

[F] PhD Extended Abstract Form *[Please, to fill out use Calibri 10 typeface]*

FULL PhD THESIS TITLE: OPTIMIZATION OF OPERATIONAL PARAMETERS FOR SPRAYING WITH UNMANNED AERIAL VEHICLE (UAV)

by

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Extended Abstract

[12000 characters max, spaces included . It is possible to include photographs, tables, and graphs]

1. Title [Introduction]: Unmanned aerial vehicle (UAV) is one of the solutions for effective and efficient agrochemical application on field crop. UAV sprays above the crops without damaging plant leaves and heavy downwash produced by propeller helps to open the plant canopy and deposit the droplets on all over the canopy of plants uniformly. Also, it is speedily operation, saves times, money, chemical, labor. In view of optimizing the operational parameters of spraying of chemicals through UAVs the experiment was conducted.

2. Title [Material and method]: Various UAVs models like battery-operated hexa-copter UAV (model-I), battery operated quadcopter UAV (model-II) and petrol engine operated quadcopter UAV (model-III) were selected for experimental evaluation of spraying on sugarcane crop. The type of nozzles used was flat fan, centrifugal and hollow cone nozzle in model-I, model-II and model-III, respectively. Based on the previous studies and preliminary trials, it was found that unmanned aerial vehicles flight height and flying speed have great effect on spray performance parameters which influences deposition and spray drift.

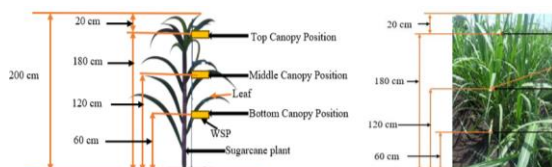


Fig. 3.29: Layout of WSP on sugarcane plant

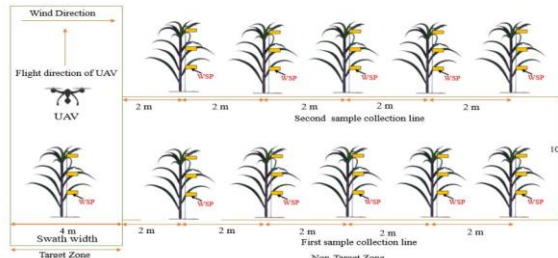


Fig.3.32: Sampling layout for UAV performance

3. Title [Result and Discussion]: The discharge of each type of nozzle measured in laboratory were found to be 0.540, 0.940 and 0.430 L.min⁻¹, for flat fan, centrifugal and hollow cone nozzle, respectively. The field study was conducted to find the effect of flight height (1.5, 2, 2.5 m above crop canopy) and flying speed (3, 4, 5 m.s⁻¹) on spray performance parameters such as droplet density, droplet size, coverage, spray deposition, uniformity coefficient and relative span factor. The crop physiological parameter of sugarcane (*Saccharum officinarum* L.) a variety Co86032 were determined. Crop height, row to row spacing, plant canopy were 2 m, 1.5 m and 1.20 m, respectively. The meteorological parameters such as air temperature, wind speed, relative humidity and gusts speed were recorded during experiments as 23.15 to 29.87 °C, 1.12 to 2.40 m.s⁻¹, 57.15 to 66.60 per cent and 2.05 to 3.85 m.s⁻¹, respectively. The water sensitive paper was attached to at three positions on sugarcane canopy i.e., bottom, middle and top at a distance of 60, 120 and 180 cm from ground surface, respectively. The operational parameters of UAV models were optimized and validated by setting goals and importances using central composite design, response surface methodology. The significant difference was observed ($p < 0.001$) at each flight height and flying speed for all three models. The lack of fit test was found to be non-significant ($p > 0.05$) for spray parameters indicating that the developed model was adequate for predicting the spray performance parameters accurately. The optimized flight height was 1.5 m and flying speed was 5 m.s⁻¹ for all three models. The optimum values were validated by comparing the predicted values and experimental values i.e., per cent prediction error was less than 10 per cent.

Also, the spray drift was 6 m, 8 m and 10 m for model-I, model-II and model-III, respectively. The model-III has more spray drift as compared to model-I and model-II due to small droplet size produced by hollow cone nozzle and heavy downwash generated by propeller. The maximum spray drift at 2.5 m flight height and 5 m.s⁻¹ flying speed while minimum spray drift at 1.5 m flight height and 3 m.s⁻¹, flying speed, for all three models. From the results it was observed that the with the increase of flight height and flying speed the spray performance parameters were deteriorated. The theoretical field capacity, effective field capacity, field efficiency and application rate was 7.20 ha.h⁻¹, 4.12 ha.h⁻¹, 57.77 per cent and 30 L.ha⁻¹ at optimized parameters of flight height and flying speed of 1.5 m and 5 m.s⁻¹, respectively, for model-I. The cost of operation was 547.51, 556.71 and 649.17 Rs. ha⁻¹ for model-I and model-II model-III respectively.

4. Title [Conclusion]: Following conclusions were drawn based on the studies conducted,

1. The discharge of single flat fan, centrifugal and hollow cone nozzle was 0.540, 0.940 and 0.430 L.min⁻¹, respectively.
2. The optimum flight height and flying speed for all the three models under investigation were found to be 1.5 m and 5 m.s⁻¹ respectively.

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3. With increase in flight height and flying speed spray deposition decreases and spray drift increases.
4. The model-I produced larger droplets size due to flat fan nozzle as compared to model-II (centrifugal nozzle) and model-III (hollow cone nozzle) in the laboratory as well as field. Spray drift was lower during spraying with model-I (up to 6 m) as compared to model-II (up to 8 m) and model-III (up to 10 m), 5. The larger droplets size 300 to 100 μm were deposited in target zone while smaller droplet size 50 to 100 μm scattered in off target zone.

Final remarks concerning benchmarks and strength points of the the Pellizzi Prize 2026

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This PhD research presents an innovative approach to optimize operational parameters of UAV-based spraying for field crops, improving spray deposition, reducing drift, and enhancing field efficiency. The study integrates engineering design, field experimentation, and response surface methodology to develop validated operational guidelines for different UAV models and nozzle systems in sugarcane. The optimized flight height and flying speed significantly improved droplet distribution and reduced operational cost and environmental risk. The research contributes to precision agriculture and sustainable crop protection by providing practical recommendations for efficient agrochemical application. The outcomes support mechanization, labor saving, and environmentally safe spraying practices, aligning with the objectives of the Pellizzi Prize in promoting innovation, sustainability, and advanced agricultural engineering solutions.

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