

NSW Cut Flower Industry

Chemical application essentials

Purpose

Chemicals play an important role in managing insect pests, diseases and weeds in flowers. When applying chemicals, aim to maximise the amount reaching the target and minimise the amount reaching off-target areas. This fact sheet provides guidance on the essentials of applying chemicals and covers conditions, coverage, compatibility, as well as equipment calibration. Spray application is important to get right to ensure effective pest control, minimise the risk of resistance, ensure farm worker safety, as well as save money.

Spray conditions

Optimising spray conditions is crucial for achieving effective chemical application. The right conditions ensure that the pesticide reaches the target area efficiently while reducing the risk of drift, evaporation, and ineffective coverage. Understanding temperature, humidity, and wind speed helps in selecting the appropriate nozzle and droplet size to maximise efficacy and minimise wastage.

Temperature and humidity (Delta T)

The Delta T chart (Figure 1) is used to determine the optimal conditions for spraying a crop with certain product types based on temperature and humidity. Delta T is a guide for the best nozzles to use to achieve the required spray droplet size and achieve optimal spray coverage in the given conditions and for the selected product.

Delta T values indicate evaporative potential i.e. the higher the temperature and the lower the relative humidity, the greater the evaporation will be. Small droplets will dry up really quickly. When the temperature is low and the humidity high, droplets will dry slowly.

High delta T values, exceeding 8 to 10, indicate fast evaporation of the droplet. Low delta T values (e.g., below 2) indicate low risk of evaporation and spray drift. Using coarse droplets will provide efficiency and reduce the airborne fraction.

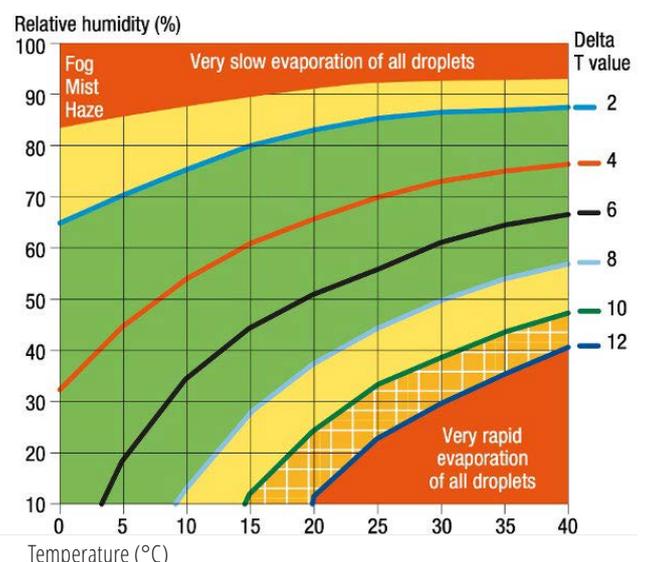
Wind speed

- Spray in wind speeds below 15-20 km/h. High wind speeds increase drift risk, while consistent speeds of 4-5 km/h are safer for daytime applications
- For night-time spraying, wind speeds should exceed 11 km/h to reduce the effects of temperature inversions

Figure 1 (right). