# A Data-Driven Decision Support System for Apricot Irrigation in Mediterranean Areas

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## Abstract

Water scarcity is one of the most critical threats in Mediterranean agriculture, particularly for high-value crops such as apricots. This study introduces AGRODIGITAL, a machine learning-based irrigation decision support system designed to predict plant water potential (Ψ) at 24- and 48-hour intervals to optimize irrigation scheduling. The approach utilizes hourly measurements of microclimate variables, soil moisture, sap flow, and water potential, collected in an apricot orchard *(Prunus armeniaca* var. *farbaly)* from May until October 2025. Six modeling approaches were evaluated using a dataset of 2,466 training samples and 1,009–1,033 test samples. For 24-hour predictions, the Random Forest model achieved the highest accuracy (MAE = 0.486 bar, $R^2$ = 0.783), whereas the Persistence baseline outperformed other models for 48-hour forecasts (MAE = 0.665 bar, $R^2$ = 0.604). Model interpretation indicated that Ψ at 1-hour lag was the dominant predictor (c. 67% of importance), followed by the 24-hour lag water potential and short-term rolling statistics. Predictions showed a consistent conservative prediction bias (under-prediction by 0.13–0.35 bar) which may reduce the risk in under-estimating impending water stress offering thus a safety margin. These findings demonstrate the viability of data-driven Precision Irrigation in water-limited Mediterranean contexts, providing a scalable methodology towards sustainable irrigation management.

## Keywords

Water scarcity, Precision irrigation, Machine learning, Irrigation decision support system, Random Forest.

## Acknowledgments

The research project 'AgroDigital' is implemented in the framework «SUB1.1 Clusters of Research Excellence (CREs) with MIS code TA 5180519 in National Recovery and Resilience Plan "Greece 2.0" (Project Number: Υ∏3ΤΑ-0560506).