

ABSTRACT

Intercropping grapes and bell peppers requires careful environmental management due to their differing physiological needs. This research developed an IoT-based system for real-time environmental monitoring and automated irrigation to maintain a stable microclimate suitable for both crops. The system utilizes an ESP32 microcontroller connected to various sensors, such as soil moisture, air temperature and humidity, light intensity (LUX), CO₂ concentration, and soil pH. Data is transmitted via the MQTT protocol and visualized in a Laravel-based web data display. Two test scenarios were conducted: a short-term evaluation of the effectiveness of the automatic watering system and a seven-day environmental monitoring. The test results showed that the system was able to rapidly increase soil moisture in just one minute and stabilize air temperature and humidity at around 2-3%—critical factors for bell pepper plants. During the seven-day monitoring, environmental conditions remained within optimal limits, meeting the light and temperature needs of the grapes while maintaining humidity levels that support bell pepper growth. This system proved capable of maintaining a stable microclimate and preventing extreme conditions that could be detrimental to the plants. Overall, the system successfully accommodated the environmental needs of both crops in a balanced manner. Future system development could include the integration of predictive automatic irrigation models and the addition of nutrient monitoring modules. These findings support innovation in real-time IoT-based sustainable agricultural practices.

Keywords: Arduino IDE, Automatic watering, ESP32, Intercropping, Multisensor.