Giuseppe Pellizzi Prize

CLUB OF BOLOGNA

INVESTIGATION ON THE SPRAY CHARACTERISTICS OF AUTONOMOUS DRONE SPRAYER AND DESIGN AND DEVELOPMENT OF AERIAL CENTRIFUGAL SEED AND FERTILIZER BROADCASTER

Dissertation presented to Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, INDIA

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1 Introduction

BACKGROUND

- Application of crop protection materials is a crucial component of pest management in agriculture
- In the present context small scale farmers are using knapsack sprayers
- These sprayers are either manual operated which are to be carried by the operator for spraying which causes drudgery and there is often leak, which causes the drenching of skin and clothing with pesticides causing health hazards. Furthermore, it increases the fatigue of operator if used for longer period.

Manual spraying

- Slow operation
- Tiresome
- More drudgery
- Less area coverage
- Less efficiency

Tractor operated spraying

- High expenses
- Difficulty in wet field
- More pollution
- Not suitable for small farmers

Piloted Aircraft/Aerial spraying

- Wastage of chemicals
- Not suitable for small scale farmer fields
- Require skilled operator
- Requires separate runway

RESEARCH PROBLEM AND JUSTIFICATION

- There is no detailed study in India regarding performance of machine operational parameters viz., height of spray, travel speed, discharge rate, type of nozzles and spacing, spray droplet characteristics and application rate for different crops.
- Commercial drone manufacturers are adopting drones without having basic information on the performance and efficacy of the drone spraying system in terms of pest control.

AUTONOMOUS DRONE SPRAYER

- In order to reduce human intervention in spraying operations, autonomous drone is an emerging technology in the field of agriculture.
- It solve the issues of effective pesticide spraying in a larger area thereby achieving timeliness of operation while reducing labour requirements and human drudgery

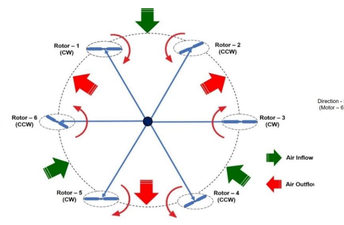
BENEFITS

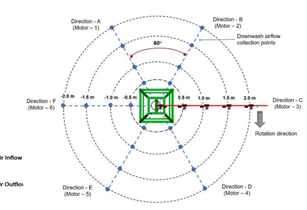
- Maximum field coverage
- Saves time & cost
- Reduces drudgery

This technology would be useful where human interventions can be avoided for spraying of chemical in paddy fields, orchards crop, sloppy/undulated terrains fields

2 Materials and Methods

1. Study on downwash airflow pattern of drone sprayer in the laboratory





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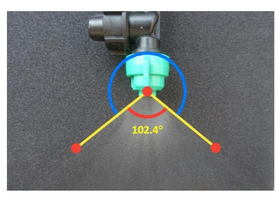
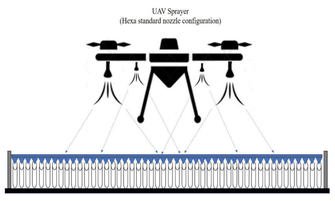
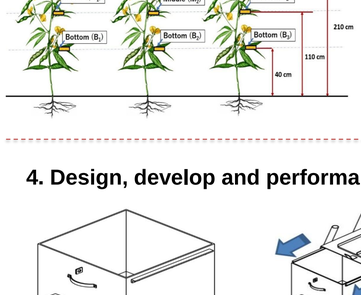
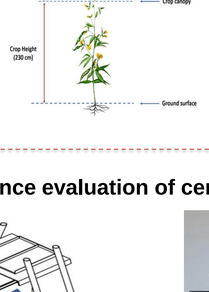
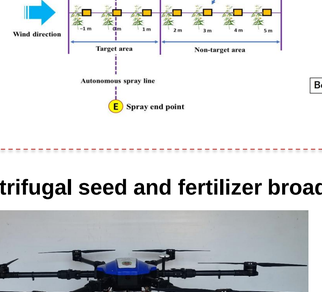


