



DOSAVIÑA® A NEW APP FOR A MORE SUSTAINABLE USE OF PLANT PROTECTION PRODUCTS IN VINEYARD

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Abstract

Aims: DOSAVIÑA® was developed with the aim of helping farmers to determine optimal volume rates for spray applications in vineyards. The final developed tool is a good example of bringing research to end users.

Methods and Results: DOSAVIÑA® is based on a modified method of Leaf Wall Area (LWA) and includes a tool for sprayer calibration support. Calibration process is highlighted in the APP, as one of the conditions for a good success of the entire process. DOSAVIÑA® also calculates the optimal parameters for working pressure, forward speed, and number and type of nozzles. DOSAVIÑA® was developed by the Unit of Agricultural Machinery at the Universitat Politècnica de Catalunya, and is available for iOS and Android, and also web (<https://dosavina.upc.edu>). The system, based on a modified version of the leaf wall area (LWA) method, calculates the optimal volume rate for vineyards considering leaf density, canopy width, and sprayer type. Results indicated that water and pesticide use could be reduced by more than 20% while still meeting economic, environmental, and food quality requirements. The design of the tool is aligned with European requirements concerning pesticide use, as established in the European Directive for the sustainable use of pesticides. In the majority of cases, the recommended volumes obtained after using DOSAVIÑA® are lower than those commonly selected by the farmers. This fact, coupled with a dose expression method based on concentration, leads to a consequent reduction in pesticide amounts, in line with the main objective established in Europe after the official publication of the Sustainable Use Directive (EU, 2009). The sprayer adjustment tool included in DOSAVIÑA® represents a convenient complement to the establishment of the optimal volume rate. The automated calculation process allows selection of the most suitable values for the most important parameters, particularly working pressure. Results of field trials demonstrated that an accurate calibration process allows similar levels of coverage to be obtained, even with low spray volumes.

Conclusion: The APP, has been shown to reduce fungicide use by up to 20%. This fact translates not only into significant time savings and higher working capacity, aspects highly valued by the producer, but also an economic benefit and a reduction in the risk of environmental contamination, not only due to the reduction in fungicide used, but also due to the use of the equipment in optimal conditions.

Significance and Impact of the Study: The social impact generated by the application, especially in the productive sector has been demonstrated. DOSAVIÑA® is also a tool included in the training programs that is especially for the European Commission through CHAFEA, in the BTSF - Best Training for Safer Food.

Keywords: DOSAVIÑA®, optimal vineyard spray rates, plant protection products

Introduction

During the pesticide application process, risk as a function of pesticide dose and harm to sensitive non-target areas are related to a) spraying efficiency and b) the amount of plant protection products (PPPs) used during the distribution process over the entire canopy. Attempts to improve dose expression procedures have included recommendations based on either two (leaf wall area) or three (tree row volume) dimensional factors related to the canopy structure (Gil *et al.*, 2011, 2019; Walklate *et al.*, 2011). However, those efforts have led to a chaotic situation in which a comparison of label instructions for PPPs authorized in different European countries reveals remarkable differences in dose expression (Koch, 2007).

After reviewing substantive and widely disseminated research on this topic, it is clear that: a) determination of the optimal volume rate is not an easy task, and b) canopy characterization is not a simple and quick procedure, even when performed by users at a specific site and with simple tools. Those important reasons have been merged in order to explore the possibility of using new technologies to develop diverse decision support systems (DSS) that offer diverse alternatives for the intended topic. This development has focused on topics such as establishing an adapted volume rate according to crop structure (Siegfried *et al.*, 2007; Furness and Thompson, 2008; Walklate *et al.*, 2011; Garcerá *et al.*, 2017), or calculating the total amount of PPP for any particular crop geometry (Siegfried *et al.*, 2007; Cross and Walklate, 2008; Codís *et al.*, 2012). In all cases, important improvements in the daily management of crop care activities have been detected after using the different devices. Focused on the specific topic of vineyard, Optidose (Davy, 2007) and the tool “Dosage Adapté” (www.agrometeo.ch) have been proposed with similar objectives to DOSAVIÑA®. Optidose proposes an adaptation of the fungicide dose applied to protect the vineyard, based on the plant surface, the disease pressure and the developmental stage. Field trials demonstrated an average reduction of 40% in fungicide application and less symptoms of downy and powdery mildew. The Crop Adapted Spraying tool was developed for the particular case of Swiss viticulture (Viret *et al.*, 2010). Leaf area adapted dosage is aimed at delivering exactly the amount of product requested for a given leaf area present at the time of spraying. An easy and user-friendly calculation module is available on www.agrometeo.ch. However, none of the previously described tools consider the influence of the sprayer type in the calculation of the recommended amount of pesticide. Furthermore, neither the applied volume rate nor the suggested working parameters are included.

