AGRAS T30 DRONE SPRAYING EFFICIENCY AND COST ANALYSIS ON SUNFLOWER FUNGICIDE APPLICATION

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Abstract

This study presents a comparative analysis of the application of Orius fungicide on a 200-hectare sunflower field using the DJI Agras T30 drone for 100 ha and the John Deere 4630 sprayer for 100 ha. The research evaluates both methods in terms of resource consumption, operational costs, application efficiency, and environmental impact. The analysis focuses on application efficiency, dosage, and economic aspects to identify the advantages and limitations of each method. The results indicate that drone application achieves superior precision with reduced chemical and water usage, while the tractor-based sprayer offers speed advantages for large-scale operations. These findings provide actionable insights for sunflower farmers aiming to optimize crop protection practices. Results indicate that the Agras T30 drone, employing ultra-low-volume spraying, required significantly less spray solution (1,100 liters) compared to the John Deere 4630 sprayer (15,100 liters), thereby demonstrating greater resource efficiency. Furthermore, the drone exhibited superior precision, minimizing chemical drift and promoting sustainable agricultural practices. However, the John Deere 4630 sprayer completed the application in half the time (3.5 hours compared to 7 hours), highlighting its suitability for time-sensitive, large-scale operations. This study underscores the advantages and limitations of each method, offering critical insights for optimizing fungicide application strategies based on specific agronomic and operational requirements.

Key words: drone spraying efficiency, precision agriculture

The application of agrochemicals, such as fungicides, is a vital practice in modern agriculture to protect crops from diseases and enhance yield. Traditionally, this has been achieved using ground-based machinery such as tractor-mounted sprayers. However, the advent of unmanned aerial vehicles (UAVs), commonly known as drones, has introduced a transformative approach to agricultural spraying (Patel V. et al, 2023). Drones have gained significant attention in precision agriculture due to their ability to provide targeted applications, reduce input waste, and minimize environmental impact.

Drone spraying systems, such as the DJI Agras T30, are equipped with advanced technologies, including GPS-guided navigation, automated flight paths, and variable-rate nozzles. These features enable drones to achieve highly precise spraying, reducing overspraying and chemical drift compared to conventional methods. Drones are particularly useful in challenging terrains or small, irregularly shaped fields where large machinery cannot operate efficiently. Additionally, their ability to apply ultra-low volumes (ULV) of chemicals makes them a resource-efficient choice, using significantly less water compared to traditional sprayers (Ahmed K. et al., 2022).

The adoption of drone technology also aligns with the growing demand for sustainable farming practices. By minimizing chemical runoff and optimizing input use, drones help mitigate the environmental impact of agricultural activities. Moreover, drones offer a level of flexibility and speed in operations, allowing farmers to respond quickly to emerging pest or disease outbreaks.

Despite these advantages, drone spraying also presents challenges, including limited tank capacity, battery life constraints, and regulatory considerations in some regions. Comparing this innovative approach with established methods, such as tractor-mounted sprayers, is essential to understand its practical benefits and limitations (Rodríguez F., Pérez C., 2021). This study contributes to this understanding by comparing the Agras T30 drone and the John Deere 4630 sprayer in the context of sunflower fungicide application, focusing on key parameters such as efficiency, cost, and environmental sustainability.

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Traditional tractor-mounted sprayers, such as the John Deere 4630, have been widely adopted for their ability to cover large areas quickly (Media N., 2018). However, recent advances in agricultural technology have introduced drones like the DJI Agras T30, offering a more precise and environmentally friendly alternative. This paper compares the use of the Agras T30 and the John Deere 4630 for applying Orius fungicide on sunflowers over 100 hectares each. The study evaluates the two methods in terms of fungicide dosage, water consumption, cost-effectiveness, and operational efficiency.

MATERIAL AND METHOD

The study was conducted on a 200-hectare sunflower field located in a temperate climate zone from NE Romania. The sunflowers were at the early flowering stage, a critical period for fungicide application to prevent common diseases. Orius fungicide, containing the active ingredient tebuconazole, was chosen due to its effectiveness against fungal infections in sunflowers. The recommended dosage was 1 liter per hectare.

Two spraying systems were evaluated: the DJI Agras T30 drone and the John Deere 4630 tractor-mounted sprayer. The Agras T30 drone has a 30-liter tank capacity and operates at an application rate of 10 liters per hectare, including water and fungicide. It covers approximately 15 hectares per hour at a flight speed of 6 m/s. The John Deere 4630 has a tank capacity of 3,000 liters and applies at a rate of 150 liters per hectare. It covers about 30 hectares per hour at a speed of 12-15 km/h. The drone required a total application time of 7 hours for the field, including refilling and battery charging, while the sprayer completed the task in 3.5 hours, including refilling intervals.

Data collection focused on operational costs, fungicide and water usage, application efficiency, and environmental impact. Costs included labor, fuel or electricity, and maintenance. Efficiency was evaluated by comparing chemical drift, precision, and coverage rates.

The DJI Agras T30 (*figure 1*) is an advanced agricultural drone designed to enhance the efficiency and precision of crop spraying operations. Equipped with a 30-liter spraying tank, it facilitates extensive coverage, making it suitable for large-scale farming activities. The drone features 16 nozzles and a high-flow plunger pump, enabling a maximum spray rate of 7.2 liters per minute. This configuration ensures uniform distribution of pesticides or fertilizers across the field.

