Feasibility and Utilization of Unmanned Aerial Vehicles (UAVs) in Integrated Pest Management

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Introduction

An unmanned aerial vehicle, commonly known as a drone, is an aircraft without any human pilot, crew, or passengers on board. UAVs are a component of an unmanned aircraft system, which includes adding a ground-based controller and a system of communications with the UAV.

As labor availability and technical manpower are extremely limited, particularly in India, drones are gaining popularity in the context of smart farming. Insect pests are known to cause catastrophe and drastic reduction in food grain production across the globe. The losses that have been predicted by FAO is over 37% due to pests and diseases. Recently, crops cultivated in India have been threatened by invasive pests like fall army worm (*Spodoptera frugiperda*) in corn and Rugose spiraling whitefly in coconut (*Aleurodicus rugiperculatous* Martin); these pests caused extensive damage during the years 2018 and 2019. It is reported that the annual global use of plant protection chemicals against trans-boundary pests was more than 3 billion kg. The utilization of pesticides that are sprayed on the crops exceeds 20–30% and the remaining 70–80% goes as run-off, leaching, evaporation, and drift that cause soil and aquatic pollution as well as deteriorating the quality of the crop produce. Under these circumstances, effective and timely spraying of plant protection measures are very important. For this, miniaturized unmanned aerial vehicles possess a wide array of benefits that include high efficiency, reduced labor requirement, saving of time and energy, quick response time, and vast area coverage, as well as environmental safety. The agricultural research institution State Department of Agriculture have devoted attention to designing and fabricating drones that suit Indian conditions.

The design of UAVs should consider various parameters such as droplet size, wind speed, flight speed, and flight height. Further, meteorological parameters like wind speed, temperature, and relative humidity can affect the efficacy of pesticide sprays under field condition. Under natural conditions, it is very difficult to control the meteorological parameters and thus scientists have attempted to study the drones under protected conditions. The efficacy of drones under a protected environment in order to prevent the external interference and the impact of drone flying speed on droplet size, shape, distribution, and uniformity. The study is very useful in optimizing various parameters to determine the effective spray of pesticides using drones. One of the most important criteria for the successful delivery of pesticides or any other input is droplet size. Drones are unmanned aerial vehicles exploited in a wide array of disciplines such as defense, monitoring systems, and disaster management but are only beginning to be utilized in agricultural sciences.

Fixed wing drones: It is an aircraft that operates without a human pilot onboard.

- Fixed wing UAVs are controlled either remotely by a human operator or autonomously via onboard computers.

Multi – Rotor drones: It is a rotorcraft with more than two lift generating rotors.

An advantage of multirotor aircraft is the simple rotor mechanics required for flight control.

Hybrid type drones:

A Hybrid drone is a type of unmanned aerial vehicle using two or more energy sources to power its flight propulsion system.

Importance of UAVs in pest management

- Aerial Spray for Brown Plant Hoppers in Rice
- Rice is a staple food crop for more than 2.7 billion people in Asia; the loss of productivity of the crop has been estimated as more than 20%.
- The brown plant hopper (BPH) *Nilaparvata lugens* causes considerable loss of crop yields globally and is a major pest in India in the late season rice crop planted during September–October.
- The BPH causes damage at the late stage of rice growth. During the late stage of the crop, it is very difficult to undertaken manual spraying as the leaves of the rice canopy overlap.

- Further, BPH often colonize at the lower part of the plant which is inaccessible through a manual sprayer.
- In addition, the muddy fields and overlapping plants makes the conventional system of pesticide spray difficult. In order to overcome the bundle of practical difficulties and acute labor shortage, aerial spray of pesticide using UAVs becomes inevitable.
- Aerial Spray of Pesticides on Aphids and Spider Mites in Cotton
- In cotton, aphids and mites are serious sucking pests of great concern that cause extensive damage to the crop.
- The control of aphids and spider mites in cotton were registered as 63.7 and 61.3%, respectively, and the efficacy was lower than boom spraying.
- UAV spray was slightly less effective in comparison to boom spraying due to the spiral arrangement of leaves in cotton.
- These data serve as the basis to determine the theoretical prediction of the pesticide effectiveness in cotton fields using drones.

Drones to Manage Fall Army Worm in Sugarcane

- The Fall Army Worm (*Spodoptera furgiperda*) is one of the invasive pests causing extensive damage in maize.
- It is a polyphagous pest that feeds on a wide range of cereals, millets, sugarcane, banana, and other crops (Khan et al., 2018). It causes extensive damage in a very short span of time.
- In order to control the pest, quick action has to be taken to ensure that pest population is kept at bay. Drones are highly useful technology to undertake spray quickly to contain the pest population.

Conclusion

Drone application in agriculture is primarily focused on pesticide applications. Extensive research has been done on optimization of spray volume, droplet size, spread of droplets, and penetrability as well as efficacy of pesticides in insect pest control. Many of the optimization parameters indicated were done mainly for pesticides use in agriculture. In order to improve insecticidal use efficiencies in crops, drone operational parameters such as flight speed, flight height, nozzle type, payload, and drone type are be optimized for the given situation. Overall, flight height of 2–3 m, flight speed of 3–5 ms−1, two fan nozzle, four rotor UAV, and 15 L payload are found to be optimal to undertake pesticide sprays using drones in agricultural crops. There are potential benefits to drone usage in agriculture that include large area coverage, less quantities of pesticides, labor saving, quick response time, and timely operation well before pest occurrence exceeds economic threshold levels. Despite the fact that there are ample advantages attached to drone technology, every country has its own regulatory guidelines for the use of drones in agriculture. Prior approvals are required from local authorities to use drones in agriculture.

Future Strategy

Drone technology is very effective in delivering pesticides for a wide array of crops. The effectiveness has been validated with conventional hand-operated sprayers. There are no ultralow volume pesticide formulations available in the market, the conventional pesticides were used in drone technology with the same optimized concentration. Thus, there is an urgent need to develop innovative new nano formulations to improve the efficacy of drone technology while minimizing the cost and improving environmental safety.

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