International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF 2023: 8.176 ISSN: 2582-3930

Development Of Agriculture Spraying Drone

Komal.R.Nikam[1], Uzma.A.Nadkar[2], Ankit.S.Prajapati[3], Prof. Pooja.M.Reddy[4]

[1]*Electronics and Telecommunication JSCOE, Pune*
[2]*Electronics and Telecommunication JSCOE, Pune*
[3]*Electronics and Telecommunication JSCOE, Pune*
[4]*Prof. Electronics and Telecommunication JSCOE, Pune*

---***---

Abstract - The primary objective of the AGRICULTURE SPRAYING DRONE is to enhance the efficiency of agricultural spraying through the utilisation of unmanned aerial vehicles (UAVs) and also to minimise waste and adverse effects on the environment while optimising conventional agricultural spraying techniques. With the help of a 22000 mAh battery, the system combines cutting-edge parts, including the Hobby wing X6plus motors, K++ V2 flight controller, Sky Droid T12 receiver and transmitter, Hobby wing pump, flowmeter, Can hub, obstacle avoidance system, and PMU. The drone, with a total weight of 29 kg and a maximum payload capacity of 12 kg, guarantees accurate and productive spraying operations across large agricultural areas. Key characteristics include adaptive spraying patterns tailored to specific field conditions, targeted pesticide application, and real-time crop health monitoring. An additional mobile application enhances the system by offering farmers the ability to remotely operate, schedule spraying, and examine field data. In order to show how the suggested drone system may be implemented practically and its effectiveness assessed in actual agricultural settings, the article describes the system architecture and provides a use-case scenario. By enabling more effective and sustainable agricultural methods, this research advances precision agriculture technologies.

Key Words: Agriculture Spraying Drone, Precision Spraying. Sustainability.

I. INTRODUCTION

The need for sustainable and effective solutions to the inherent inefficiencies and environmental problems connected with traditional spraying techniques is growing in the modern agricultural landscape. Unmanned aerial vehicle (UAV) integration appears to be a potential way to address this requirement. This paper presents a new method of precision spraying agriculture using a high-capacity hexacopter drone fitted with cutting-edge parts. Using state-of-the-art technology such as obstacle avoidance systems, K++V2 flight controllers, and Hobby Wing X6plus motors, the main goal of this project is to transform spraying operations. The proposed drone system intends to greatly improve agricultural methods, boost output, and lessen environmental effects by utilising these developments. Specifically, the drone's capacity to accurately apply pesticides, track the health of crops, and adjust in real-time field circumstances highlights its revolutionary potential in contemporary agriculture. This project aims to open the door for future generations of agricultural practices that are both sustainable and productive by investigating novel aerial spraying techniques.

A. *Relevance of Project*

The ability of this initiative to address important issues facing contemporary agriculture makes it significant. Crop yields are decreased, and the environment is harmed by traditional crop spraying practices that frequently lead to inefficiencies, including uneven pesticide dispersion and chemical misuse. This project aims to revolutionize agricultural practices by implementing a precision spraying drone system, equipped with cutting-edge technology and real-time monitoring capabilities.

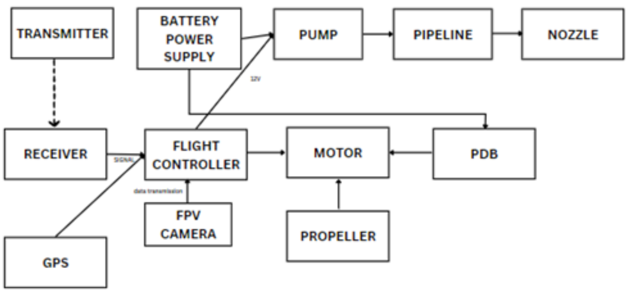

Fig -1: Block diagram of Development of Agriculture Spraying Drone

Problem Statement

Conventional spraying methods in agricultural contexts can result in inefficiencies and environmental concerns due to inaccurate pesticide application and chemical abuse. Optimizing spraying operations is an issue faced by farmers, which can result in lower crop yields and a greater environmental effect. Additionally, manual spraying methods add to labour-intensive procedures and worker safety hazards. In order to address these problems, a precision spraying drone system that can administer pesticides efficiently and accurately, adjust to changing field conditions, reduce environmental impact, and improve worker safety and agricultural output must be developed.

i. *Objective*

The project aims to develop a drone system for precise agricultural spraying, with the following goals:

Efficiency Improvement: Create a drone system that can apply fertiliser, insecticides, and herbicides to crops with precision and efficiency.
Real-time Monitoring: By integrating sensors and data analytics, it is possible to monitor crop health and field conditions in real-time.

