Review Article

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A Future for Ultra-Low Volume Application of Biological and Selected Chemical Pesticides

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There is now increasing awareness that Global temperatures are increasing and one result of this is the movement of more water from the Oceans up into the atmosphere. This increases the amount of rain falling which can have an impact on crops. While the rain can be welcome by the crops, the raindrops can remove any deposits of pesticides applied to control pests of crops, especially if the pesticide had been formulated to mix in water.

The problem of a formulation designed to mix with water is that when it rains the plant foliage is wetted so spray deposits are removed depending on the amount of rain (Figure 1), so the pesticide reaches the soil and subsequently moves through the soil to streams and rivers. There has been concern recently about the impact of pesticides on fish and other organisms in rivers.

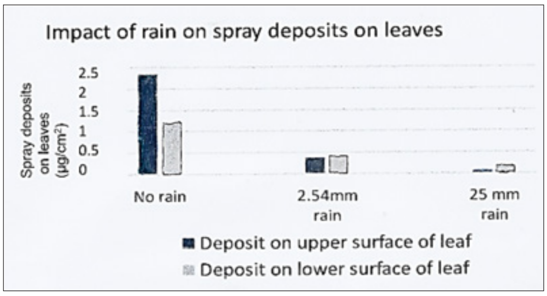

Figure 1: Comparison of the amount of pesticide removed by different quantities of rain

Pesticides have generally been applied mixed in water, since the 1890's when Copper sulphate in Bordeaux mixture was applied on vineyards as a fungicide (Lodeman, 1896). Knapsack sprayers were followed by the development of larger sprayers and the use of aircraft.

Farmers used a knapsack sprayer fitted with a lance, but spray coverage depended on how the lance (Fig. 2) was held and directed the spray and farmers walking through sprayed plants were exposed to the insecticide, especially if the nozzles were held higher. The development of attaching a vertical boom on the spray tank and walk away from the spray was not introduced until 1960 (Fig. 3). This enabled the volume of spray applied per hectare to be increased as the crop increased in height. In India in 2017 sadly many farmers died when spraying a highly hazardous insecticide late in the season as the nozzle was in front of their face (Fig. 4).

Figure 2: Knapsack Sprayer with lance.

Figure 3: Knapsack sprayer with Tailboom.

Figure 4: Farmer in India holding lance high, so spray is just in front of face.

Figure 5: Tractor mounted sprayer applying insecticide on cotton crop.

Figure 6: Tractor with trailer spray tank and boom.

Figure 7: Tractor with air assisted distribution of spray.

Figure 8: Drone spraying cotton in China.

If large volumes of spray are applied a drone may need to land frequently to refill the spray tank, so ULV spraying is more appropriate to use with drones. The drone should use rotary atomiser to minimise small droplets that could drift down wind. Figs 14-15.

Another development was due to many farmers having a problem to get sufficient water to use a knapsack sprayer. The introduction of a rotary atomiser, developed by Bals (1969) who started Micron Sprayers in 1954. A small hand-held sprayer fitted with a rotary atomizer was tried in several countries and in Malawi a trial made direct comparison between the hand-carried sprayer to apply a ULV spray and a knapsack sprayer with Tailboom. Ultra low volume spraying of cotton in Malawi. The SULV formulation used in Malawi contained isophorone. An α, β-unsaturated cyclic ketone, as a solvent (Matthews, 1973).

Figure 9: ULV spraying with Rotary atomiser.

Treatment	Yield (kg/hectare)	% Damage
Unsprayed	457	13.8
Knapsack with Tailboom	2259	6.7
ULV 1 Row Swath	2255	12.1

If large volumes of spray are applied, the drone has to be frequently landed to refill the spray tank. The solution is to use an Ultra-low volume spray. The Special SULV formulations used in the trials were described by Matthews (1973) (Fig.9), Solvents used in a ULV formulation, e.g. dissolving power, volatility, viscosity and phytotoxicity are discussed by Maas (1971).

The use of ULV sprays had been introduced to control swarms of locusts, but during the outbreaks in 2019 -2021 in Somalia, the locusts were controlled using a biopesticide based on *Metarhizium acridum* mixed in diesel oil applied at 1 litre per hectare with aircraft and ground equipment. Figs. 10-13. Owour & McRae (2022).

An advantage of using an oil carrier results in the pesticide applied remains effective over a longer period of time, so the actual effective dose can be less than previously used with sprays mixed in larger volumes of water.

Figure 10: Rotary atomiser on truck mounted sprayer.

Figure 11: Using aircraft to spray biopesticide.

Figure 12: Locust hoppers dying after a spray using Biopesticide.

Figure 13: Dead Locust.

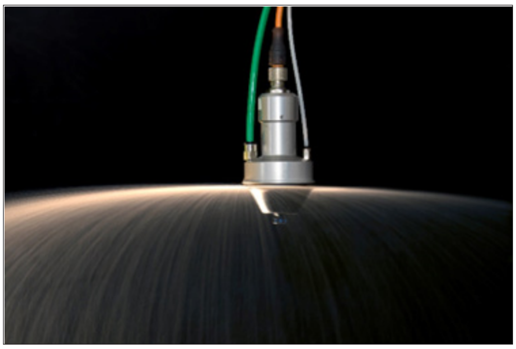

Figure 14: Example of a Rotary atomiser.

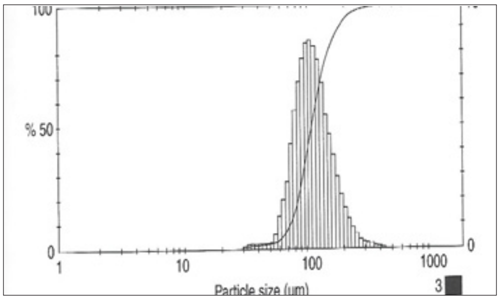

Figure 15: Range of droplet sizes with rotary atomiser that excludes small and large droplets.

Another development for applying ULV sprays was an electrostatic sprayer (Fig. 16) (Coffee, 1979).

Figure 16: A hand-held electrostatic sprayer that was used in Brazil on cotton. It was withdrawn as it needed less active ingredient to provide effective control.

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