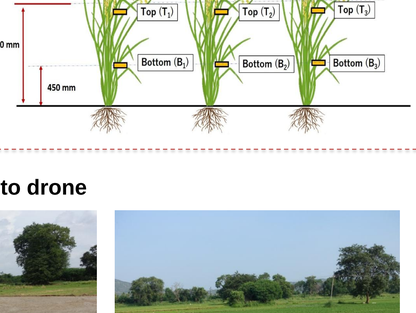


3. Study on spray deposition and drift characteristics for application of Insecticide in the field condition

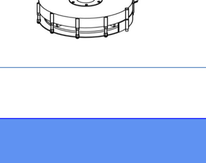


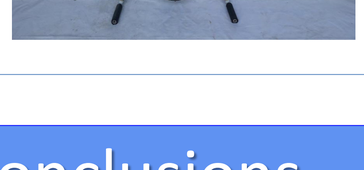


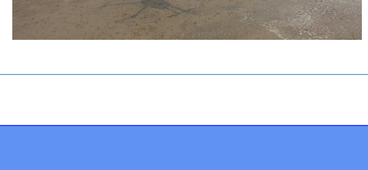


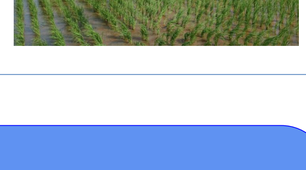


4. Design, develop and performance evaluation of centrifugal seed and fertilizer broadcaster as an attachment to drone



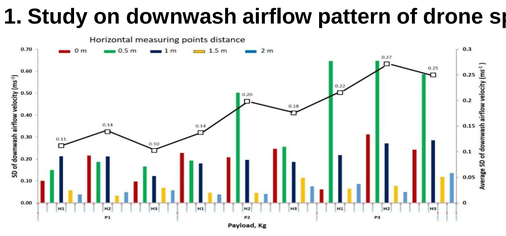


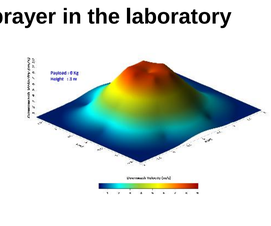


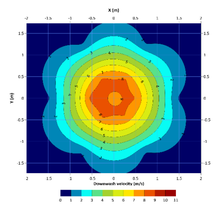


3 Results and Discussion

1. Study on downwash airflow pattern of drone sprayer in the laboratory







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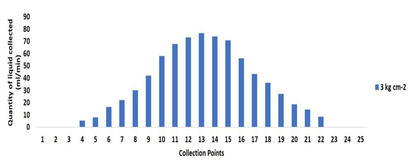

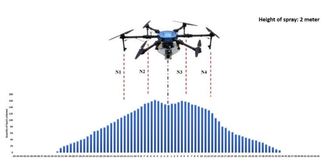

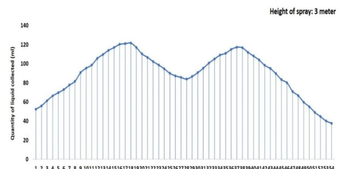

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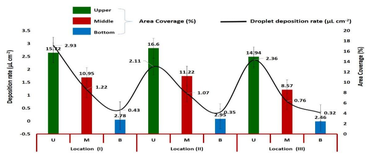
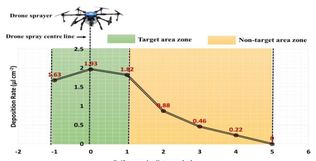
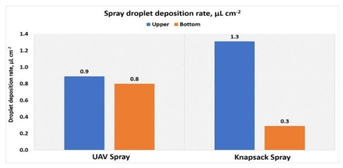
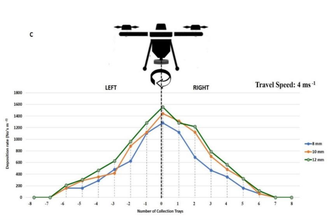






4. Performance evaluation of developed centrifugal seed and fertilizer broadcaster in field



4 Conclusions

1. In this investigation, a six-rotor UAV drone sprayer operational parameters *viz.,* height of spray (m), operating pressure (kg cm^{-2}) and nozzle mounting confirmation (boom and hexa), discharge rate (l m^{-1}), spray angle (º), effective spray width (m), spray liquid loss (ml) and spray distribution uniformity (%) were optimized.
2. The optimum spray height was 2.0 m, in which the downwash air flow has a better effect on spray volume distribution.
3. The drone sprayer should be operated at an appropriate spray height of 2.0 m to attain the recommended application rate of pesticide.
4. Droplet deposition rate decreased as the lateral distance from the center of the UAV spray line increased (from 1.93 ± 0.05 µL cm^{-2} to 0.22 ± 0.05 µL cm^{-2}), and similarly, the spray droplet drift distance was reduced with the increase in droplet size, which showed that the increase in spray droplet size can effectively minimize the spray droplet drift.
5. The UAV spray method is quite effective, not only in terms of reach but also in mitigating health risks faced by farmers who walk through the fields with handheld sprayers, exposing themselves to toxic chemicals.
6. Drone multi-rotor downwash airflow had a great impact on the spray droplet deposit rate in the rice crop, which will be useful for fighting stem borers, which are usually present in the lowest part of the plant.
7. Design and developed the functional components of aerial broadcaster attachment to drone sprayer.
8. Then optimized the machine and operational parameters of aerial broadcaster for paddy, green manuring seeds and urea fertilizer application at laboratory condition.
9. Then finally evaluated its performance in field condition for application of paddy seeds, urea fertilizer and manure seeds and showed better results compared to the conventional method with frames.

n Final Remark(s)

An attempt was made to adopt the six-rotor drone sprayer for aerial centrifugal seed and granular fertilizer broadcasting. This developed customized equipment enables farmers to carry out three operations with a single autonomous drone viz., spraying, seed and granular fertilizer application, thereby increasing the productivity and income of the farmers. The cost of operation can be reduced and timeliness of operation could be achieved. A single unit can perform all three operations, which would increase utilization of the equipment.

These research results of optimized machine and spray operational parameters of autonomous drone sprayer helps and references to the farmers, researchers, startups entrepreneur, policy makers for usage of drone spray technology in agriculture production.