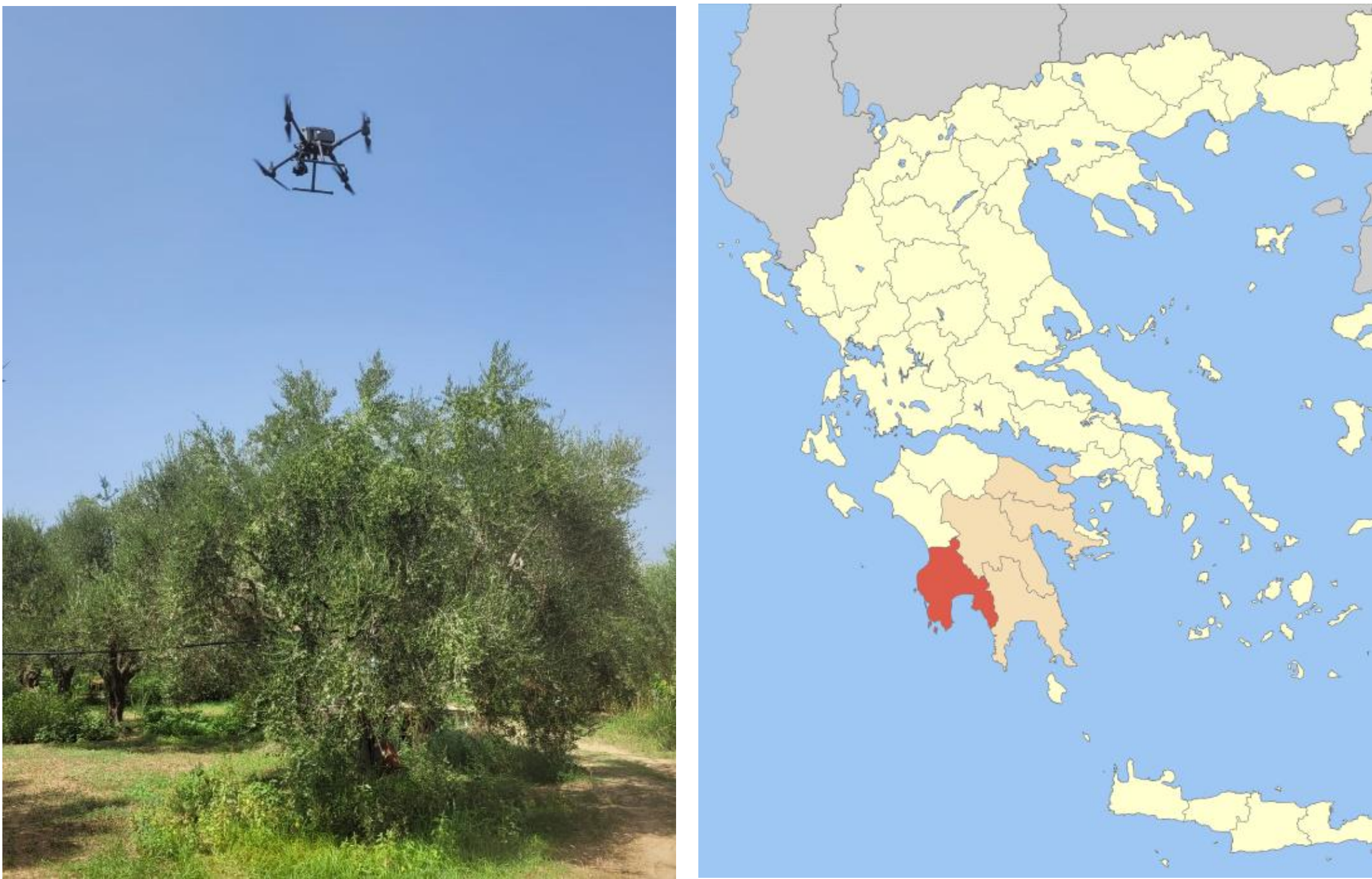


Assessing the impact of different irrigation regimes on olive trees

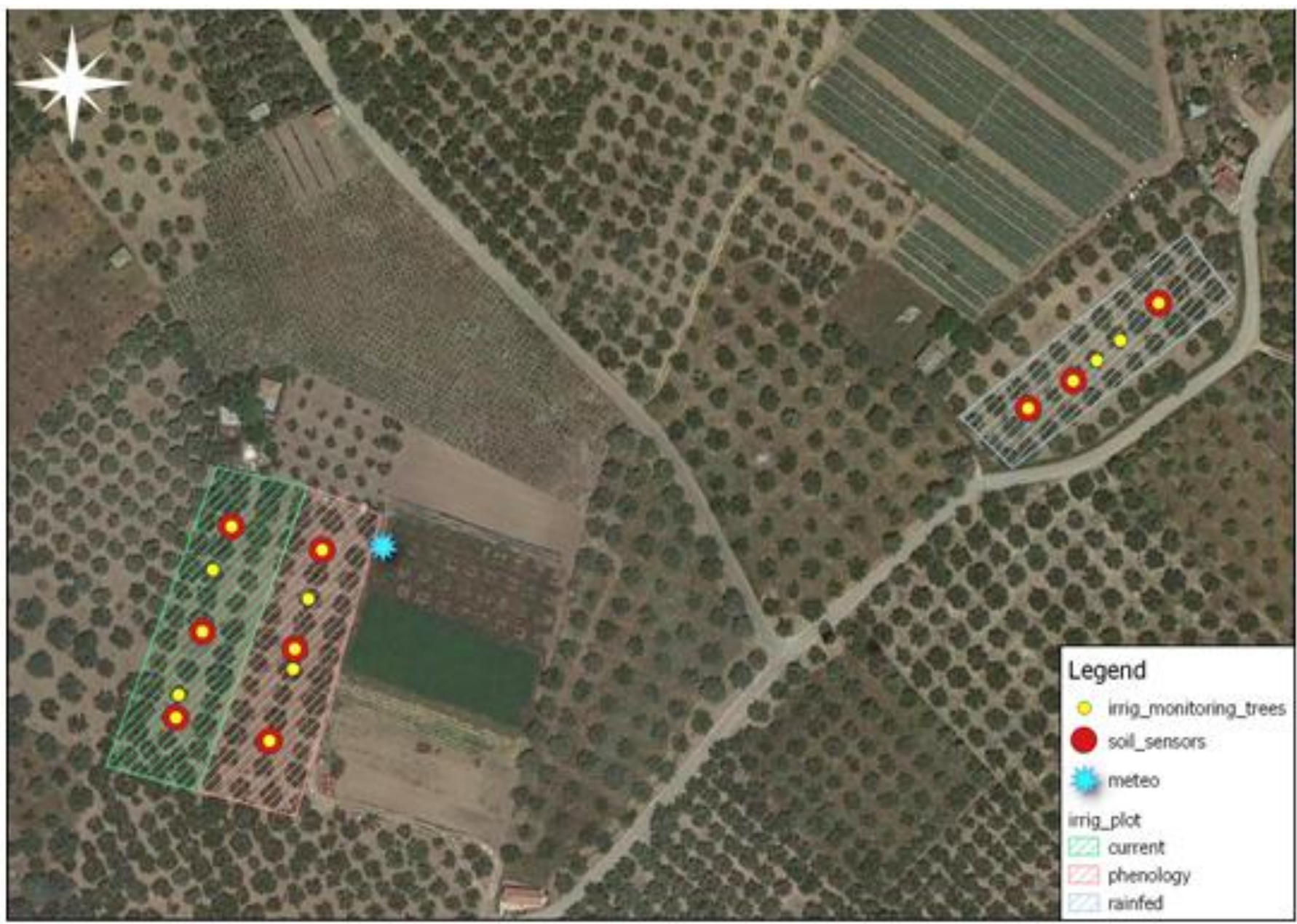
Giovanni Marino¹, Matthew Haworth¹, Christos Panzatis^{2,3}, Stavros Solomos³, Sabrina Mazzoni¹, Felicia Menicucci¹, Maddalena Grieco¹, Giulia Atzori¹, Mauro Centritto¹

¹Institute for Sustainable Plant Protection, National Research Council of Italy, Florence/Metaponto, Italy; ²Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Athens, Greece; ³Research Centre for Atmospheric Physics and Climatology, Academy of Athens, Athens, Greece

