Optimizing the impact of spray characteristics of hybrid drone on spray deposition in cotton crops

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The effectiveness of a hybrid unmanned aerial vehicle (UAV) for optimizing crop booster application on cotton crops (variety Co-14) at Tamil Nadu Agricultural University is evaluated in this research. The hybrid UAV, featuring a 12-litre sprayer tank and powered by an internal combustion engine and brushless direct current motor, was tested at heights of 1 and 2 m and speeds of 3 and 4 m s^{-1}. The objective was to determine optimal parameters for maximizing droplet deposition and minimizing spray drift. The results indicated that at 1 m and 3 m s^{-1}, the droplet density in the target area was 148 ± 8 drops/cm^2, compared to 136 ± 4 drops/cm^2 at 2 m. The volume median diameter at 1 m and 3 m s^{-1} was 361 µm, and the number median diameter was 392 µm, showing higher deposition and uniform droplet sizes at lower heights and lower speeds. Spray drift analysis indicated reduced off-target movement at 1 m and 3 m s^{-1}, showing a non-target droplet density of 54 ± 4 drops/cm^2 compared to 42 ± 6 drops/cm^2 at 2 m. The study concludes that the optimal UAV operation parameters are 1 m height and 3 m s^{-1} speed, enhancing droplet deposition, minimizing drift, and improving spray efficiency.

Keywords: Droplet deposition density, operational parameters, spray drift analysis, UAV spraying technology, UAV system.

cover 1.6 hectares per hour due to frequent stops and downtime[3]. The UAV sprayer's operational efficiency was 4.11 hectares per hour which far exceeded the speeds of the self-propelled boom, Knapsack mist-blower and electric air-pressure (EAP) sprayers, being 1.7, 2.6 and 20 times faster respectively[4]. The UAV had better performance to the EAP sprayer at higher spray volumes (>16.8 l/ha) with coarse nozzles but performed less effectively at lower spray volumes (<9.0 l/ha) with fine nozzles[5]. UAV sprayer requires a large investment, but operating costs are higher for conventional sprayers compared to UAV sprayers. Li *et al.*[6] stated that the aerial spray technology of plant protection UAVs in China has addressed traditional operation limitations, offering higher efficiency, improved atomization, and herbicide utilization, making it the preferred method for crop protection. Yellappa *et al.*[7] highlighted the necessity of optimizing nozzle configurations and operational parameters to enhance spray uniformity and effectiveness in drone-assisted application. Lan *et al.*[8] conducted research on UAV revealed that optimizing flight height significantly affects droplet uniformity and the effectiveness of pesticide application. Yellappa *et al.*[9] demonstrated that operational parameters influencing the droplet deposition and drift characteristics in battery operated UAV sprayers mainly due to downwash airflow generated by a multi-rotor propeller. Xinyu *et al.*[10] stated that UAV spraying in lower altitude with fluorescent dye resulted in increased deposi-