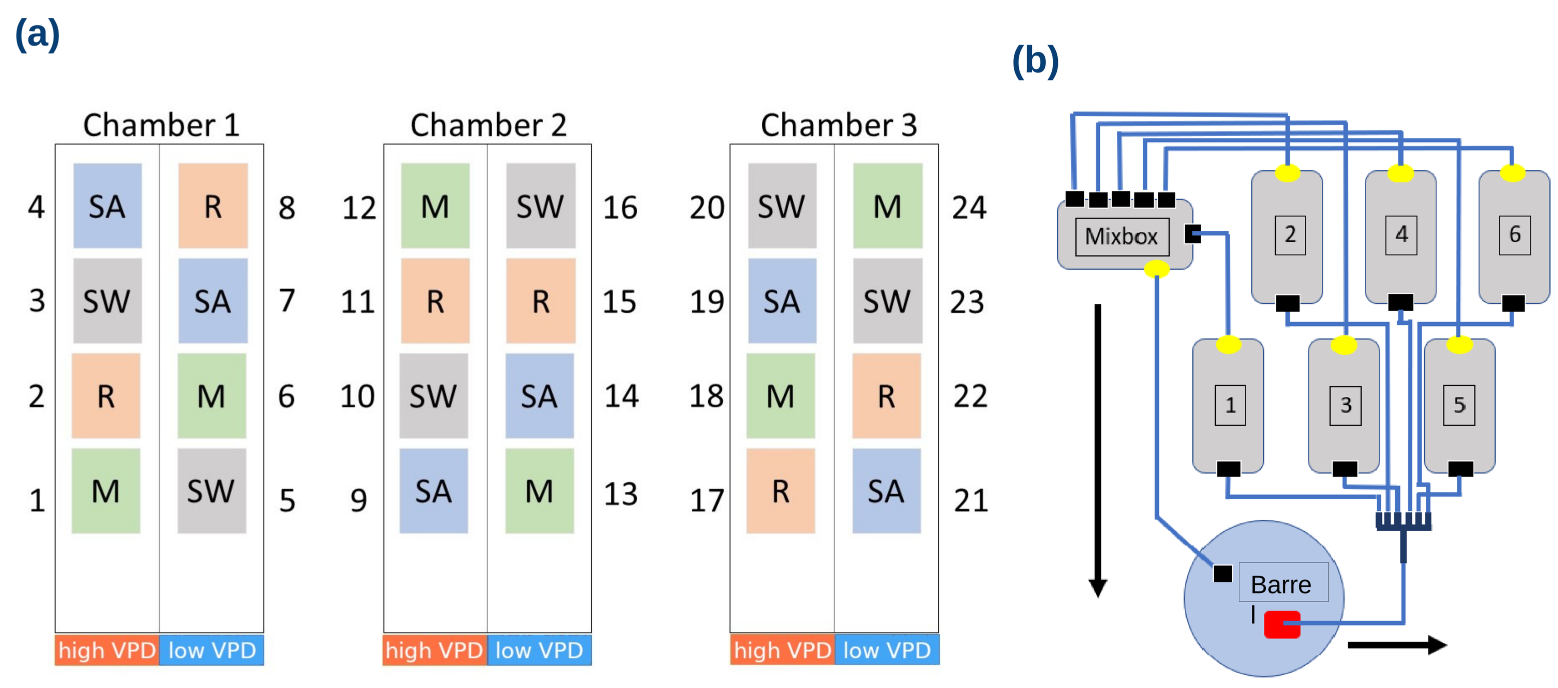

Fig. 2: (a) Experimental design of the first experiment with the varieties Moneymaker (M), Reddery (R), Saluoso (SA), Sweeterno (SW) and three replications and (b) schematic layout of one hydroponic set.

