Environmental and Cultivation Factors Affect the Morphology, Architecture and Performance of Root Systems in Soilless Grown Plants

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"Far from eye, far from heart" – Is this why most studies are dedicated to the aboveground part of the plant? However, the plant root system plays an essential role in plant growth, yield, and product quality. They are confined into a specific root zone and are exposed to environmental changes and cultivation factors. The recent scientific evidence regarding the effects of several environmental and cultivation factors on the morphology, architecture, and performance of the root system of plants grown in soilless culture systems, one of the fastest-growing sectors in horticulture, was the objective of this review study. The effect of root restriction, nutrient solution, irrigation frequency, rootzone temperature, oxygenation, vapor pressure deficit, lighting, rootzone pH, root exudates, CO_2, and beneficiary microorganisms on the functionality and performance of the root system are discussed.

The main result of this review demonstrates that researchers have carried out great efforts in innovation to optimize soilless culture systems, water and nutrients supply, correct pH, temperature, and oxygen levels at the rootzone, proper lightening and CO_2 concentration, and effective plant–beneficiary microorganisms, while contributing to plant yields and product quality. By using multi-element sensors and interpretation algorithms based on machine learning logic, it is possible to monitor the availability of nutrients in the hydroponic solution and modify its composition in real time while reducing economic costs and minimizing the environmental impact. Developing an effective data-processing method to compensate for signal drift and interference is essential. Similarly, advanced Big Data analytics and simulation techniques might allow forecasting the quality and quantity of greenhouse vegetable and fruit production under various conditions and, in turn, determine the optimal parameters,

Finally, this review analyses the new trends based on emerging technologies and various tools that might be exploited in a smart agriculture approach to improve root management while procuring a deeper understanding of plant root–shoot communication, and the response of root-associated microorganisms under different stress conditions.

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