

Measuring the Aerosol Characteristics of the Optimum Insecticide Spray

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Keywords: Spray Characteristics, Agglomeration, Collision, Single- and Double-Hole Nozzles

Spray characteristics were investigated to determine the optimum aerosol spray for insecticides while considering volatile organic carbon (VOC) reduction. Our ultimate goal is to improve the efficiency of killing insects while using less aerosol spray, which contains chemicals, oil, and dimethyl ether (DME). The chemical content of the aerosol is greatly reduced in the attachment region 1-2 m from the nozzle. Most of the oil and propellant fail to reach the target, and fall on the ground. The propellant is used to break droplets into smaller droplets and to carry them to the target. Most of the propellant's energy is used for carrying these droplets, although the remaining droplets are very small compared to those produced at the nozzle. We investigated the droplet characteristics over the entire distance from the nozzle to the target. As Fig. 1 shows, the main phenomena involved in an aerosol spray system are injection, collision, momentum loss, separation, evaporation, agglomeration, and attachment to test insects. Since the target insect is usually flying, its wing movements and surface characteristics can lead to the collision of spray droplets, drag, and second stage agglomeration. In developing aerosol sprays, it is necessary to consider the spray characteristics, mixture formation, and how droplets fall to the ground and are transported to the target insect. In studying the configuration of the spray nozzle, the spray characteristics near the nozzle can be evaluated using optical diagnostics. Here, we tested different nozzle dimensions and compared single- and double-hole nozzles. Furthermore, the effect of surfactant on the agglomeration and break-up of spray were investigated. We measured the spray characteristics near the nozzle to evaluate the droplet-forming process by examining droplet separation, agglomeration, collision, and size to elucidate the

spray behavior and determine the dominant factors involved in designing and developing a nozzle for spraying insecticides most effectively. With a single-hole nozzle, the droplet velocity at 30 mm from the nozzle was 25 m/s, and this decreased with distance to almost 10 m/s at 110 mm from the nozzle, indicating that the droplets lost momentum. Most of the droplets were carried by the surrounding cloud of pressurized gas. The droplet diameter increased with distance, while the velocity decreased. The droplet diameter (D_{32}) at the nozzle exit was about 50 μm . The droplets collided, separated, and agglomerated to attain a size of 75 μm at 120 mm. As agglomeration occurred, the droplet diameter increased to between 75 and 80 μm . We measured the same characteristics for double-hole nozzles. The initial droplet velocity was lower with the double-hole nozzle than with the single-hole nozzle. The initial droplet size was about 35 μm and this increased to 60 μm at 120 mm. Therefore, the key factor for developing the optimum nozzle for spraying insecticides is not the number of holes or nozzle diameter, but the agglomeration process and formation of effective diameter with surfactant in consideration of minimizing spray fall on the floor. The key to developing a system that decreases VOC dramatically is how the effective droplets at 1 m away from the nozzle exit can be produced at the nozzle exit. Droplet diameter and velocity when exiting the nozzle need to be understood quantitatively and controlled; the most important considerations are to maximize spray agglomeration coefficient, in order to deliver droplets with an effective diameter to the target, and to reduce the number of oversized droplets failing to reach the target.

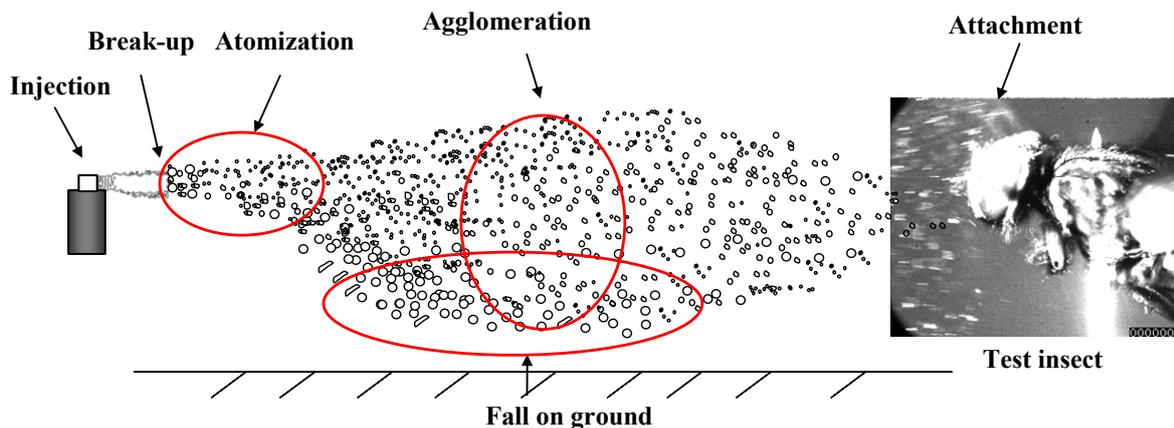


Fig. 1 Main phenomena that take place in an aerosol spray system