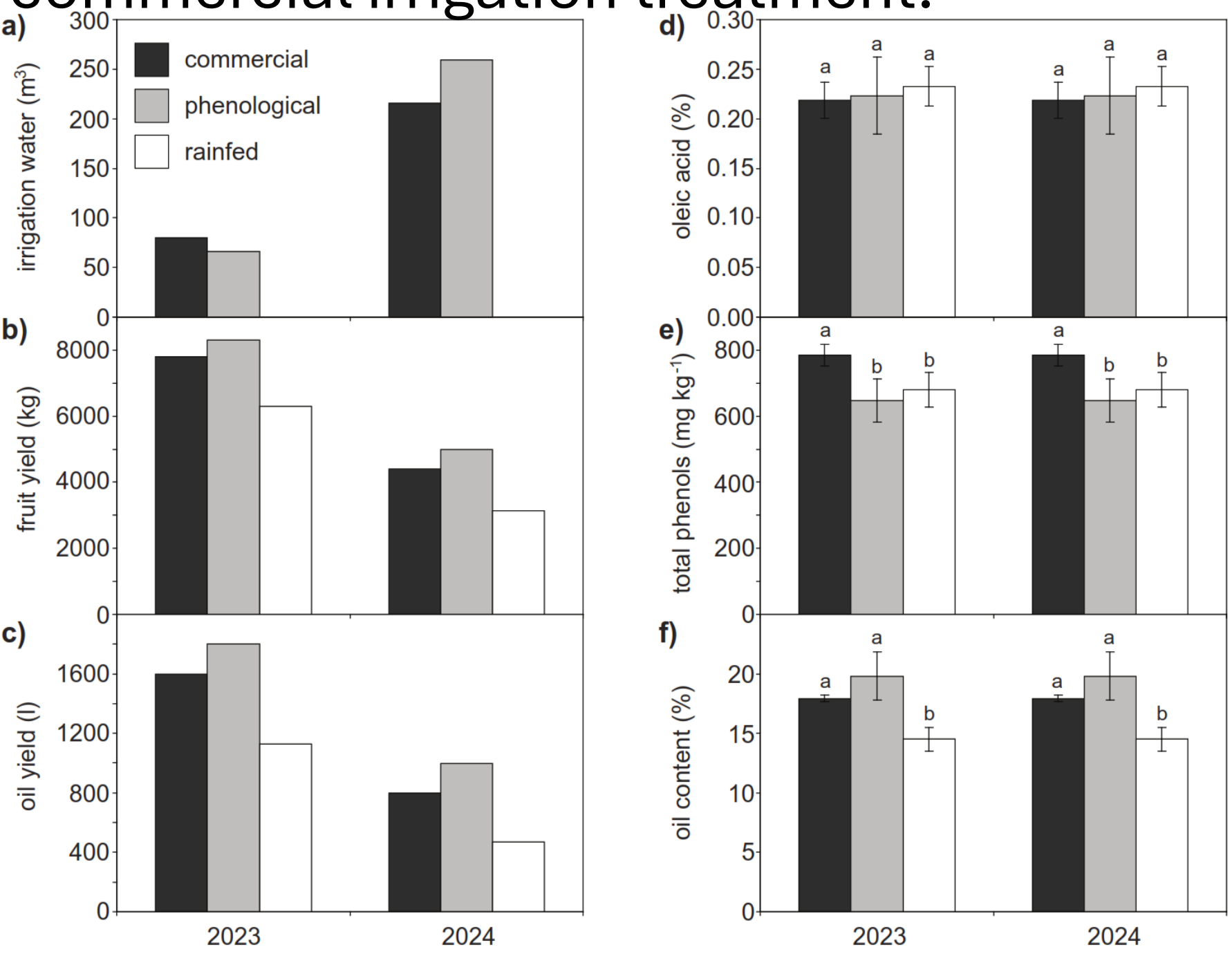
CONTEXT: The olive tree (*Olea europaea* L.) is predominantly cultivated in regions with semi-arid hot climates. Although olive trees are well adapted to conditions of low water availability and high temperatures, increasing climate variability, reflected in longer and more severe droughts and heat events, makes olive production particularly vulnerable to the adverse effects of climate change. Limited water resources are also expected to intensify competition between agricultural and domestic water use, especially in coastal areas with a strong tourism industry. Furthermore, increasing irrigation volumes does not necessarily lead to higher fruit yield, as it may instead favor excessive vegetative growth. Therefore, the development of innovative technologies aimed at optimizing water use and improving crop water productivity is essential. In this context, digital irrigation systems based on effective monitoring of plant water status and photosynthetic performance offer significant potential for enhancing irrigation efficiency.