One of the standout features of the Agras T30 is its spherical omnidirectional obstacle avoidance radar. This system provides comprehensive detection in horizontal and overhead directions, enhancing operational safety by allowing the drone to navigate complex terrains and avoid obstacles effectively.

The drone's design includes adjustable arms and branch-targeting technology, which improve penetration in dense canopies, ensuring thorough application of agrochemicals.

This capability is particularly beneficial for crops like fruit trees, where even coverage is crucial.

Figure 1 **Agras T30 drone**

In terms of efficiency, the Agras T30 can cover up to 40 acres per hour, operating at a flight speed of up to 15.6 miles per hour. Its flight time extends up to 20.5 minutes per battery charge, depending on load and environmental conditions.

The drone is built to withstand harsh agricultural environments, featuring an IP67 rating for water and dust resistance. Its foldable design enhances portability, allowing it to be easily transported between fields.

Overall, the DJI Agras T30 represents a significant advancement in agricultural drone technology, offering farmers a reliable and efficient tool for modern farming practices.

The John Deere 4630 Sprayer (*figure 2*) is engineered to deliver efficient and precise agrochemical applications across extensive agricultural fields. It is powered by a 6.8-liter John Deere PowerTech Plus engine, producing 165 horsepower, which enables effective operation in diverse field conditions.

Equipped with an 80-foot (24-meter) boom, the sprayer features a five-section configuration with polypropylene plumbing, ensuring durability and chemical resistance.

The solution tank has a capacity of 600 gallons (2,271 liters), complemented by a 70-gallon (265-liter) rinse tank, facilitating extensive coverage and efficient cleaning between applications.

The 4630 Sprayer incorporates advanced precision agriculture technologies, including the GreenStar™ 2 system with the GS2 1800 Display. This system integrates functions such as SprayStar, Swath Control Pro, and AutoTrac, enabling operators to manage application rates, reduce overlap, and enhance steering accuracy.

Figure 2 **John Deere 4630 Sprayer**

Designed for operator comfort and safety, the sprayer features a spacious cab with climate control and ergonomic controls, reducing fatigue during prolonged operations.

The machine's full-time four-wheel drive and optional traction control provide enhanced maneuverability and stability across various terrains.

Overall, the John Deere 4630 Sprayer combines robust performance with advanced technological features, making it a reliable choice for large-scale farming operations seeking efficiency and precision in crop protection practices.

RESULTS AND DISCUSSIONS

The drone required significantly less water than the sprayer due to its ultra-low-volume (ULV) spraying capability. For 100 hectares, the drone used 100 liters of Orius fungicide diluted in 1,000 liters of water, totaling 1,100 liters. In contrast, the sprayer used the same 100 liters of fungicide but required 15,000 liters of water for dilution, totaling 15,100 liters (*table 1*).

This difference highlights the drone's efficiency in resource usage, reducing the overall environmental footprint.

The total operational costs for the Agras T30 drone were €1,380, compared to €1,950 for the John Deere 4630 (*table 2*). Labor costs were higher for the drone (€200) due to the need for frequent refilling and battery management.

However, the drone incurred significantly lower costs in fuel (€30 vs. €400) and water (€50 vs. €150). Maintenance costs were also lower for the drone (€100 vs. €300), making it the more economical option despite its longer operation time.

Table 1

Results regarding the dosage and water consumption

Machine	Fungicide (liters)	Water (liters)	Total Volume (liters)
Agras T30 Drone	100	1,000	1,100
John Deere 4630	100	15,000	15,100

The drone demonstrated superior precision in fungicide application, minimizing chemical drift and ensuring even coverage across the field. This precision reduces overspraying and potential environmental contamination. The sprayer, while faster, was less precise, increasing the likelihood of chemical wastage and uneven application. The drone's ability to operate in hard-to-reach areas further enhances its versatility compared to the tractor-mounted sprayer.

Table 2

Results regarding the economical analysis

Cost Component	Agras T30 Drone (€)	John Deere 4630 (€)
Labor	200	100
Fungicide	1,000	1,000
Water	50	150
Fuel/Electricity	30	400
Maintenance	100	300
Total Cost	1,380	1,950

The sprayer completed the task in 3.5 hours, making it twice as fast as the drone, which required 7 hours due to smaller tank capacity and battery recharge intervals, meaning also a lot of traveling patterns (*figure 3*). This speed advantage makes the sprayer more suitable for large-scale operations where time is a critical factor. However, the trade-off in precision and environmental impact should be considered.

The drone's reduced water usage and lower chemical drift contribute to a smaller environmental footprint. It is particularly advantageous in areas where water conservation is a priority. The sprayer, while efficient in time, presents higher risks of chemical runoff and environmental damage due to its high water usage and potential for overspraying.

Figure 3 **T30 drone map pattern**

CONCLUSIONS

The comparison between the Agras T30 drone and the John Deere 4630 sprayer for applying Orius fungicide on a 100-hectare sunflower field highlights distinct advantages and limitations for each method. The drone offers precision, reduced chemical and water usage, and lower operational costs, making it ideal for resource-conscious and environmentally sustainable farming practices. In contrast, the sprayer excels in speed and efficiency for large-scale operations but incurs higher costs and environmental risks. Farmers should consider their specific operational needs, field conditions, and sustainability goals when selecting a spraying method. For precision and resource conservation, the Agras T30 is recommended, whereas the John Deere 4630 is preferable for time-sensitive, large-scale applications.

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