Resource Optimisation: It involves the utilisation of algorithms to reduce resource consumption and environmental effects.
Safety Assurance: To reduce hazards related to drone operations, ensure regulatory compliance, and improve worker safety, incorporate obstacle avoidance technologies and safety regulations.
Operationally Friendly: Providing user-friendly interfaces and mobile applications that make it simple for farmers and agricultural technicians to deploy, monitor, and operate drone systems will increase user acceptance and the overall user experience.
Through the accomplishment of these goals, the project hopes to transform agricultural spraying techniques and advance farming operations productivity, efficiency, and sustainability.

ii. Scope of Project

The project's scope includes the development of a precision spraying solution specifically for agricultural use. The drone project aims to spray crops. It involves creating, integrating, testing, and deploying a drone with cutting-edge parts for effective pesticide spraying. Through the use of user-friendly interfaces, obstacle avoidance technologies, and real-time monitoring capabilities, the project will aim to overcome the drawbacks of conventional spraying techniques. We will also consider scalability and future system improvements to transform agricultural spraying techniques and advance sustainability in farming operations.

iii. Methodology

A. Field Mapping

For autonomous drone navigation, the entire field must be mapped. In addition to helping to store and manage the useful data and the locations of the plants around the field, the map provides a clear picture of the workspace. First, the drone takes off to a specific height that encompasses the whole field and records the view via the camera. A web-based tool must be used by farmers to draw a contour around their land in order to demarcate its bounds. A method for image processing saves and manipulates this data, employing the Simultaneous Localization and Mapping (SLAM) technique to generate a three-dimensional map.

Fig -2: Drone mapping of the agricultural area

Fig -3: Outline of field collected by the system

B. Positioning and Calibration of Drone

Drone technology plays a vital role in the agricultural sector by facilitating tasks like pesticide spraying Calibrating drones for agricultural applications involves a meticulous process crucial for ensuring accurate and reliable performance. It begins by calibrating onboard sensors such as the gyroscope, accelerometer, and magnetometer, which are essential for precise drone navigation independent of GPS. Additionally, if the drone is equipped with a camera, calibration of its parameters such as focal length and lens distortion is necessary to optimize image quality. Before executing the flight, thorough flight planning occurs, defining waypoints, altitude, and speed parameters to maximize coverage of the designated area. During flight, the drone follows this predefined path, capturing images or sensor data at regular intervals. Post-flight, operators process the collected data rigorously, including image stitching, georeferencing, and data correction based on calibration parameters, to ensure accuracy and reliability. Operators then implement quality control measures to validate the generated maps and data, often involving comparisons with ground truth data to confirm precision. Finally, operators make any necessary adjustments to calibration settings and flight parameters iteratively based on initial mapping results, ensuring continuous improvement in mapping precision and consistency for agricultural applications. The SLAM approach is then utilized to create a three-dimensional map for drone navigation.

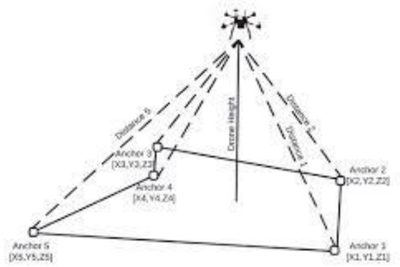

Fig -4**:** A technique for calibrating drones for accurate field placement.

C. User Application

A user application tailored for drone operations in agriculture prioritizes simplicity, accessibility, and functionality to cater to the diverse needs of farmers and agricultural professionals. It features an intuitive user interface, guiding users through various functions and settings with clear icons, labels, and menus for easy navigation, even for those with limited technical knowledge. The application assists users in setting up and calibrating drones before flight operations, offering step-by-step instructions and interactive prompts. Additionally, it provides robust flight planning tools, enabling users to define waypoints, set altitude and speed parameters, and designate areas of interest for data collection, both manually and automatically. Users can monitor vital metrics such as battery life, GPS signal strength, altitude, and speed in real-time, ensuring safe and efficient operation throughout missions. Furthermore, the application facilitates data visualization and analysis, allowing users to visualize aerial images, maps, and sensor readings, overlay data layers, measure distances, and identify areas for further investigation. Remote control features empower users to manage drone movements and actions remotely, including takeoff, landing, and emergency procedures, with responsive and intuitive controls. Integrated safety and compliance checks ensure adherence to regulatory requirements and best practices, supported by pre-flight checklists, airspace restrictions, and hazard notifications. Offline functionality ensures accessibility in remote areas or locations with limited connectivity, allowing essential features such as flight planning and data analysis to remain accessible. The application also fosters integration with external systems and services, such as weather forecasts and agricultural databases, enriching its capabilities and providing users with valuable additional information. Finally, feedback and support channels, including in-app chat support, help documentation, and community forums, empower users to seek assistance, report issues, and contribute to ongoing improvements, fostering a collaborative and user-centric approach to development and enhancement.

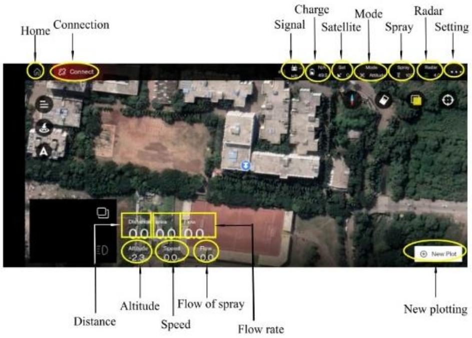

Fig -5**:** Web Application

II. LITERATURE SURVEY

[1] Author: Dongyan • Title: Aerial spraying systems M-18B & Thrush 510G • Content: Dongyan (2015) conducted a study on aerial spraying systems, specifically focusing on the M-18B and Thrush 510G models. The research highlighted the significant impact of flight height on swath width for both systems, underscoring the importance of optimizing flight parameters for efficient aerial spraying in agriculture.
[2] Author: Huang • Title: Low-volume sprayer integrated into unmanned helicopters • Content: Huang et al. (2015) investigated the integration of low-volume sprayers into unmanned helicopters for agricultural purposes. Their findings showcased that this integration allowed for higher target application rates and facilitated the dispersion of larger droplet sizes, as indicated by the Volume Median Diameter (VMD). This innovation has the potential to enhance pesticide and fertilizer distribution efficiency in UAV aerial application systems.
[3] Author: Yallappa • Title: Hexacopter with 6 BLDC motors and LiPo batteries • Content: Yallappa (2017) developed a hexacopter featuring six BLDC (Brushless Direct Current) motors and LiPo (Lithium Polymer) batteries. Capable of carrying 5.5 liters of liquid with an endurance time of 16 minutes, this drone contributes to advancing drone technology for precision agriculture and aerial spraying applications.
[4] Author: Kurkute et al. • Title: Quadcopter UAV and its spraying mechanism • Content: Kurkute et al. (2018) studied a Quadcopter UAV equipped with an Atmega644PA microcontroller and its spraying mechanism. Their research concluded that this quadcopter, owing to its efficient design and implementation, is suitable for various agricultural purposes. It emphasized the potential of quadcopters for precise and targeted spraying in agriculture.
[5] Author: Rahul Desale • Title: UAV for agricultural applications • Content: Rahul Desale (2019) designed a UAV optimized specifically for agricultural applications, with a focus on tasks such as spraying and monitoring agricultural fields. The research aimed to identify cost-effective and lightweight solutions to enhance the utilization of drones in modern agriculture.

III. SYSTEM REQUIREMENTS SPECIFICATION

a. Functional Requirement

To ensure continuous spraying operations in agricultural areas, the agriculture spraying drone system must retain operational stability without crashing even after extended durations of operation.
To ensure exact pesticide application and optimize crop protection, the system should accurately analyze data for a variety of input circumstances.
In order to help farmers and agricultural professionals watch the progress of spraying, identify abnormalities, and make necessary adjustments in a timely manner, it must have real-time monitoring and feedback methods.

b. Nonfunctional Requirement

Product specifications: To ensure adaptability and dependability in agricultural settings, the agriculture spraying drone system should be able to operate in a variety of environmental situations.
Essential conditions for operation: The system needs to follow legal requirements. and safety regulations controlling drone.
Organizational requirements: In order to facilitate smooth interaction with other precision agriculture technologies and to grow its capabilities over time, the system must be scalable to accommodate future improvements.

