VTOL UAVs for spraying insecticides

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India is an agriculture-dependent nation. From ages, India has been the driver of this sector. The data on agriculture and the crop defines the mood of the nation. As the economy of India is concerned, agriculture contributes nearly 5 to 6 percent of the GDP. Considering these factors, the modernizing the agriculture sector has become the need of the hour. In agriculture, information plays an important role in all types and stages of the crop. Lack of information leads to over or under production and crop loss. In the modern era of agriculture, this problem can be solved by adopting modern technologies like Imaging and the Internet of things (IoT) are going to play an important role.

In the agricultural activity, labour is adding a major cost factor. Aspects like lack of skilled labour and an increase in basic wages are pushing the engineering community to find an alternative solution. One such innovation is the use of UAVs (Unmanned Air Vehicles) in agriculture for various purposes. There are 2 major ways of deploying UAVs *viz.*, Imaging, and Crop-spraying (application of plant protection chemicals). The economic viability of these activities has been the centre of study for the government to take it further. Here we deal with crop spraying.

Crop spraying: There are many factors involved in crop spray activity in agriculture like

a. Type of crop
b. Type of pest and composition of spray
c. Crop canopy
d. Area
e. Season
f. Frequency
g. Effects of spray
h. Economics

A new technology called Aerial Electrostatic Spraying system using helicopters is now becoming popular. Helicopters can deliver pesticides in low altitude areas. Studies have shown that electrostatic spraying produces uniform and fine droplets with better distribution, deposition, low environmental contamination, and higher efficiency.

UAV based crop spraying activity is catching up fast. Various companies are deploying the VTOL (Vertical Takeoff and Landing) UAV for the purpose. The above-mentioned factors need to be studied before the successful deployment of VTOLs for crop spray.

When UAVs are deployed for spraying in agricultural tracts, the distribution and spread of active ingredients or particles on the crop canopy should be appropriate. The particles should not drift over or the particles should not impinge on crop canopy by imparting stress. The liquid should be able to penetrate the crop canopy and reach the target site on the plant.

I. **Type of pest and composition of the spray**

Type of pest, whether it is highly mobile or sedentary with chewing or sucking mouthparts and feeding parts of the plants by the pests are crucially important. The composition of the spray mixture whether it is systemic or contact or dust or aerosol matters a lot. The formulation of the spray should be ultra-low volume spray such that it is meant for aerial spraying and not for a knapsack or gator spraying. Presently, a majority of the operators are increasing the dosage level to suit lesser flights for the same area, which harms the crop, soil, biodiversity, and environment.

II. **Crop canopy**

It plays a pivotal role in dispersing the spray particles. Horizontally -spread crop canopies imbibe major portion of the spray swathe. However, vertically shaped canopies require a different mode of delivery wherein the spray particles should disperse along with the height of the canopy. Since UAVs discharge, the spray particles overhead the crop canopy, the bottom portions of the crop remains free from the spray.

III. **Area**

Utilizing UAVs for spray applications will cover almost 5 times the area covered by manual spraying using power pack sprayers. But the cost per acre remains very high. Instead, it can be done utilizing more labour by creating jobs and value for money.

IV. **Season**

There are 2 major seasons of cropping in India *viz*., *Kharif* and Rabi. *Kharif* being a monsoon cropping constitutes 65% of major crops. During this season the wind speeds are very high with rain. When UAVs are deployed for spraying activity due to windy conditions it is observed that spray particles drift from the crop canopy. This is not desirable because of the loss of material and the effectiveness of the dosage/a.i. Since UAVs fly very low to the ground chances of gust and crash are

Fig. 1. Insecticide application using drone.

high.

V. **Frequency**

During Kharif season it is required to have multiple forays as the area under the crop will be high and rain washes away the sprayed chemicals. This becomes more expensive because of multiple deployments of UAVs.

VI. **Effects of spray on crop**

The impact of spray applications should not adversely affect crop architecture and structure. These UAVs are VTOLs that produce 12 to 14m/s downwash wing hitting the crop and lodging it. Further, this induces a high amount of stress on crops affecting the yield.

VII. **Economics**

The cost of a typical VTOL UAV with 10 liters to 15ltr liquid carrying capacity is about Rs12-14 lakhs (with minimum spares) in India. The total life of VTOL in most favoured conditions lasts for 1000 landings (if no accidents occur) i.e., Rs1200/- per landing of VTOL in addition to other overheads will add like, cost of labor, cost of transport, cost of operating overhead, cost of maintenance of UAV and profit of the company. This roughly comprises Rs. 2000/- flight. In each flight, UAVs are expected to cover only 1 acre (in *Kharif*). Therefore the cost of operating VTOLs for crop spray becomes unaffordable. It is also observed that the cost of UAVs and operating overheads have not reduced over the years.

Unlike imaging activity, the spraying activity is more labour intensive and time-consuming. So, by considering all these factors VTOL UAVs are economically not feasible in the present scenario of Indian Agriculture.

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