AN AIR ASSISTED SPRAYER WITH ELECTROSTATIC NOZZLE FOR COCONUT PALMS

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ABSTRACT

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ABSTRACT

An air-assisted electrostatic sprayer prototype suitable for coconut palms was designed and developed. Studies on the important plant parameters, including height of palm, canopy diameter, and angle of leaf orientation, were carried out as the primary step in developing the prototype. The major components of the developed unit are a High Voltage DC (HVDC) System, nozzle unit, liquid delivery unit, and an air-assistance unit. The high-voltage DC system capable of generating voltages in the range of 1 to 10 kV was developed using a Line Output Transformer (LOPT 1010A) coupled with a Metal Oxide Semiconductor Field Effect Transistor (MOSFET IRFZ44E). Among major electrostatic spray droplet charging methods, induction with a ring electrode (4.3 mm diameter copper wire) was chosen due to its several advantages over the other methods. The diameter of ring electrode (40, 60, and 90 mm) and the horizontal position (5, 10, and 15 mm) of the electrode in front of the nozzle were optimized under laboratory conditions in terms of charge to mass ratio (CMR) of the developed electrostatic system using a specially designed Faraday Cage apparatus. A high-pressure hydraulic nozzle was selected for the liquid atomization and a double-stage diaphragm pump with a cut-off pressure of 10.5 $kg \cdot cm^{2}$ was selected for the liquid supply unit. An Electric Ducted Fan (EDF) was chosen for the air assistance unit.

The spray gun comprising both the nozzle and the EDF was mounted on an 8 m long telescopic carbon fiber pole, and all other major components and control units were arranged as a backpack unit for easy handling. Water Sensitive Papers (WSPs) were used to study the effect of electrostatic charging on spray characteristics. The performance evaluation of the developed prototype in terms of deposition, droplet density, spray drift and biological efficacy was carried out under actual field conditions and compared with a conventional sprayer (Rocker sprayer). The field trials were conducted under optimized operating conditions viz. electrode diameter (90 mm), electrode position (10 mm), operating pressure (5 $kg \cdot cm^{2}$), VMD (156 μm), and EDF air flow velocity of 17 $m \cdot s^{-1}$. The results concluded that

the spray deposition of the developed sprayer has 20.69, 27.23, and 63.95 per cent higher in the adaxial surface at the lower, middle, and upper middle canopy respectively compared to the air-assisted spraying. And 39.05, 22.7, and 84.33 per cent higher with respect to the conventional rocker sprayer. Moreover, electrostatic spraying has 1.81 times more droplet density compared to rocker sprayer, and 1.2 times more than the air-assisted sprayer. The deposition efficiency was calculated as 69.77, 43.09, and 33.86 per cent for the spraying with electrostatic sprayer, air assisted sprayer and rocker sprayer respectively. Spraying with the developed sprayer was able to reduce the Rugose Spiralling Whitefly (RSW) incidence, severity and RSW live colony per leaflets by 32.76, 64.17, and 74.91 per cent respectively. The total cost of the developed prototype was Rs. 22,120/- The operational cost of the developed electrostatic sprayer was calculated to be ₹151 per hour, significantly lower than that of the conventional rocker sprayer, which stood at ₹231 per hour