B. Hardware Specifications

I. Hobbywing X6plus Motor

The Hobbywing X6plus is a professional agriculture motor with a maximum thrust of 12 kg, but optimal efficiency at 5–8 kg. The X6plus is the latest model in the Hobbywing Agriculture propulsion System, which includes an ESC Motor, propeller, and direct motor mount. It has a 24-inch, 8-pitch propeller for precise spraying and lifting. For a hexacopter, it can take up to 30 kg in total weight.

Fig -6: Hobbywing X6plus Motor

II. K++V2 Flight Controller

The K++V2 flight controller stands as a pivotal component within unmanned aerial vehicle (UAV) systems, offering a robust suite of features and functionalities essential for

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF 2023: 8.176 ISSN: 2582-3930

stabilizing, controlling, and navigating aircraft. Boasting advanced sensor integration including GPS, accelerometers, gyroscopes, and barometers, the controller facilitates precise flight control in various modes such as angle, rate, and acro. Its navigation capabilities extend to GPS-based position hold, return to home (RTH) functionality, and waypoint navigation, ensuring accurate positioning and reliable autonomous flight. Compatible with a range of airframes and propulsion systems, the K++V2 flight controller offers a versatile solution adaptable to diverse UAV applications, from aerial photography and mapping to search and rescue missions.

Fig -7: K++V2 Flight Controller

III. Hobbywing Pump

The Hobbywing pump is designed for agricultural UAV drones represents a pioneering solution for precision agriculture applications. Its compact and lightweight design makes it well-suited for integration into UAV platforms, enabling aerial spraying tasks with ease. Equipped with a 5L/min capacity, the pump provides one solution for agricultural operations by covering larger areas in a single flight. The 10-12 liter tank in an agriculture spraying drone serves as the reservoir for holding liquid agrochemicals, such as pesticides, fertilizers, or herbicides.

Fig -8: Hobbywing Pump

IV. Skydroid Transmitter

The SKYDROID T12 2.4GHZ 12CH Remote Controller with R12 Receiver is a state-of-the-art transmitter designed for superior control and reliability. With its 2.4GHz frequency, it ensures a stable and interference-free connection between the controller and the receiver. The T12 offers 12 channels, allowing for precise and customizable control over various functions. Its ergonomic design provides a comfortable grip, while the intuitive interface and responsive buttons enhance the user experience Dual Antenna plus dual RF module with integrated control algorithms ensuring reliable communication via full angle high gain antennas. The T12 uses the latest in FHSS technology to achieve perfect control and operation. Integrated digital video transmission able to achieve up to 20 KM transmission under SD resolution. Internal integrated data link able to achieve up to 30km transmission. Parameter adjustment via APP with upgraded traditional OSD to touch panel control.

Fig -9: Skydroid Transmitter

V. Obstacle Avoidance

Obstacle avoidance technology improves safety, efficiency, and precision in aerial spraying operations by giving agricultural spraying drones the capacity to automatically detect and maneuver around impediments in their flight path.

Fig -10: Obstacle Avoidance

VI. GPS

The agriculture spraying drone project heavily relies on the GPS (Global Positioning System). It provides real-time tracking and monitoring of the drone's location, giving operators vital situational awareness and the flexibility to modify flight plans as necessary. Moreover, post-flight analysis using GPS data enables farmers to evaluate spray coverage and improve subsequent operations for increased efficacy and efficiency.

Fig -11: GPS

VII. Ground Radar

A technology used in agricultural spraying drones to map and identify subsurface properties such soil moisture content, soil texture, and underground impediments is called ground radar, commonly referred to as ground-penetrating radar (GPR). Its significance stems from its capacity to offer insightful data that can enhance spraying operations in a number of ways.

Fig -12: Ground Radar

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF 2023: 8.176 ISSN: 2582-3930

VIII. PDB

In drones, PDB stands for Power Distribution Board. It is a critical component of the electrical system responsible for distributing power from the main battery to various electronic components onboard the drone, such as flight controllers, motors, ESCs (Electronic Speed Controllers), LEDs, and other accessories.

