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A Statistically Rigorous Approach to Experimental Design of Vertical Living Walls for Green Buildings

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Abstract: Living walls (LW) have been widely proposed as a form of green infrastructure to improve aesthetics, energy consumption, and microclimate in urban environments by adding densely-planted vegetation to the outside walls of buildings. Scientific studies using multiple treatments in a single LW face challenges due to the close physical proximity of different treatments, particularly the potential for plants above to influence those below. A study on a west-facing LW was undertaken to investigate 36 unique treatments in Adelaide, South Australia, for nine months. The LW comprised combinations of six native plant species, three soil substrates and two irrigation volumes. The LW consisted of 144 modular trays mounted on a wall in a 12 × 12 grid with four replicates of each treatment. The location of each treatment was designed to account for a cascading carry-over effect that may be present when one plant is placed above another. Carry-over effect of the model designed showed mixed results among the plant groups identified. It was also found that long-form plants can significantly shade smaller plants below them. Experimental research into the performance of plants in mixed species LW should consider the carry-over effect to account for this.

Keywords: living wall; vertical greenery system; carry-over effect; native plants

1. Introduction

From 2009–2013, 411 research articles on urban heat island (UHI) mitigation were published, reflecting a growing number of UHI phenomena research and found that vegetation-related measures were most researched compared to other measures [1]. A UHI study for Adelaide suggested that microclimates within the city may change within 1 km [2]. In another study, one of the factors that control the difference in UHI intensity is evaporation capability. Hence, green infrastructure has been recommended for implementation in cities [3].

Living wall is one of two popular vertical greenery systems (VGS), the other being the green façade [4–8]. The two are structurally different, in that with living walls the plants are contained in modular trays or felt pocket systems, while green façades provide structures for climbing plants. There are multiple VGS applications [9] but they are widely reported for their thermal benefits on building façades [10,11]. They provide shading that reduces the temperature of the façades, while evapotranspiration from the plants also reduces the temperature of their surrounding environment [12,13]. Subsequently, as the temperature of the building decreases [14–19], energy demands will also be reduced as less energy is required to heat or cool the building [20–23].