The objective of this research was to develop and test a new decision support system (APP and website) for determining the optimal volume rate and amount of PPP to be used during spray application in vineyards trained to a trellis system. A complementary objective was to determine whether the developed tool could help reduce the risk of environmental contamination in vineyards by increasing the efficiency of PPP applications.

Fundamentals of DOSAVIÑA®

The principle used by DOSAVIÑA® for calculating the optimal volume rate is based on a modified method of the leaf wall area (LWA) principle, which has been recently proposed by EPPO (EPPO, 2016) as the recommended method for dose expression in orchards and vineyard with a uniform canopy wall. The proposed method for determining the optimal volume rate in trellised vineyards includes the following parameters (Equation 1):

$$V (l ha^{-1}) = LWA \times [f_{cw}] \times [f_{cd}] \times [f_s] \times i (l m_{LWA}^{-2}) \quad [\text{Equation 1}]$$

Where:

V is the calculated amount of liquid to be sprayed ($l ha^{-1}$); f_{cw} is the canopy width factor (dimensionless); f_{cd} is the leaf density factor (dimensionless); f_s is the factor considering the type of sprayer (dimensionless); and i is the unit volume rate per LWA canopy surface ($l m_{LWA}^{-2}$).

The unit volume rate per LWA canopy surface i ($l m_{LWA}^{-2}$) was previously established after more than 20 years of field trials combining different canopy structures, crop stages, and application rates (Gil *et al.*, 2011), resulting in a recommended value of $0.037 l m_{LWA}^{-2}$. This value, based on the LWA concept, was also converted into the corresponding value for the TRV (tree row volume) method, establishing a reference canopy width of 0.8 m at the full growth stage (BBCH 75). The obtained result was $0.1 l m_{TRV}^{-3}$, very similar to recommended values established by other researchers (Byers, 1987, Viret *et al.*, 2007).

Structure and Main Characteristics of DOSAVIÑA® APP for Smartphones

DOSAVIÑA® was designed to be used with the two main mobile platforms, IOS and Android. A web-based version of DOSAVIÑA® has also been developed (<https://dosavina.upc.edu>). The main characteristics of the newly developed app are shown in Table 1.

Once the settings have been selected (language, unit system, location, etc.) the process starts with two options: a) calculation of the optimal volume/PPP rate for a trellis vineyard; and b) calibration of the sprayer. These two steps are directly linked to the design of the trellis systems in the vineyards. The device can also be used in calibrations for other 3D canopy crops (e.g. orchard fruits, citrus, almonds, olive trees, etc.) where users set the desired volume per hectare (L/ha).

Table 1: Technical characteristics of DOSAVIÑA® APP.

Concept	Characteristics
OS compatibility	IOS and ANDROID
Languages	English, Spanish, French, Italian, Greek, Catalan
Units	IS (International System) and US-Imperial
Country identification	Yes
IOS link download	https://itunes.apple.com/es/app/dosavi%C3%B1a/id1413664423?mt=8
ANDROID link download	https://play.google.com/store/apps/details?id=edu.upc.deab.uma&hl=es
Web site version	https://dosavina.upc.edu
Developer	UPC - https://uma.deab.upc.edu



The APP is structured into several correlated packages (Figure 1), covering settings for the device, canopy characterization, sprayer type, and pesticide information.