Fig -13: PDB

IX. Nozzles

Drones used for agricultural spraying must have nozzles since they are crucial to the accurate application of liquid agrochemicals to fields or crops. There are many different kinds of nozzles that are made to fit particular environmental criteria and spraying needs.

Fig -14: Nozzles

C. General Technical Specifications

Specification	**Value**
Tank Capacity	10 liters
Payload Capacity	10 kg
Radio Frequency	2.4 GHz
Radio Control Range	2 km (Line of Sight, LOS)
Camera	RGB camera
Video Output	1080p @ 30 fps
Max Take-off Weight	25 kg
Flight Time	15 min (Manual and Autonomous Flying Modes)
Coverage Rate	1 acre in 7 mins
Spraying Width	3-4 meters
Spraying Rate	0.5-3 L/m
Nozzle Type	Flat Fan/Jet Nozzles
No. of Spraying Nozzles	4 Nozzles

IV. RESULT DISCUSSION

A. Flow chart

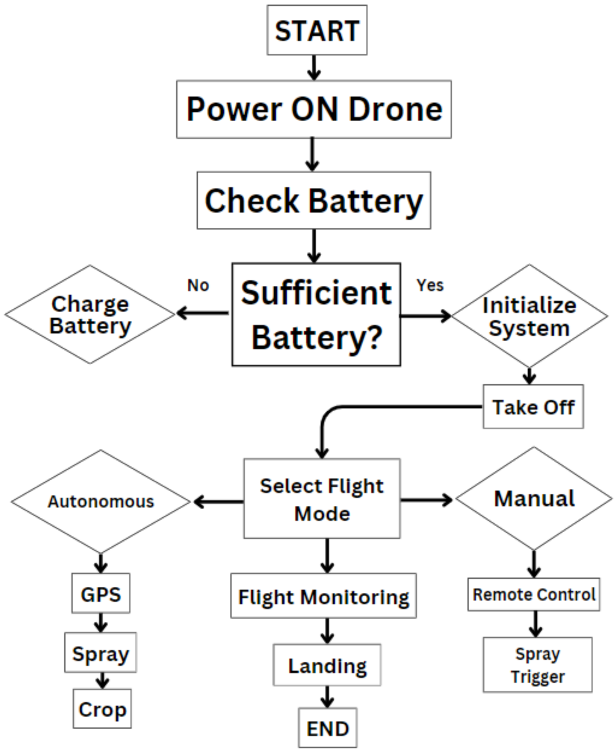

Fig -15: Flow Chart

B. Circuit Diagram

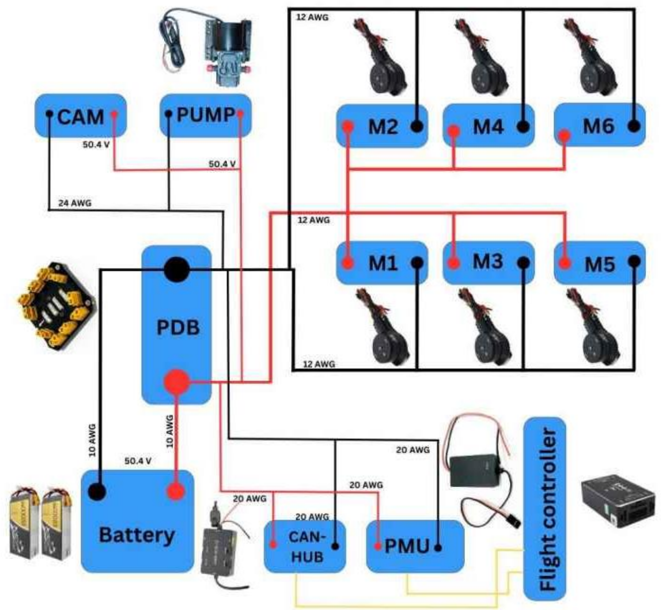

Fig -16: Circuit Diagram

C. Flight And Operational Specifications

Specification	Value
Max. Flying Altitude	20 m
Flying Speed	1-10 m/sec
Frame Type	Foldable (Six - Hexacopter Drone)
No. of Rotors	Six
Battery	Lithium polymer
Flight Altitude	1500m above mean sea level
Hovering Accuracy	10 m above ground level, ±0.8 m vertical, ±0.5 m horizontal
Max. Speed Resistance	25 km/hr
Operating Temperature	0-50 °C
Obstacle Detection & Terrain Following	Collision avoidance range: Minimum 10 meters, up to 12 meters

