Grafting improves the growth and nutrient acquisition capabilities of tomato plants

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Keywords: soilless cultivation systems, grafting, root traits, salinity, nutrient translocation index

Salinity is one of the most detrimental environmental factors on the growth and productivity of cultivated crops. The saline soil area is large and enlarging. Counting on that, the soilless production systems (SCS) are fast spreading as an effective alternative. However, the poor quality of irrigation water, mainly due to high salt content, remains a main concern even for SCS-s. Growing plants with a limited rooting volume imposes roots to grow very densely to compensate for the limited root zone volume. It might improve the utilization efficiency of water and nutrients but expose the root system to environmental changes and human-imposed mistakes which impact the morphology and nutrient uptake capabilities of SCS plants. Grafting might help overcome these issues, although the restricted root volume condition might significantly impact the performance of commercial rootstocks themselves. Therefore, this research aimed to study the behavior of several rootstocks grafted with a commercial tomato cultivar regarding growth, root morphology, and nutrient uptake capabilities under saline conditions and indicate the potential mechanisms of salinity alleviation of grafted tomato plants in restricted volume conditions. For that purpose, a tomato cultivar ('Izmir F1') was grafted onto six commercially available rootstocks ('Arnold', 'Dohkko', 'Emperador', 'He-man', 'Kaiser', and 'Suzuka'). All heterografts and the self-grafted tomato plants (Izmir/Izmir) were incorporated in a pot experiment. Growth, root morphology, and nutrient uptake parameters were evaluated under different salinity conditions (0 and 50 mM NaCl). It was found that grafting tomatoes onto appropriate rootstocks increases root length (RL), specific root length (SRL), and root length ratio (RLR). These enhance hetero-grafted plants' capabilities to exploit a larger soil volume or else increase root density under root restriction conditions. Therefore, besides currently recognized scion characteristics, RL, RSA, and RLR should be considered useful QTL associated with grafted tomato salt response. Significant variations were revealed regarding root and shoot concentration of macro and micronutrients between the self-grafted and hetero-grafted plants. Since the root traits and nutrient concentrations in hetero-grafted variants were less impacted by a change in the salinity level, the use of specific rootstocks ('Arnold', 'Dohkko', 'Kaiser') could contribute to a steadier growth and yield of tomato plants under fluctuating salinity levels in the irrigation water. The lower sodium translocation indexes than the self-grafted variant indicated higher Na sequestration/compartmentalization capabilities of the hetero-grafted tomato plants. This helps to maintain a more appropriate K^+/Na^+ ratio under saline conditions, demonstrating a higher tolerance of hetero-grafted plants to raised salinity. The lower translocation indexes revealed for Al, Ni, Zn, and Cd suggest that appropriate rootstock/scion combinations might as well be a useful tool to reduce the risk of heavy metal accumulation in edible plant organs. Yet, good results could only be achieved in appropriate rootstock/scion combinations.

Reference: Astrit Balliu, Ismet Babaj & Glenda Sallaku. 2024. Root morphology parameters and nutrient acquisition capabilities of grafted tomato plants in root-restricted conditions are subject to salinity and rootstock characteristics, International Journal of Vegetable Science, DOI: 10.1080/19315260.2024.2383847