*Multi-row sprayers are becoming increasingly prevalent on orchards with modern, narrow canopies*

# OPTIMISE SPRAYING COVERAGE FOR CLEAN FRUIT

*Spray applications are an essential part of sustainably growing high-value, clean fruit. We often rely on very small amounts of selective plant protection products to control pests or diseases.*

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**For some products it almost looks ridiculous putting a couple of tablespoons of product into a 2000L tank, knowing that it will be successfully spread over a few thousand trees, proving effective in preventing crop damage.**

Sustainable integrated pest and disease management utilises the best plant protection products, applied at the right time, at the correct rate and with good coverage of the parts of the tree or vine that need to be protected. Good spray coverage is critical to successful sustainable fruit production, where we want to use as little product as possible while ensuring good control and minimising risk of over-spray, drift losses and residues on harvested fruit.

Research focusing on optimising spraying is being undertaken as part of the Smart and Sustainable programme, funded by NZ Apples and Pears and the Ministry for Primary Industries' Sustainable Food and Fibres Futures fund (now replaced by the Primary Sector Growth Fund). This year's research focused on establishing a baseline understanding of how canopy size and density influence spray deposits.

*Drones allow for very timely spray application due to their speed and are particularly useful when ground conditions don't allow tractors to enter the orchard*

This was done using ground sprayers (axial fan airblast versus tower-type) compared with aerial application (helicopter or drone). To do this we applied a known concentration of yellow food colouring then collected the leaf samples from the inner and outer canopy at different heights. Dye was then extracted from each sample using a known quantity of water. The concentration of extracted dye was measured using a spectrophotometer which told us the amount of spray deposit in each sample. In total, we measured nearly 1500 samples – so we managed to get a reasonably clear picture of spray application efficiency.

**The key findings were:**

### Droplet size matters – especially on larger trees

For the ground-based sprayers we tested fine droplet nozzles (most typically used by growers for seasonal crop protection applications) compared to air-induction nozzles (larger droplets, commonly used to reduce spray drift risk) using the same application volume (500L/Ha) and the same dye concentration. The leaves sprayed using coarse droplets had lower deposits than those sprayed using standard fine droplet nozzles – 10 percent lower on the smaller trimmed canopy and 26 percent lower on the larger 'standard' canopy (4.5 x 2m spacing).

> **"...a higher volume of spray is needed to achieve good coverage on larger trees**

Similarly with aerial application, helicopter applications require very coarse droplets to reduce drift risk. Because drones fly much slower, closer to the canopy and produce much less down-draft they can use finer droplets. Our study found lower deposits of dye applied by helicopter compared to those applied by drone.

Our study confirmed that there is a trade-off when using coarse droplet size – lower drift risk but a slightly lower amount of product ends up in the 'right place'.

### Spray volume matters

In general, a higher volume of spray is needed to achieve good coverage on larger trees (with greater height, width and density). The complicating factor is that smaller, narrow-canopy trees are typically planted on shorter row widths. The traditional method for accounting for these differences was to calculate tree-row volume (TRV) and adjust spray application volume accordingly.



*1 Water sensitive papers turn blue when spray droplets come into contact and are a good tool for evaluating spray coverage, 2 Yellow dye tracer was used to measure how much spray was deposited on leaves or 'artificial leaves' (plant tags), 3 Samples were rinsed in water to extract the dye then measured on a spectrophotometer*

Our experiment found that although there were higher deposits on smaller trees with narrow row spacing, TRV did not completely account for the differences observed. One explanation is that when you have narrower row spacing (in this case 3.2m versus 4.8m) the sprayer must travel a greater distance each hectare (3.1km total on narrow rows versus 2.1km on wide rows). The net result is that the amount of spray delivered to each metre of row as the sprayer drives along needs to be less on narrow rows to achieve the same per hectare rate.

**Good spray coverage is critical to successful sustainable fruit production**

This suggests that the traditional TRV model for spray volume adjustments may not suit modern planar canopies with narrow row-spacings. The original TRV worked well accounting for the decrease in spray volume from around 3000L/Ha on massive 20' x 20' style plantings to the 2000L needed for 'high density' 4.5m x 2m orchards using M9 rootstocks. But that relationship does not seem to directly apply to the narrow systems that are increasingly prevalent.

## Concentrate spraying achieves higher deposits

The application rates for all plant protection products used for tree fruits are expressed as the amount per 100L applied as a dilute application to the point of run-off. The volume of spray required to achieve 'point of run-off' is dependent on the canopy size, density and row spacing (as discussed above). However, most spray applications are applied as 'concentrate' sprays – typically at two to four times lower volume than required for dilute applications, with the rate per 100L increased by the same factor. Our findings showed that on average ten to twenty percent more product applied was deposited on leaves when spraying concentrate compared to dilute spray.

The main reason for higher deposits with concentrate spraying is that when spraying to the point of run-off, some amount of product that hits the target leaves drips off. With concentrate spraying, more of the applied product is retained on the target canopy.

Dilute applications are still useful in some situations. For example, products that need to be absorbed by the plant usually benefit from the additional drying time afforded by dilute applications. In addition, some products need to drip down into hard-to-reach areas, which won't occur when using concentrate water volumes.

## Sprayer type

Axial fan airblast sprayers are the workhorse for spraying tree fruit. Newer tower-type sprayers are increasing in prevalence and are well-suited to narrower, uniform canopies, with some designs adapted to spray multiple rows at the same time. We confirmed that tower sprayers deposit a greater proportion of spray with better uniformity of coverage but can struggle to reach the top of very tall trees without careful adjustment. The tower sprayers bring the air and spray output closer to the canopy, so less of the spray is lost to the ground or punched through the 'target zone' and into the next row. Tower type sprayers can cost almost twice as much as traditional airblast sprayers, so there needs to be a clear benefit for your orchard to justify the investment.

## Conclusions

Optimising your spray deposition is essential for sustainable and profitable fruit growing. Due to the diversity of tree forms, sprayer types, weather conditions and sprayer set-up options, no single prescription can be made. Our research is focused on quantifying the influence of these factors so that we can better utilise the wealth of data and computing power available to growers. However, the best sensor will remain the keen eye of an experienced grower, and the best decision will always be that made by a person with dedication to growing excellent, high value, clean fruit.