D. Features

- Precisely Define Field Boundaries Pre-Spray
- 10L Spray Capacity for Efficient Coverage
- Save 90-95% Water Consumption
- Boost Yield by 10-15%
- Cover 1 Acre in Just 5-7 Minutes
- Spray 25-30 Acres Daily
- Labor-Free Operation for Seamless Efficiency

E. Advantages

- Efficiency
- Accessibility
- Sustainability
- Safety

F. Applications

- Crop monitoring
- Pest control
- Fertilizer application
- Disease detection
- Irrigation management

V. CONCLUSION

Using drones for agricultural spraying represents a significant advancement in modern farming practices, offering numerous advantages across various aspects. These drones provide exceptional precision, ensuring accurate application of fertilizers and insecticides, thus minimizing wastage and optimizing crop treatment effectiveness. Moreover, they enhance operational efficiency by swiftly and effectively covering expansive agricultural areas, leading to increased productivity and reduced operational costs. Additionally, drones for agricultural spraying offer unparalleled accessibility to remote or challenging terrain within farming fields, ensuring comprehensive coverage and crop maintenance. Their targeted approach minimizes pollution and chemical runoff, making a substantial contribution to sustainable farming practices. Furthermore, by prioritizing safety, drones eliminate the need for manual spraying, safeguarding the health and well-being of agricultural workers.

REFERENCES

[1] S.R. Kurkute, B.D. Deore, Payal Kasar, Megha Bhamare, Mayuri Sahane, "Drones for Smart Agriculture: A Technical Report", IJRET, ISSN: 2321-9653, April 2018.

[2] Rahul Desale, Ashwin Chougule, Mahesh Choudhari, Vikrant Borhade, S.N. Teli, "Unmanned Aerial Vehicle for Pesticides Spraying", IJSART, ISSN: 2395-1052, April 2019.

[3] F. G. Costa, J. Ueyama, T. Braun, G. Pessin, F. S. Osorio, P. A. Vargas. "The Use of Unmanned Aerial Vehicles and Wireless Sensor Network in Agriculture Applications", EEE International Geoscience and Remote Sensing Symposium, 2012

[4] Sadhana, B., Naik, G., Mythri, R. J., Hedge, P. G., & Shyama, K. S. B. "Development of quad copter based pesticide spraying mechanism for agricultural applications", International Journal of Innovation Research Electrical Electronics Instrumentation Control Engineering, Vol.5, No.2, pp.121-123, 2017.

[5] Shaik.Khamuruddeen, K.Leela Rani, K.Sowjanya, Brahmaiah Battula. "Intelligent Pesticide Spraying System using Quad Copter", International Journal of Recent Technology and Engineering, Vol.7, No.5S4, 2019.

[6] Patel, P. N., Patel, M. A., Faldu, R. M., & Dave, Y. R. "Quadcopter for agricultural surveillance", Advance in Electronic and Electric Engineering, 3(4), 427-432, 2013.

[7] Shahid Karim, Ye Zhang. Asif Ali Laghari, Rizwan Asif, "Image Processing based Drone for monitoring and controlling crime" in Research Gate at IEEE Conference 2017.

[8] Gao, P.; Zhang, Y.; Zhang, L.; Noguchi, R.; Ahamed, T. "Development of a Recognition System for Spraying Areas from Unmanned Aerial Vehicles Using a Machine Learning Approach", Sensors, 19, 313, 2019

[9] Kim, J.; Kim, S.; Ju, C.; Son, H.I. "Unmanned Aerial Vehicles in Agriculture: A Review of Perspective of Platform, Control, and Applications", IEEE Access, 7, 105100–105115, 2019.

[10] Qin, W., Xue, X., Zhang, S., Gu, W., & Wang, B. "Droplet deposition and efficiency of fungicides sprayed with small UAV against wheat powdery mildew", International Journal of Agricultural and Biological Engineering, 11(2), 27-32, 2018