IVES Technical Reviews vine & wine
https://doi.org/10.20870/IVES-TR.2022.5402

Quality assessment of drone spraying in steeply sloping vineyards

Xavier Delpuech[1], Henri Gorioux[1], Guilhem Pouxviel[2]

1 Institut Français de la Vigne et du Vin, France
2 INRAE, France

Following the ban on aerial spraying in 2015, crop-protection spraying of steeply sloping vineyards is mainly carried out by workers on the ground, who are subject to arduous working conditions, increased risk of exposure to sprays, as well as the risk of accidents (overturning of machinery). Drones (UAV, Unmanned Aerial Vehicles) could provide an alternative to ground spraying of plots that are inaccessible to machinery. The PULVEDRONE project assessed the quality of drone spraying over 3 years of trials from 2019 to 2021 (Ardèche, France).

Experiments since 2019

Drones have many advantages over the helicopters that were used in steeply sloping vineyards before the ban on aerial spraying. They are cheaper, safer, quieter, more precise and smaller, allowing them to fly lower and thus limit aerial drift. Given these advantages, the authorities granted a waiver for a 3-year experimental period at the end of 2018, to assess the utility of drone spraying in plots with a slope greater than 30%. As part of the PULVEDRONE project, we assessed spraying quality, a prerequisite for ensuring satisfactory crop protection, in 4 different types of vineyard. Between spring 2019 and summer 2021, 25 trials were carried out in the vineyard at the early-, mid- and late-season canopy stages: stake-trained vines in the Ardèche, trellised vines in Beaujolais and Alsace, and bush vines in the Pyrénées-Orientales. The goal was (i) to get an overview of drone spraying in different contexts and (ii) to identify the main factors affecting spraying quality.

Experimental results

The trials involved spraying an area of approximately 400m² on each plot with a solution of water and a tracer (E102, a food-grade coloring). On a sample of 9 vines, 20cm² PVC collectors were placed in the canopy to quantify tracer deposition on the vine. The measured deposit was expressed in nanograms of tracer per square decimeter of collector for 1 gram of tracer sprayed per hectare ($ng.dm^{2}/ g.ha^{1}$).

Compliance of spraying parameters

The main factor determining spraying quality is control of the spraying parameters: flow rate, speed of progress, trajectory. Non-compliance with these parameters leads to variations in the volume per hectare and hence the dose applied, which affects the protection of the vine. Drone spraying technology ensures a regular trajectory (position and speed) that complies with the guidelines, with average coefficients of variation of between 3% and 5%. Conversely, the trajectory is less regular when spraying from a backpack (Figure 2): the operator's walking speed is affected by the unevenness of the terrain, the slope (going uphill versus down), the changing load weight, as well as personal factors and operator fatigue. With a pass every 3 m and a speed of 1.7 $m.s^{-1}$ compared with 1 $m.s^{-1}$ for a worker, the drone also provides faster spraying speeds (Figure 2).

FIGURE 1. Drone in flight in Cornas, Ardèche, July 2020.

Nevertheless, vigilance is required to maintain the flight height of the drone, with sometimes significant variations depending on the technologies on board (ground radar, prior mapping of the plot or manual control, flight plan, etc.).

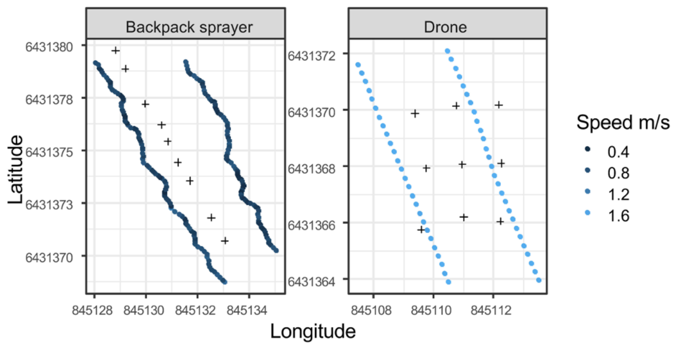

FIGURE 2. Comparison of the trajectory of a drone (https://youtu.be/mreswpXY8BA) and a backpack sprayer (https://youtu.be/LzJ2VyneOsI). The crosses represent the vines sampled during the trials, and the dots the recorded positions of the spraying equipment.

The translation of this article into English was offered to you by Moët Hennessy. Moët Hennessy

At full canopy, a low level of spray deposited in the bunch zone

While the quality of drone spraying seems satisfactory during the earliest stages of canopy growth, at later growth stages and on trellised vines the results were generally inferior to the benchmark methods for ground spraying (Figure 3). The drone generates a downward stream of spray, and hence the deposits follow a decreasing gradient from the top to the bottom of the canopy. Spray penetration rates into the canopy during the trials were generally lower than those measured for ground spraying. A high-to-low gradient combined with a low penetration rate results in generally lower deposits at the heart of the canopy and in the bunch zones than those for benchmark equipment on the ground at full canopy expansion.