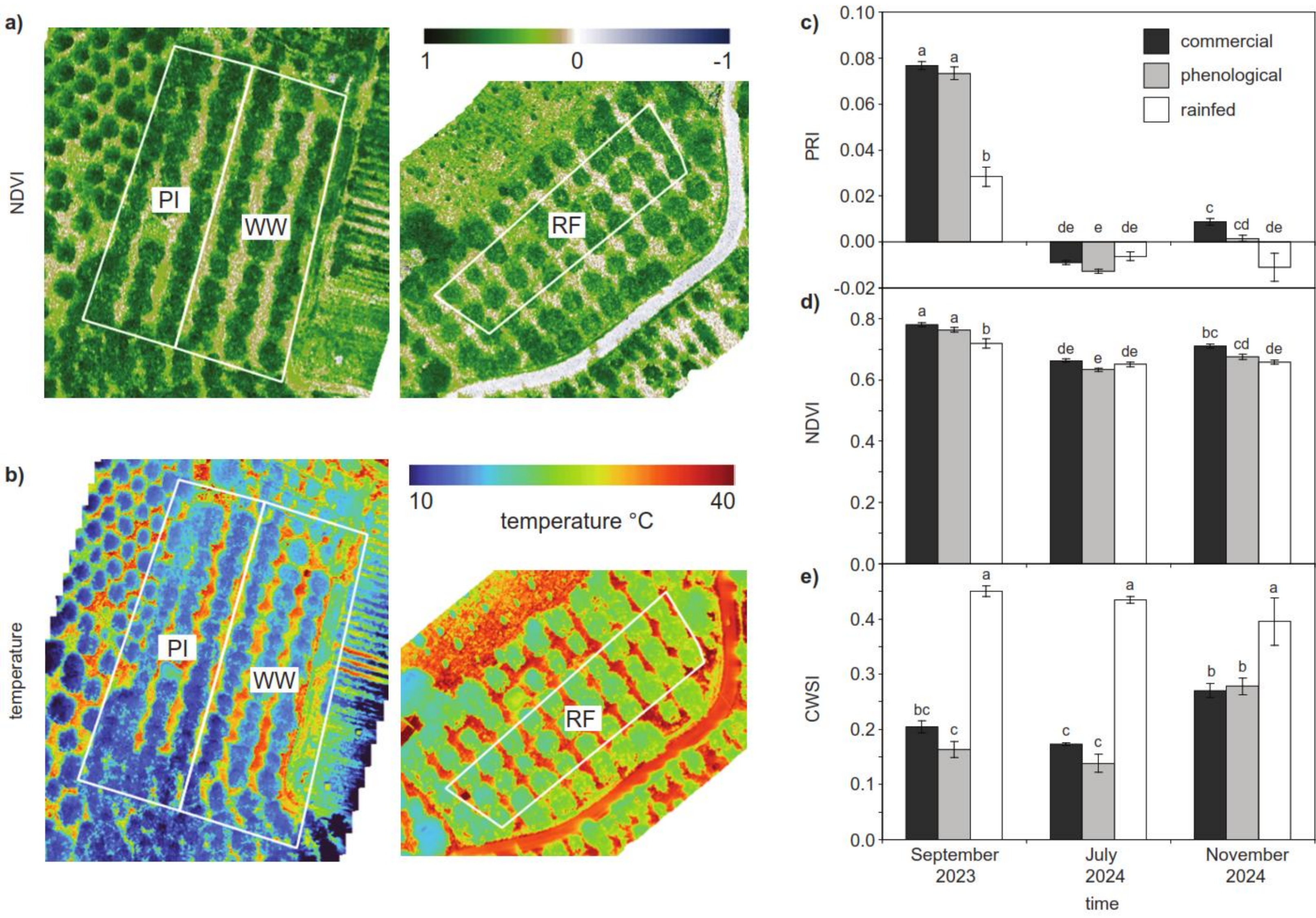
OBJECTIVE: i) Assess the impact of three different irrigation approaches on physiology and water status of olive; ii) explore the potential of remote sensing to optimise yield, oil quality and water productivity in commercial olive orchards utilising digital agriculture techniques.



