EVALUATING THE EFFECT OF SUBSTRATE COMPOSITION ON IRRIGATION DEMAND IN SMART-IRRIGATED SYSTEM INTENDED FOR TROPICAL LIVING WALLS

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Rapid urbanization has increased interest in modular living wall systems (MLWs) as a sustainable strategy for enhancing urban environmental quality. However, the long-term sustainability of MLWs in tropical climates is strongly influenced by irrigation demand. While moisture-responsive smart irrigation systems are recognized as water-efficient technologies, the influence of substrate composition on irrigation demand under controlled moisture conditions remains insufficiently understood. Therefore, this study evaluated the effect of different recycled demolition waste (DW) based substrate compositions on irrigation demand and water-use efficiency under moisture-responsive smart irrigation. Four substrate mixtures containing recycled mixed DW and organic amendments (compost and coco peat) were developed and evaluated using an Arduino-based five-channel moisture-responsive irrigation system to maintain near-field-capacity conditions for each substrate independently, with *Epipremnum aureum* as the test species. The experiment was conducted over eight weeks using a completely randomized design with five treatments (including the organic control) and four replicates. A total of 5006 continuous irrigation cycles were evaluated during the experimental period. Moisture normalization and system validation analyses confirmed that comparable moisture availability was maintained across all substrate compositions despite differences in substrate physical characteristics. Substrate composition significantly influenced bulk density, porosity, and water-holding capacity, resulting in distinct irrigation demand patterns. Plant growth responses across substrate compositions remained statistically similar among treatments under comparable moisture conditions. Water use efficiency, expressed as biomass produced per unit of water applied, varied significantly among substrate compositions ($F = 124.08$, $p < 0.001$); 50:50 and 40:60 substrate compositions exhibited the highest water use efficiencies, indicating that substrate compositions with similar plant growth outcomes may differ substantially in irrigation demand. These findings indicate that smart irrigation alone does not guarantee maximum irrigation efficiency, as substrate physical properties remain a critical factor governing the water demand of moisture-responsive smart irrigated systems. Integrating moisture-responsive irrigation systems with optimized substrate design may therefore provide an effective approach for improving the water efficiency and sustainability of tropical modular living wall systems.

Keywords: irrigation demand, living walls, smart irrigation, water use efficiency