The system calculates the requested working pressure to achieve the desired volume rate with the number and size of nozzles previously selected. When the calculated pressure falls out of the recommended pressure range for a particular type of application, a warning message appears on the screen. The APP allows adjustment of the sprayer when using nozzles of the same size, or when using a combination of different nozzle sizes, with the goal of mimicking the vertical leaf distribution. At the end of the process, a complete report with detailed information is generated; users can save the report in a favorites folder and/or send the report as a pdf file. Several field trials demonstrated the achievement of an optimal spray distribution and a 20% reduction using DOSAVIÑA (Gil *et al.*, 2019).

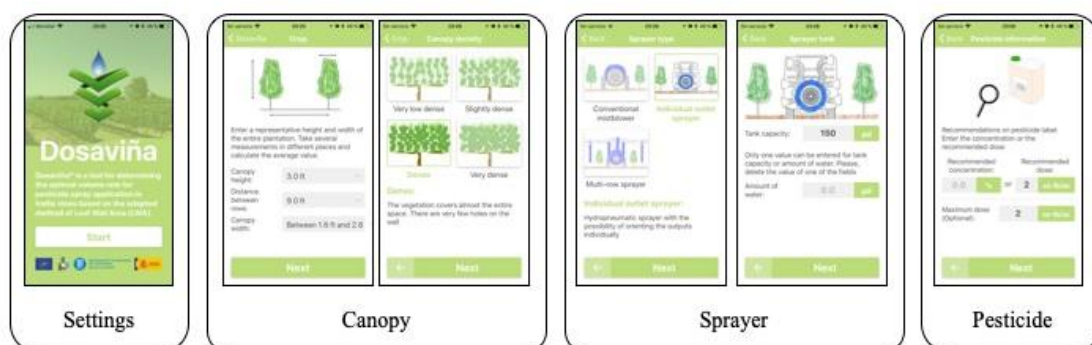
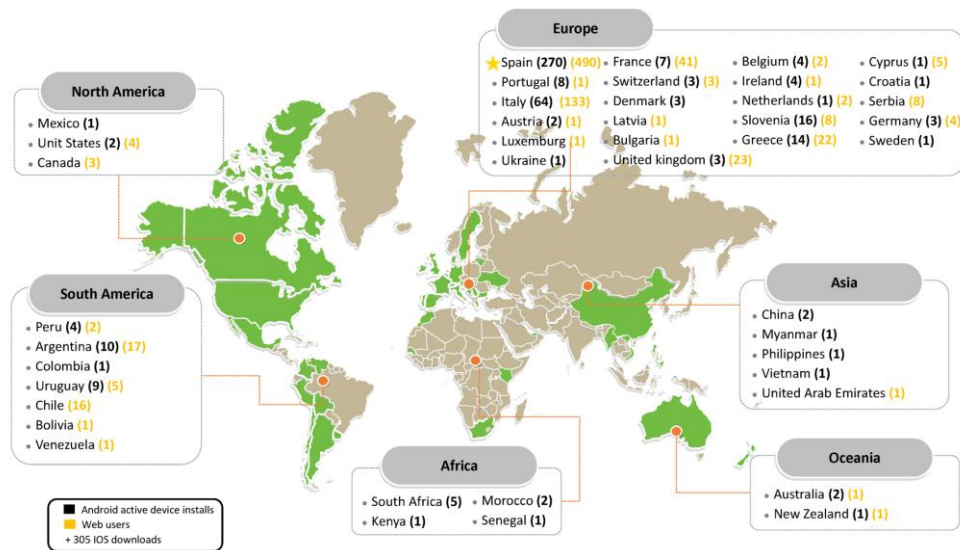


Figure 1: DOSAVIÑA® includes four different packages: settings, canopy characteristics, sprayer, and pesticide information.

DOSAVIÑA® has been, since its launch (Gil *et al.*, 2019), widely used in all vineyard zones around the world (Figure 2) with excellent results. In all cases, the use of this APP allows farmers to reduce the total amount of pesticides through improved management of canopy characteristics and accurate calibration of their sprayers. Within LIFE

PERFECT project (<http://perfectlifeproject.eu>) DOSAVIÑA® has been adapted to alternative vineyard structures, as *Gobelet* and *Pergola*.



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