UNIVERSITY OF HOHENHEIM

HYPOWAVE

Anton & Petra Ehrmann-Stiftung
Research Training Group
Water – People – Agriculture

Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute) Water stress Management (490-g)

The effect of vapor pressure deficit on genotypic nutrient uptake and biomass production of hydroponically grown tomato

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Introduction

Controlled environment farming based on hydroponics is becoming increasingly important in resource-efficient crop production. Exploiting alternative water sources such as wastewater as a basis for hydroponic nutrient solutions can further increase the sustainability of the system. However, reconciling the required water quality with consistently high yields presents a major challenge, since crop varieties vary in their nutrient uptake as a function of water quality and environmental conditions. To assess the potential of wastewater as a nutrient source, we analyzed the nutrient uptake dynamics and plant growth of four tomato cultivars growing in low concentrated nutrient solution at different vapor pressure deficits.

Conclusions

- ✓ Reducing air humidity can positively affect plant growth, nutrient uptake and yield formation
- ✓ The effect of humidity control differs significantly between cultivars and finally relies on the specific genotypic response
- ✓ Dryer conditions in greenhouses can also contribute to mitigating fungal diseases and other abiotic stressors

Results and Discussion

Biomass production

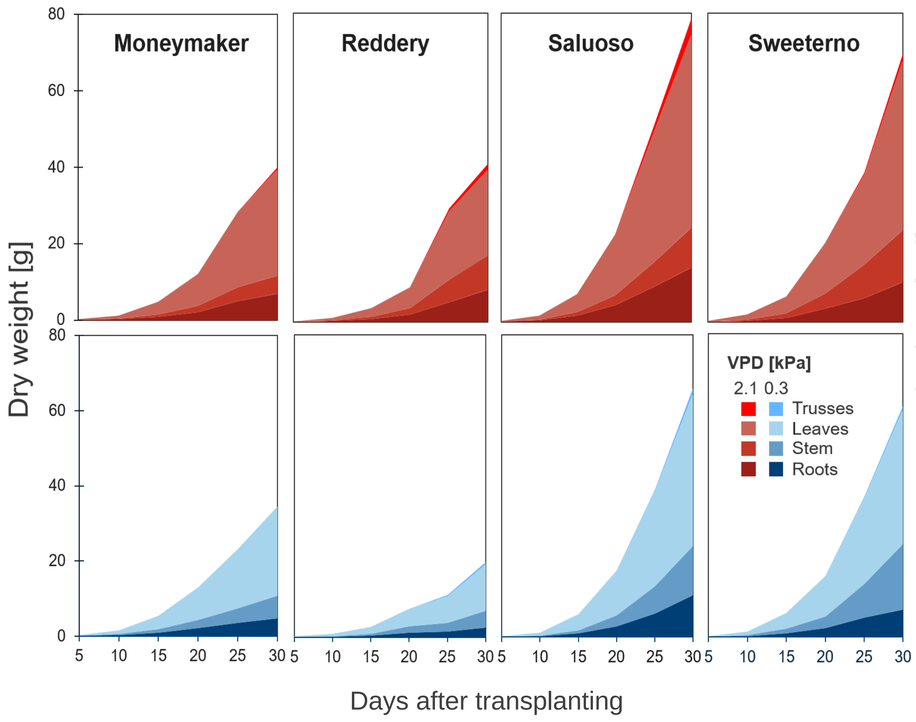

Fig.1: Biomass production and allocation to different plant parts of four tomato cultivars grown under two different levels of vapor pressure deficits (VPD)

- Total biomass of all cultivars increased under high vapor pressure deficit (HVPD)
- More biomass was allocated to roots, leaves and trusses under HVPD conditions
- Saluoso and Sweeterno had significantly higher biomass in both treatments

High vapor pressure deficit affected leaf and truss biomass production which can positively affect yield formation

