

EVALUATION OF AN IOT-BASED GREENHOUSE CLIMATE SIMULATION SYSTEM USING BLACK PEPPER (*Piper nigrum* L.) PLANTS

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Controlling climatic conditions in agricultural experiments, particularly in tropical regions, poses a significant challenge. The performance of an Internet of Things (IoT)-based greenhouse climate control system using black pepper *Piper nigrum* (L.), a widely cultivated economically important perennial crop was evaluated. The experiment was conducted in Rajarata University Controlled Environment Facility (RuCeF), Anuradhapura, Sri Lanka. Three thermal chambers were assessed for their capacity to simulate the climatic conditions: (i) baseline conditions representative of Matale and conditions with (ii) a +2°C and (iii) a +4°C increment from the baseline. The mean set temperatures for the chambers were 25.8°C, 27.8°C, and 29.8°C respectively. The growth of black pepper was monitored over a 50-day acclimation period. Results revealed that chamber 3 simulated the desired conditions (i), (ii), and (iii) with low absolute deviance from set values ($\delta|T| = 0.68\text{--}0.87^\circ\text{C}$). Chamber 2 successfully simulated conditions (i) and (ii), with $\delta|T| = 0.58\text{--}0.75^\circ\text{C}$. However, chamber 1 exhibited substantial deviance ($\delta|T| = 1.72\text{--}2.85^\circ\text{C}$) from the set conditions (ii) and (iii) as it received a high heat load. During this period, stress indicators ($p < 0.05$), such as increased electrolyte leakage and decreased chlorophyll content were observed with warming, suggesting the crop's vulnerability to warming. However, the growth parameters such as plant height, leaf count, nodes, and branches, internodal distance, and whole-plant leaf area did not significantly increase ($p > 0.05$). This poor growth was due to an extended rainy period with low light intensities, leading to guttation and mortality in some pepper plants. The RuCeF demonstrated the ability to effectively simulate future climatic conditions. However, during rainy periods, dehumidification measures are necessary to optimize crop growth.

Keywords: Black pepper, Climate simulation, Greenhouse, Internet of Things