applied sciences

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The Impact of Salinity and Nutrient Regimes on the Agro-Morphological Traits and Water Use Efficiency of Tomato under Hydroponic Conditions

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Abstract: The effects of saline water on three greenhouse tomato cultivars (Feisty-Red, Ghandowra-F1, and Valouro-RZ) under three salinity concentrations (S1, ~2.5 dS m^{-1}; S2, ~6.0 dS m^{-1}; and ~9.0 dS m^{-1}) and four nutrient regimes (N1–N4) were studied by evaluating the vegetative growth, chlorophyll content, leaf area, water use efficiency (WUE), and fruit yield of the cultivars. Vegetative growth parameters, such as plant height, leaf area, and stem diameter, were negatively correlated with increased levels of salinity. Also, the lowest WUE was noted for the high-salinity (~9.0 dS m^{-1}) treatments. The Valouro-RZ cultivar performed better in terms of vegetative growth parameters when compared to both the Ghandowra-F1 and Feisty-Red cultivars. The plants grafted onto Maxifort rootstock showed more tolerance to salinity stress, with significant differences in plant growth, tomato yield, and WUE when compared with the non-grafted plants. The use of a modified nutrient solution (N2) in combination with moderately saline water (S2, ~6.0 dS m^{-1}) resulted in a high mean yield (30.7 kg m^{-2}), with a reduction of about ~1.6% compared with the mean yield of the control (i.e., the combination of S1 and N1), which was estimated to be about 31.2 kg m^{-2}. High salinity significantly affected the mean WUE, which was the highest at 31.3 kg m^{-3} for the control plants (low salinity—S1), followed by the moderate-salinity (S2) plants at 30.4 kg m^{-3}, and the lowest mean WUE was recorded for the high-salinity (S3) plants at 17.7 kg m^{-3}. These results indicate that a combination of grafting onto rootstocks and using an appropriate nutrient recipe (i.e., N2 in this study) can mitigate the negative effects of salt stress on tomato plants grown under hydroponic conditions.

Keywords: hydroponics; salinity; yield; water use efficiency

Citation: Madugundu, R.; Al-Gaadi, K.A.; Tola, E.; Patil, V.C.; Sigrimis, N. The Impact of Salinity and Nutrient Regimes on the Agro-Morphological Traits and Water Use Efficiency of Tomato under Hydroponic Conditions. *Appl. Sci.* **2023**, *13*, 9564. https://doi.org/10.3390/app13179564

Academic Editors: Bongani Ncube and Nebo Jovanović

Received: 21 June 2023
Revised: 9 August 2023
Accepted: 14 August 2023
Published: 24 August 2023

1. Introduction

Saudi Arabia is a desertic land exposed to extreme temperatures and an arid climate, with limited groundwater resources [1]. Despite the harsh environmental conditions, such as high levels of evapotranspiration and low levels of precipitation, the Kingdom has managed to become self-sufficient in the production of some vegetables and food crop products [2]. With the rapid growth of the population, there is a rising demand for vegetables and tomatoes. Hence, the sustainability of agriculture and water resources in Saudi Arabia is essential for food and water security [3]. Soil and water resources, along with the application of agricultural inputs, determine the production potential of agricultural ecosystems. Increased crop yields are associated with an increased use of water