Leaf area

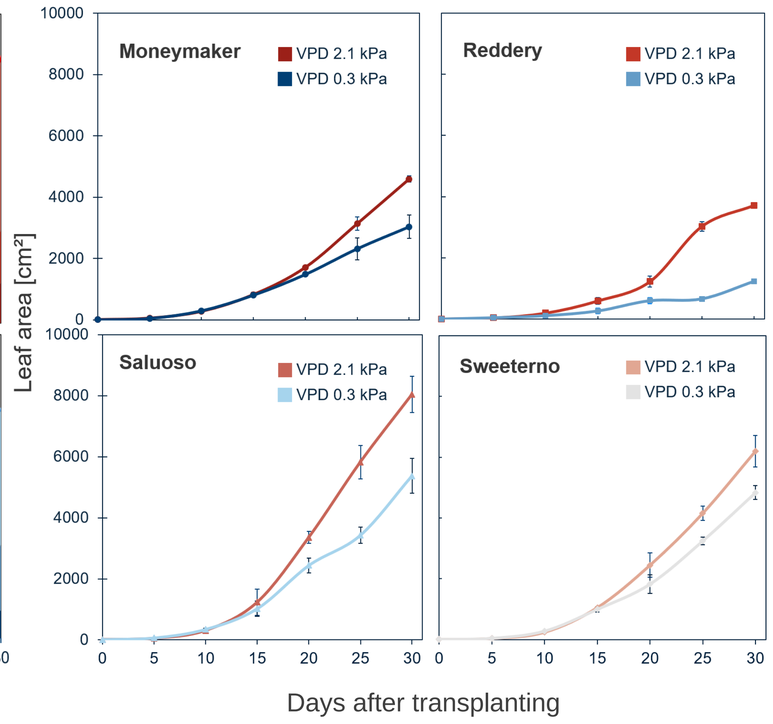

Fig.2: Leaf area development of four tomato cultivars affected by vapor pressure deficit (VPD)

- Leaf area (LA) per plant increased significantly under HVPD: Moneymaker by 44%, Reddery by 67%, Saluoso by 33%, and Sweeterno by 22%
- Leaf Area development was affected from 10 – 15 days after transplanting

Higher LA increases transpiration and the light capturing surface which can enhance nutrient utilisation, and overall plant growth

Nutrient uptake

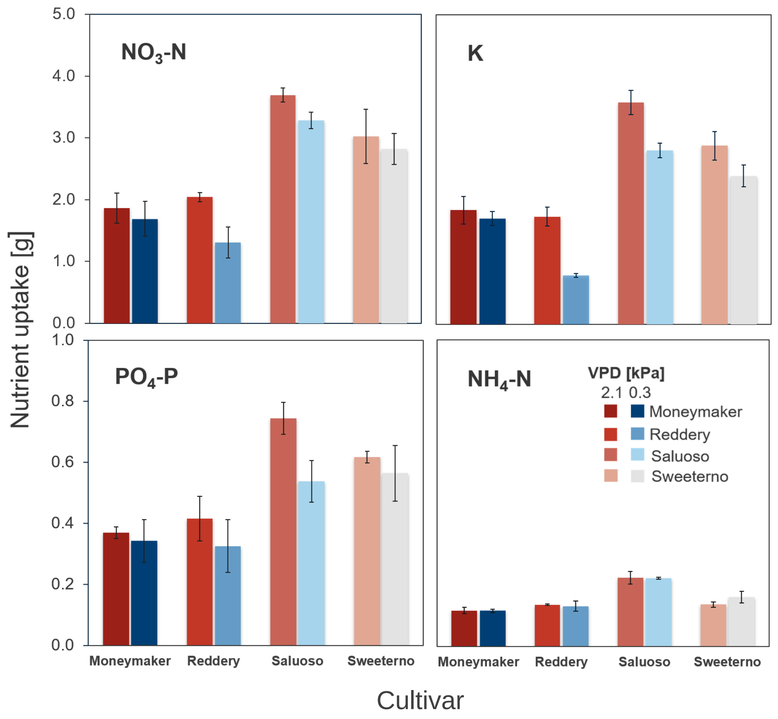

Fig.3: *Nutrient uptake per plant of four tomato varieties estimated by nutrient solution depletion affected by vapor pressure deficit (VPD)*

- Significant differences in nutrient uptake were found among cultivars and humidity treatments
- Cultivar Saluoso showed greater uptake rates of NO3, K and PO4 compared to the other cultivars under HVPD

Drier conditions resulted in better nutrient uptake and thus more efficient use of the low-concentration nutrient solution

Materials and Methods

Four different tomato cultivars (cv's Moneymaker, Reddery, Saluoso, and Sweeterno) were grown in humidity-controlled growth chambers at the University of Hohenheim, Stuttgart. Tomato seedlings were transplanted into a deep flow hydroponic system which was operated in a feed & deplete mode. The nitrogen and phosphate concentration in the nutrient solution was kept at a level as expected in anaerobically-aerobically treated wastewater (20 ppm N_{tot}, 5 ppm PO_4) and replenished when the nitrate concentration dropped below a defined threshold (5 ppm NO_3). For a period of 30 days, plants were subjected to an average relative air humidity of 40% in the chamber with high vapor pressure deficit (2.1 kPa) and 90% in the chamber with low vapor pressure deficit (0.3 kPa).

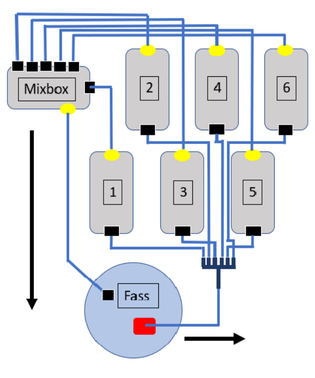

Fig.4: Visualization of one set of hydroponic system.