VEGEnotes
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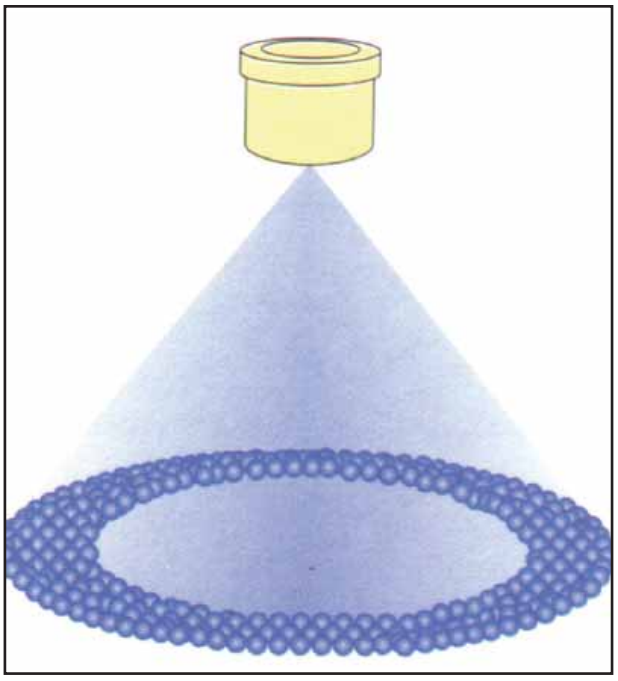
Spray Application

Chemicals are used in the vegetable industry to control pests, diseases and weeds. The majority of agricultural chemicals are applied in the form of droplets produced from different types of nozzles mounted on spray booms.

To maximise spray efficiency, droplets must be uniformly distributed on the target surface with minimum loss (usually caused by drift, evaporation and run-off). Poor spray application techniques waste chemicals, reduce control of pests and result in loss of yield and quality. This ultimately leads to lower returns for the grower.

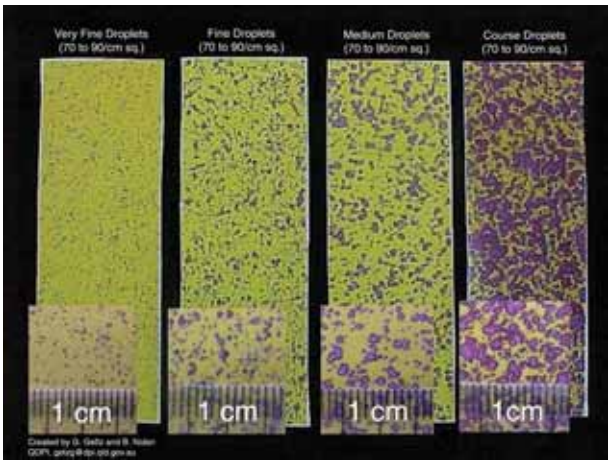


Hollow cone nozzles are still one of the most recommended types of nozzle for insecticide and fungicide use.

Droplet size

Droplets are very small and usually measured in microns (µm), with one micron equalling 0.001mm. When operating at any given pressure, hydraulic nozzles produce a range of droplet sizes.

The British Crop Protection Council (BCPC) has classified droplets into six different sizes (see Table 1). This classification is a useful guide for assessing the suitability of a nozzle for a particular spray job.



Water sensitive cards showing the difference between droplet sizes at the same density.

Spray volume versus droplet size

There is an important relationship between droplet size, volume and the number of droplets that can be produced from a fixed volume of spray application. As the size of droplets reduces, the number produced from the same volume of spray increases.