Results and Discussion

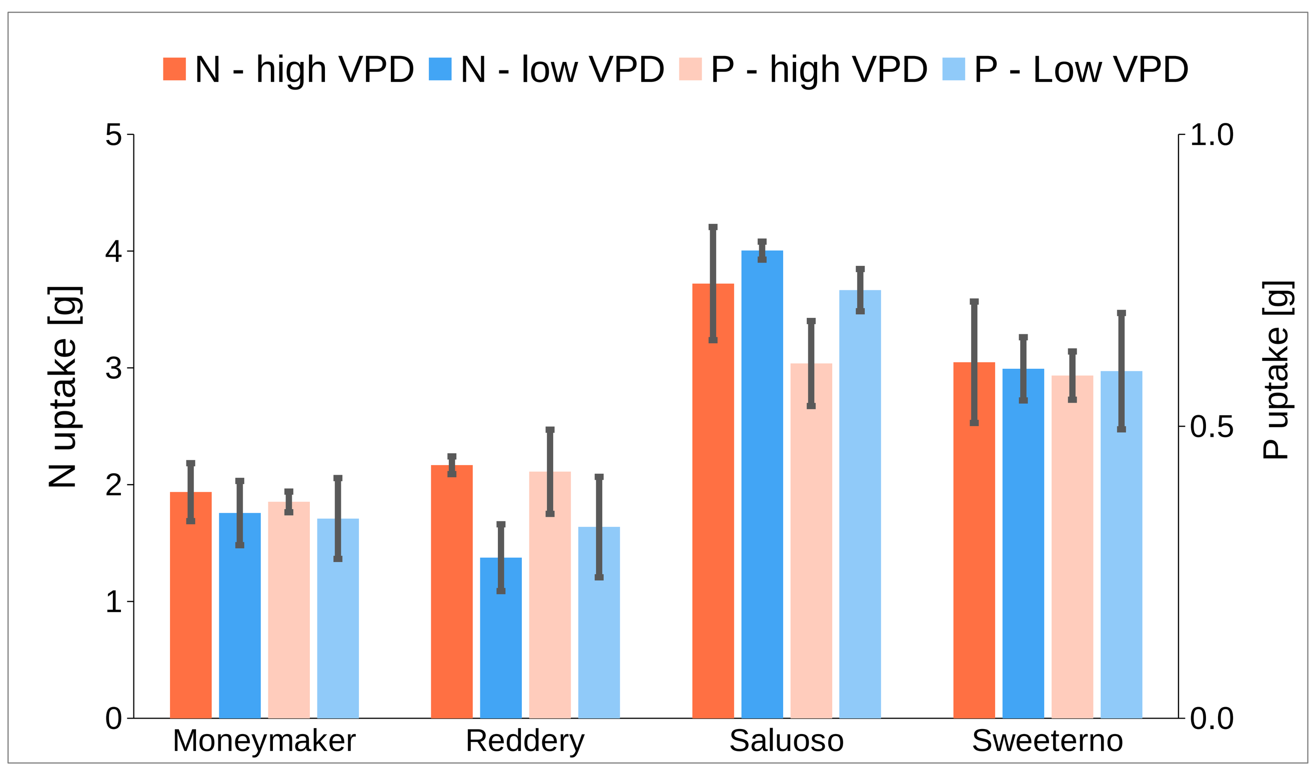

Fig. 3: Nutrient uptake per plant of four tomato varieties as estimated by nutrient solution depletion

- Significant varietal differences in nutrient uptake
- No VPD effects on nutrient uptake in M & SW
- R & SA show contrasting uptake response to VPD

Variety and VPD affect nutrient uptake in tomato

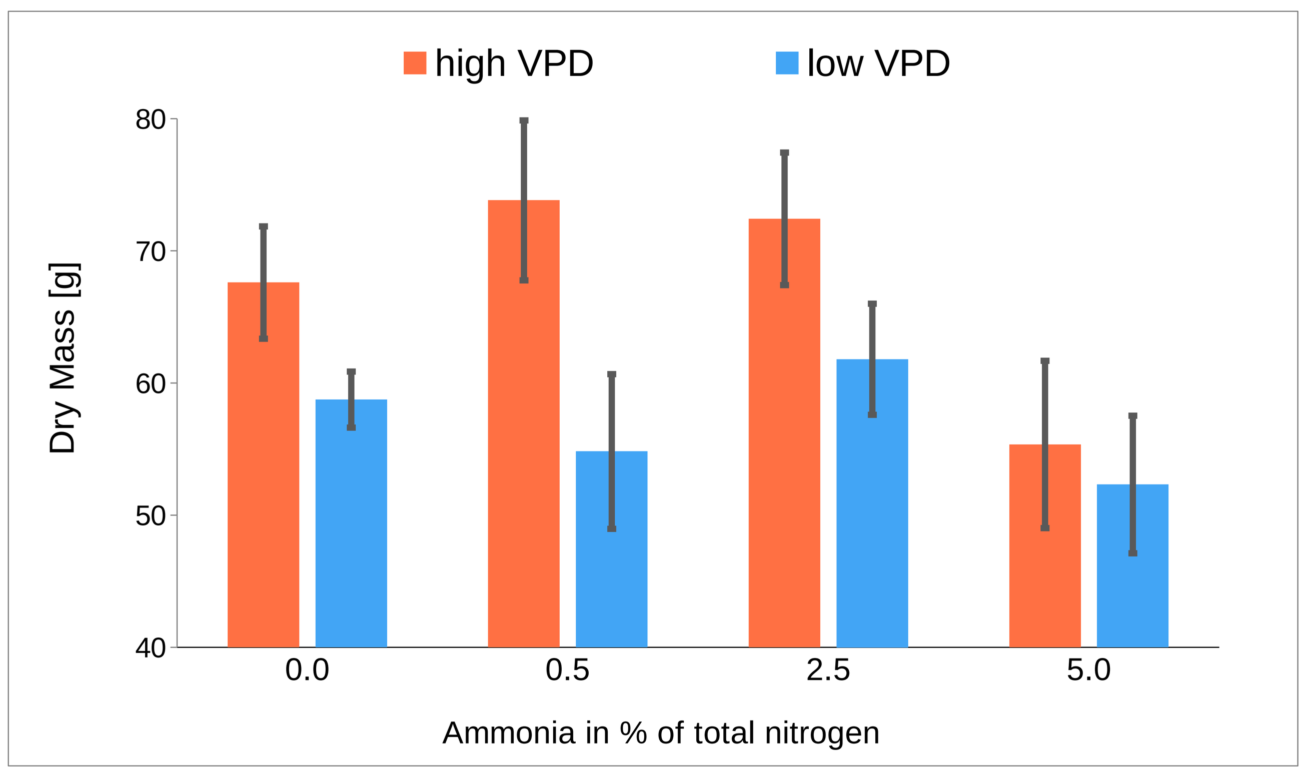

Fig. 4: Biomass production per plant (var. Saluoso) as affected by constant NH_4 to N_{tot} ratio and VPD

- The highest NH_4 concentration reduced at high VPD the biomass production
- In contrast to exp. 1 SA preformed better at high VPD

Low and stable NH_4/N_{tot} ratios increase production

Fig. 5: Saluoso 16 days after transplanting in a low VPD chamber during the second experiment

Data interpretation ongoing

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