NOVATERRA. DEVELOPMENT OF A READY-TO-USE SMART FARMING PLATFORM FOR CROP PROTECTION MANAGEMENT

Mario de la FUENTE[1,2], Andrea CASQUETE[1], Emilio GIL[3], Fran GARCÍA[3], Javier CAMPOS[3], Josep M. CAMPOS[4], Juan F. HERMOSO[4], María T. MARTÍNEZ[4] and Felicidad de HERRALDE[4]

[1] Plataforma Tecnológica del Vino de España (PTV); [2]Grupo de Investigación en Viticultura (U.P.M.), [3]Unidad de Mecanización Agraria de la Universitat Politècnica de Catalunya; [4]Institut de Recerca i Tecnologia Agroalimentàries . [1]e-mail: gerencia@ptvino.com

OBJECTIVE and SCOPE

NOVATERRA aims to significantly reduce the use and negative impacts of contentious plant protection products for integrated pest, disease and weed management in two of the main Mediterranean crops in Europe, **grapevines** and olive trees**.** NOVATERRA is led by the *Institut de Recerca i Tecnologia Agroalimentàries* (IRTA), which will work until the end of 2024 with other 22 entities from 6 European countries: Spain, Portugal, France, Italy, Greece and Belgium. This EU project comprises novel strategies in 6 working packages, among them, ***Smart Farming*** (WP3) has been developed in field trials, for establishing integrated sustainable strategies. Given the current EU framework with its last claims and directives (soil strategy 2030, green claims directive, CSRD, etc.), which is important to limit or reduce the use of inputs in agricultural production. Downey mildew (*Plasmopara viticola*) and Powdery mildew (*Erysiphe necator*) are the major spread grapevine diseases and, the main cause of copper and sulphur application in vineyards, being their reduction one of the current challenges in European viticulture. For this purpose, several trials (France, Greece, Portugal and Spain) have been developed during 2021, 2022 and 2023. In Spain, 15 commercial vineyards located within the Penedès area (Spain) under Mediterranean climate (Csa, Tª 15.1 ºC; R 602 mm; annual average) were selected to obtain field data. In parallel, field experiments (2022 and 2023) in four selected plots were monitored for platform validation.

Smart Farming (WP3) Downy and Powdery mildew control

Development of an advanced Decision Support System (DSS) for Vineyards. First, with all gathered dada, an Artificial Intelligence (AI) image classifier was developed to properly identify the grapevine diseases under lab and field conditions (determining the relevant wavelengths, multispectral system, etc.). The AI system achieved an F1-score 0.80 for Powdery mildew. Then, the developed NOVATERRA DSS (Fig 1.) provides information regarding the prediction of powdery mildew in EU vineyards, giving the risk of infection ratios derived from models' outputs, after meteorological data analysis retrieved from 3,000 meteorological stations (Picture 1). Downey mildew model will be easily implemented through an advanced DSS (OPTIMA by AGENSO).

Fig 1. NOVATERRA DSS platform (https://novaterra.agenso.gr/) .

Holistic methodology for a smart canopy characterization (Fig 2). A total of 6 measurements (each 10 days) of canopy height and width per year were carried out (May to late July) in the 15 commercial vineyards (plots) coupling with the period of the season when plant protection treatments are more intensively done. Ultrasonics sensors and a GNSS system were placed in a frame-tractor. Parallel to ground data measurements, satellite images for the same day of ground sampling were acquired from PlanetScope and the images obtained were converted to vegetation index (NDVI). Other canopy parameters like Tree Row Volume (TRV) were calculated for fitting the PPPs applications through correlations. Even if the R^2 was low (0.24), results obtained showed that a moderate correlation (0.49; p<0,05) between NDVI and TRV; and the mean absolute error was less than 25%, which means 43L/ha for each application.