The bottom line

To achieve the best possible spray coverage you need to consider the following:

- Accurate pest and disease identification
- Suitable droplet size and water volume
- Application under the appropriate environmental conditions
- Using clean water of the correct pH
- Correctly calibrated and maintained spraying equipment

Table 1: BCPC classification of droplet size and their application

BCPC Category	Droplet size	Description	Uses
Very fine	< 150µm	Mist or fog	Insecticides and fungicides
Fine	150-250µm	Fine spray	Insecticides and contact herbicides
Medium	250-350µm	Medium spray	Residual herbicides
Coarse	350-450µm	Very fine rain	Residual herbicides and foliar fertilisers
Very coarse	450-550µm	Fine rain	Foliar fertilisers
Extremely coarse	> 550µm	Heavy rain	Foliar fertilisers

Note: Droplets smaller than 80µm cannot be readily seen by the naked eye.

For example, one 400µm droplet is equal, in volume, to 64 droplets each of 100µm. A far better spray coverage is achieved on a leaf surface with 64 droplets of 100µm than with one droplet of 400µm (see below).

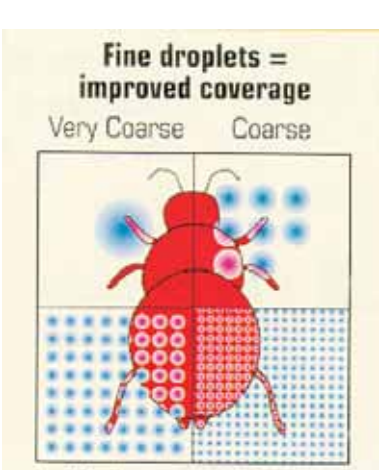


Photo courtesy of Hardi Australia.

Droplet density

To achieve good results, droplets not only need to be uniformly distributed over the target area, the density also needs to be sufficient. Different types of chemicals require a different droplet density. Systemic type chemicals require a droplet density as low as 20-30 droplets/cm^2. When targeting mobile insects or using contact fungicides, a higher density of 70-100 droplets/cm^2 is recommended. Table 3 gives a guide to the droplet densities required to ensure adequate levels of control.

Table 2: Number of droplets produced from 1ml of spray

Droplet size	Number of droplets produced
100µm	1909559
200µm	238732
400µm	29841
800µm	3730

Water Rate

Water rate as well as droplet size, help determine droplet density. A low water rate can lead to insufficient droplet density and poor coverage. If the water rate is too high, plants will be left dripping with excess pesticide, which can lead to environmental pollution. Good spray application aims to use a water rate that gives a uniform droplet distribution at the desired density. You may need to use more nozzles to maintain water rates with smaller droplets.

Table 3: The approximate droplet density required for adequate chemical control

Product	droplets/cm^2
Insecticides	
Mobile insects	60-100
Systemic	20-30
Contact	50-70
Herbicides	
Pre-emergent	20-30
Post-emergent	30-40
Fungicides	
Systemic	20-30
Contact	50-70
Foliar nutrients	20-30

The importance of droplet size

Knowing the importance of droplet size, droplet density and water volume will help spray operators get the best possible results. When targeting the plant, spray droplets should be distributed uniformly over the entire plant, which includes the underside of the leaves as well as the top of the plant. To achieve this, droplets need to be small enough that they swirl around as they are depositing onto the plant surface.

Large droplets

Large droplets, being heavier, tend to fall straight down and are not usually deflected by air movement. Therefore, their redistribution within the crop foliage is limited. Large droplets are also fewer in number and are more difficult to retain on the leaf surface as they tend to bounce or roll off, cascading down the foliage and onto the ground.

Smaller droplets

Droplet size is often reduced to improve spray coverage. However, droplets that are too small are more likely to drift or evaporate before reaching their target.

Small water based droplets evaporate rapidly in hot conditions. A 50µm droplet will evaporate over 250 times quicker than a 200µm droplet. On a hot day, a 50µm droplet may only travel between 0.1 and 1m before it evaporates.

Efficient spray application aims to achieve good target coverage, while reducing spray drift and any negative impacts it might have on the environment, public health and property.

