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## AI-DRIVEN EVAPOTRANSPIRATION PREDICTION USING PLANT WEARABLE SENSOR FOR SMART IRRIGATION

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### Abstract

The global expansion of greenhouse cultivation has created a need for reliable crop evapotranspiration (ET) estimation to enable precise irrigation, thereby improving yields, enhancing crop quality, and addressing challenges related to water scarcity and environmental sustainability. This study proposes the development of a plant signal-based artificial intelligence (AI) model for ET prediction, tailored to the unique environmental conditions of greenhouse systems. Unlike empirical models that rely solely on environmental variables, the proposed approach incorporates physiological plant signal—sap flow—captured in real-time through plant wearable sensor. Using a data-driven AI approach, the model will be trained on both environmental and plant signal inputs to estimate ET and provide more precise irrigation scheduling. The performance of the AI model will be evaluated through a comparative analysis with the Penman-Monteith (FAO-56) empirical model, a widely recognized standard for ET estimation. By integrating plant physiological signals and overcoming the limitations of conventional models, this research demonstrates the potential of intelligent, adaptive modeling using plant wearable sensor.

**Keywords:** greenhouses, evapotranspiration, artificial intelligence, plant wearable sensor, irrigation management

### INTRODUCTION

Greenhouse cultivation is rapidly expanding worldwide, creating a need for reliable crop evapotranspiration (ET) to improve yield, crop quality, and resource efficiency. While the weight balance method provides a simple baseline for ET measurement, it cannot capture dynamic plant physiological responses. Wearable sensors, such as sap flow devices, combined with environmental data and AI modeling, enable real-time ET prediction and smarter irrigation management in greenhouse systems.

### MATERIALS AND METHODS

The experiment was conducted in a greenhouse at Gyeongsangnam-do Agricultural Research & Extension Services, Jinju, Korea (35.1775°N, 128.0903°E). Evapotranspiration (ET) was quantified using a weight balance system that continuously measured irrigation input and drainage output at one-minute intervals, with data aggregated for each hourly irrigation cycle

(Rahimikhoob et al., 2020). ET per slab was then estimated using the water-balance approach for accurate comparison and analysis.

$$ET = I - D \quad (1)$$

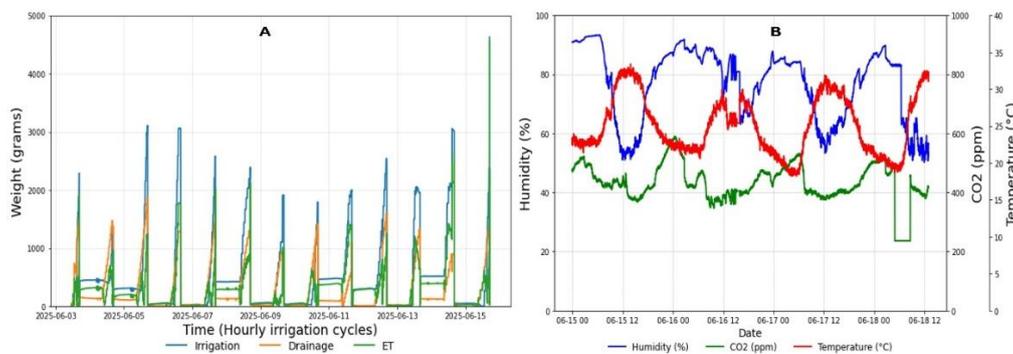
ET ( $\text{g slab}^{-1} \text{h}^{-1}$ ) was calculated using hourly irrigation input ( $I$ ,  $\text{g slab}^{-1} \text{h}^{-1}$ ) and hourly drainage output ( $D$ ,  $\text{g slab}^{-1} \text{h}^{-1}$ ).



**Fig. 1** Weight balance monitoring setup.

## RESULTS & DISCUSSION

The weight balance method enabled accurate, continuous measurement of greenhouse evapotranspiration (ET) dynamics, capturing daily fluctuations in plant water use under varying environmental conditions. Irrigation and drainage data supported precise ET estimation, and integration with microclimate monitoring revealed interactions with  $\text{CO}_2$ , humidity, and temperature, reflecting plant physiological responses. These results demonstrate the reliability of the weight balance approach and its potential to enhance water-use efficiency in controlled environments.



**Fig. 2** (A) ET is based on irrigation and drainage, and (B) environmental conditions in greenhouse cultivation.

## CONCLUSIONS

The study shows that the weight balance system provides accurate, continuous measurement of greenhouse crop evapotranspiration, offering insights into plant water use and supporting precision irrigation. Future research should utilize weight balance data as a reference standard for calibrating plant-based sensors, thereby strengthening AI model development and enabling more accurate and adaptive irrigation strategies.

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## REFERENCES

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