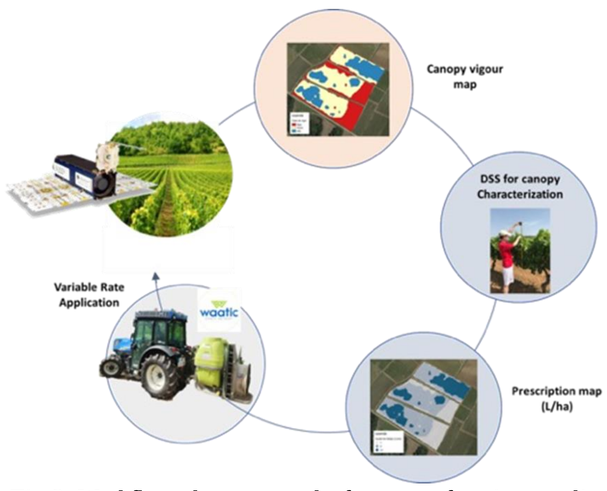

Fig 2. Workflows between tasks for smart farming applications.

Development of a machine learning-based system for canopy characterization. During the season 2022, the vision system was developed and implemented in the frame built for the DDS. More than 6000 images were finally recorded. Additionally, a set of manual measurements of the canopy geometrical characteristics (4 per plot) for training a convolutional neural network (CNN) according to canopy density levels. Dataset was cleaned up and annotated, merging it with the one collected in the previous canopy characterization and validating (Fig. 3). We obtained differences less than 15 cm (height, above ground, etc.), with a validation accuracy between 50-65% for each parameter (p<0.001) and with a high spatial resolution (1 m; better than satellite resolution).

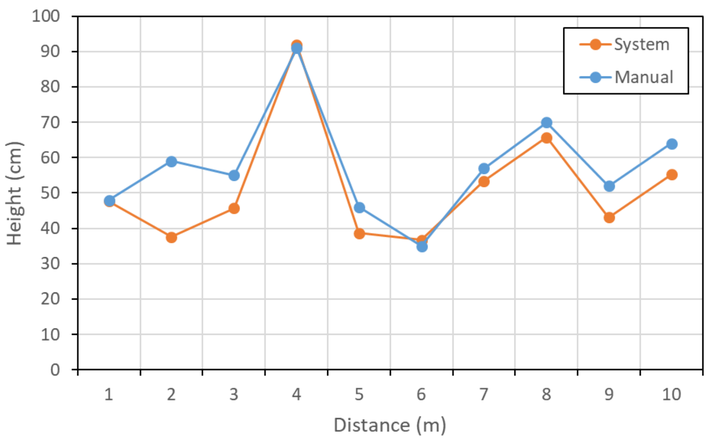

Fig 3. Example (10m row) of results obtained with the developed system vs manual.

Vineyard Pilot treatments validation (2023). A representative commercial vineyard (Penedes area) was selected, and two different plots were identified where pesticides were applied based on Variable Rate Application (VRA) maps. Cultivars Xarel·lo and Muscat de Fortignan. Three treatments were applied (June and July) according to the spraying calendar proposed by the farmer. NDVI and canopy characteristics for each plot were obtained to correct the DOSAVIÑA® DSS doses (truth ground rates). A control area (10 rows) was treated according to the conventional rates provided by the farmer to assess the biological efficacy.

Results (Table 1) showed that water and inputs can be saved between **33-43**%, close to reaching the objectives established in the European Green Deal (50 % reduction in pesticide use and risk). Theorical model presented a deviation between predicted values and ground truth measurements around ±23L deviation (RMSE). This represents an 18% maximum divergence between treatments.

Xarel-lo	Water (L)	Copper (kg)	Sulfur (kg)
Convenctional	2296	15,3	38,3
VRA	1548	10,3	25,8
Savings	-33%	-33%	-33%
Muscat	**Water (L)**	**Copper (kg)**	**Sulfur (kg)**
Convenctional	1701	11,3	28,4
VRA	962	6,4	16
Savings	-43%	-43%	-43%

Table 1. Savings of water and product obtained after using VRA in season 2023 in the vineyard planted with Xarel·lo and Muscat.

CONCLUSIONS

- NOVATERRA DSS is an innovative tool that provides accurate predictions about possible infections caused by the two main plant pathogens in Europe for olive and vineyards and based mainly on meteorological data.
- Even if the smart canopy characterization and machine learning-based systems should be improved (low determination), the models showed good validation accuracy with a high spatial resolution.
- Using these smart tools, a 33-43% reduction in water and product for each application is possible, keeping the biological efficacy and without losing yield (kg/plant) or quality.

The NOVATERRA project has received funding from the European Commission's Horizon 2020 grant agreement number 101000554