Selection of nozzle type

Different operating pressures will change the droplet size and water rate of hydraulic nozzles. Therefore, when selecting a nozzle type you need to refer to the manufacturers catalogues. The catalogues give recommendations on appropriate nozzle types and a guide to the water rate and droplet size produced at various pressure settings.

Droppers on a conventional boom help direct the spray into the canopy from multiple angles.

Selection of sprayer type

Hydraulic spray boom

Conventional spray booms with hydraulic nozzles are the most common method of applying chemicals. The best results are achieved when spraying in a light breeze of about 7 km/h. This benefits application by creating turbulence to assist in carrying the droplets into the crop canopy.

A curtain of air directs the spray into the canopy to improve penetration and coverage.

The addition of droppers can improve spray penetration and coverage from this type of boom sprayer. These droppers are short lengths of semi-rigid plastic tubes attached to the boom, with modified nozzles positioned between plants at the lower end to direct spray from a lower angle.

Air assisted boom

In its most common form, this sprayer is a conventional hydraulic spray boom with the addition of a high volume output fan mounted centrally above the boom with an air duct extending the full length of both arms.

The slotted outlet of the air duct produces a curtain of air adjacent to the spray nozzles. This air curtain directs the spray down into the crop canopy, agitating the plants and improving spray coverage on both sides of the leaves. Air assisted booms also have the potential to reduce spray drift and allow the operator to spray in conditions unsuitable for conventional booms.

CDA sprayers

Controlled Droplet Application (CDA) is a method of spray application where 80% of all droplets produced are within a very narrow size range, usually about 100 to 150µm.

A rotating cage, inverted cone or a flat serrated disc produces droplets by means of centrifugal force when liquid is introduced at the centre of the rotating element. Most, but not all, CDA sprayers incorporate air assistance as part of their design. The air stream directs spray down into the plant canopy causing turbulence that assists in achieving better, overall coverage.

Focused research

Horticulture Australia has helped fund a number of projects, which have included improving spray application as a component of the project. The following recommendations have been generated from the results of two of these projects:

Sweet corn

When controlling heliothis with insecticides, at the reproductive stage of sweet corn, it is critical to target the silks. Trials have shown that a boom fitted with short droppers will give the best results. Droppers are fitted with flat fan nozzles that produce a droplet size of 150 to 200µm (BCPC 'Fine' category). A minimum water rate of 300 L/ha is recommended with a ground speed no faster than 10 km/hr.

When operating without droppers you can expect a reduced spray coverage, with up to 65% less chemical reaching the silks. The best nozzle types to use for a standard boom are hollow cones at 250mm spacing with 300 L/ha with a slightly faster ground speed if possible.

A well-optimised, air assisted boom can also give good results. When using these booms in sweet corn, it is best to have a high clearance boom, which is able to clear the top of the plants by at least 300mm. The nozzle setup should be the same as for a standard boom.

Lettuce

When controlling insect pests and disease in lettuce, it is critical to get good spray coverage on both the top and underneath side of leaves. To achieve adequate spray coverage on the underside of the lower leaves, trials have shown a boom fitted with short droppers can increase the spray coverage by threefold. An air assisted boom can also improve spray coverage to the underside of leaves, but care must be taken as the high air velocities can damage plant tissue.

Hollow cone nozzles are still the most recommended hydraulic nozzle for insecticides and fungicides as they can produce more droplets in the fine to very fine category of the BCPC classification table. A minimum water rate of 400 L/ha is recommended when trying to achieve 50-70 droplets/cm^2 for non-systemic chemicals.

Further Reading

David White and Rod Eamens, 2000, *SMARTtrain Reference Manuals*, NSW Agriculture

Dr Sandra McDougall et al, 2002, *Integrated Pest Management in Lettuce*, NSW Agriculture

Peter Deuter et al, 1999, *Integrated Pest Management in Sweet Corn Milestone 4*: *Pesticide Application Techniques*, QLD Department of Primary Industries

Roger Broadley et al, 2000, *Pesticide Application Manual 3rd edition*, QLD Department of Primary Industries and Fisheries

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