RESULTS: Olive trees from the commercial and phenological irrigation treatments produced higher fruit and oil yields than rainfed counterparts. Total phenol content was higher in oil from the commercial irrigation treatment.

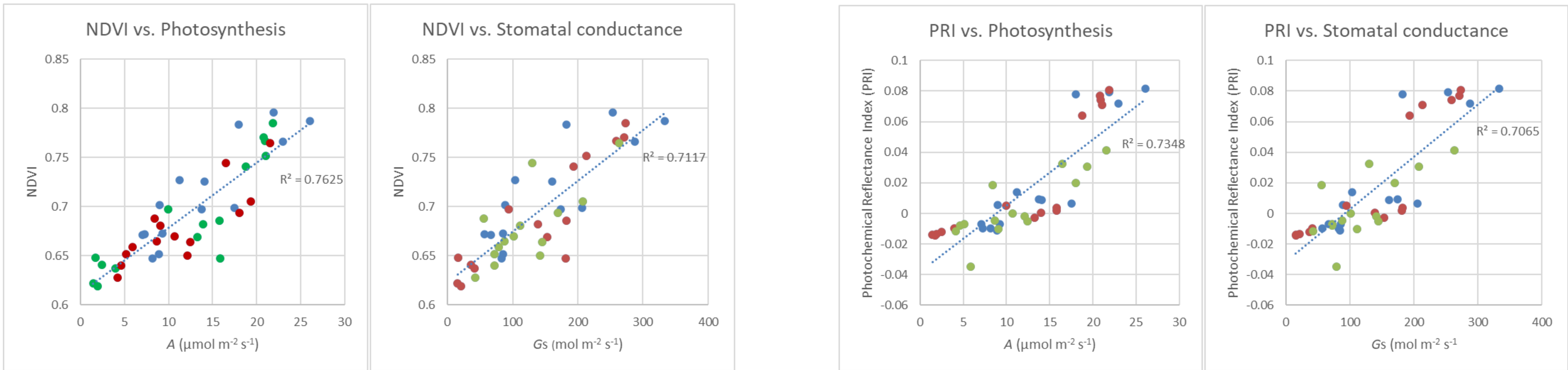


METHODOLOGIES: Field experiment in collaboration with a local farmer in Messenia region, Greece. Two orchards and three irrigation regimes: i) based on the farmer's traditional knowledge (*current irrigation*), ii) managed according to phenological stages (*phenological irrigation*), iii) left under rainfed conditions (*rainfed*). **DIRECT MEASUREMENTS:** Soil moisture; Photosynthesis (*A*) Stomatal conductance to water (*g_s*) and fluorescence quantum yield of chlorophyll a (Φ_{PSII}); Fruit and oil yield and quality (oil, oleic acid and phenols content). **REMOTE SENSING MEASUREMENTS:** UAV-based sensors (multispectral, hyperspectral and thermal) to detect reflectance indices (Normalized Difference Reflectance Index - NDVI), Photochemical Reflectance Index - PRI, Crop Water Stress Index – CWSI.



PRI followed similar trends to the rates of *A* and *g_s*. NDVI did not always detect significant differences between olive plants grown in the 3 irrigation regimes. CWSI was the only spectral reflectance index capable of differentiating between the rainfed and the irrigated treatments. There was no significant difference between CWSI values of olive under *current* or the *phenological* irrigation.

Correlations were observed between leaf level measurements of gas exchange with hyperspectral indices. Photosynthesis was significantly linearly correlated to PRI and NDVI. Similar correlations were recorded between stomatal conductance with PRI and NDVI. The data outlined within the present study illustrate the potential for proximal sensing alongside infra-red thermography as a powerful tool to infer leaf physiological status at high temporal resolution over wide spatial scales.



SOCIAL AND POLITICAL IMPACTS: Given the economic, social, and environmental importance of olive production in Mediterranean countries, it is essential to develop technologies and strategies that can strengthen the sector's resilience to climate change, particularly in view of the expected shifts in the temporal distribution of precipitation across the region. Increasing competition for water resources from urban and industrial sectors will make it unfeasible to fully irrigate perennial crops such as olive to achieve maximum potential yields. Consequently, there is a pressing need for innovative technologies that optimize water use and enhance crop water productivity. Digital irrigation systems offer promising solutions by improving irrigation efficiency through precise scheduling and regulation of water delivery to crops.