Hydraulic and Aeration Properties of Soilless Greenhouse Substrate Mixtures

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Abstract

With the global population projected to grow to more than 8 billion by 2024, irrigated agriculture faces momentous challenges to keep up with the increasing demand for adequate food supplies, especially in the arid regions of the world. As a result, soilless culture is regaining increased attention as it allows a more sustainable management of production resources along with higher achievable crop yields. Individual soilless substrates with desirable and complementing properties for plant development and production are commonly mixed at varying ratios. Organic components, such as coconut coir, often lack coarse particles necessary for adequate aeration and they hold moisture relatively tight in small pores. To optimize aeration and water holding properties they are commonly mixed with coarser materials such as volcanic tuff to create larger pores that rapidly drain after irrigation, thereby creating optimal rhizosphere conditions that can be tailored for a specific crop. Such mixtures often exhibit bimodal pore size distributions and water retention characteristics, where the fraction of smaller pores mainly retains water and the larger pore fraction allows for optimal aeration. The optimum mixing ratios are commonly selected through trial and error by growing plants in a series of mixtures. Replacing this trial and error approach with physical relationships for prediction of mixture behavior from well characterized constituent properties will significantly advance soilless culture production and eliminate costly mistrials. Based on this premise, the hydraulic properties of three mixing ratios of dual component substrates made up of perlite, tuff, and coconut coir have been studied. Constitutive relationships parameterized with hydraulic properties of individual components will be presented.