These results lead to ground passes being recommended in addition to drone spraying if the pressure on health is high during the sensitive flowering period, in order to ensure sufficient crop protection.

In the Pyrénées-Orientales, on bush vines with a spread-out canopy at an intermediate growth stage, the quality of drone spraying was clearly superior and deemed satisfactory for the protection of the vine (Figure 3).

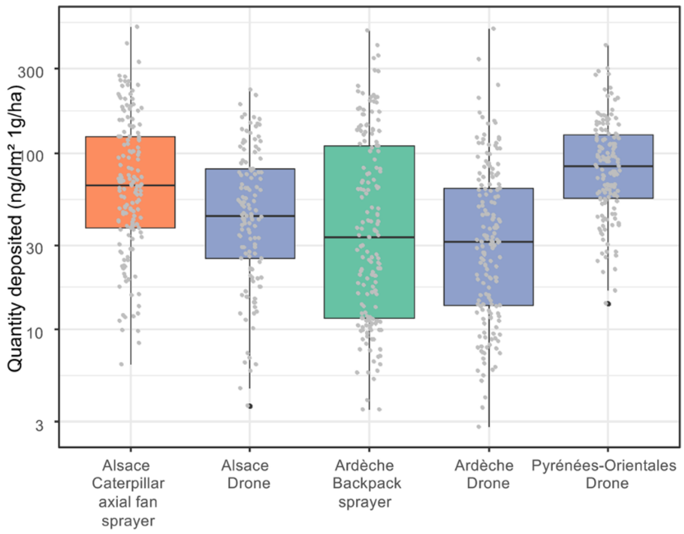

FIGURE 3. Distribution of deposits intercepted by the canopy after spraying by drone or from the ground, in 3 different types of vineyard (stake-trained vines in the Ardèche, trellised vines in Alsace, bush vines in the Pyrénées-Orientales).

Optimization factors and future work

These trials also identified the factors that influence the quality of drone spraying. The nozzle type has a significant effect: the fine drops generated by conventional slotted nozzles (Teejet XR or TXA) penetrate the canopy better and enhance deposits at the heart of the canopy and in the bunch zone. At full canopy expansion, the best results were obtained with this type of nozzle, at a flying height of 3.5m and with a volume per hectare of 140 $L.ha^{-1}$. However, fine drops from this type of nozzle are very sensitive to aerial drift. To ensure good control of the risk of drift, the use of anti-drift nozzles is recommended, and work to optimize spraying quality with this type of nozzle is to be carried out.

The positioning of the drone in relation to the target canopy is another identified area for improvement: stable positioning (height, drone-vine distance) would allow more precise configuration of the spraying system (nozzle type, position and orientation) to optimize spraying quality.

Conclusions

While the drone provides good compliance with the basic spraying guidelines, the quality from the drone is generally inferior to benchmark ground methods at full canopy expansion. These results should be confirmed through biological effectiveness trials across the entire spraying season. Drone spraying is sensitive to drift, so it is important to apply good spraying practice to control this risk: flying at low altitude and speeds below 3 $m.s^{-1}$, light to zero wind, use of anti-drift nozzles. The battery life of the drone (providing a maximum of 15 to 20 minutes' flight) and the volume of spray it can carry remain limited. In steeply sloping vineyards that are inaccessible to machinery, the drone nevertheless provides a useful coverage rate, between 1 and 2 hours per hectare depending on the plot configuration. In addition, the gains for workers in terms of arduous working conditions, safety and exposure make drone spraying a much-awaited technical solution for these vineyards. Winegrowers in these sectors are therefore hoping for a change in the regulations, but this cannot take effect before 2023.

What are the current regulations in France?

The aerial spraying of crop-protection products is banned in principle (article L253-8 of the Rural and Fisheries Code), except in exceptional cases. A waiver granted for 3 years (2018 – 2021), adopted as part of the so-called Egalim law of October 2018, allowed drone spraying for experimental purposes under very specific conditions. As this period is over, drone spraying of any crop-protection product subject to Marketing Authorization is currently forbidden. This is not the case for canopy fertilizers or *Trichogramma*, for which drone spreading is authorized and sometimes practiced.

In addition, the Directorate General of Civil Aviation (DGAC) defines the rules for the aircraft themselves and their conditions of use. Different rules apply to drones depending on their mass and the overflown area. ■

***Sources :** Sourced from the research article: "Pulvérisation par drone en vignoble de forte pente" (Phytoma - La santé des végétaux n° 741, février 2021).*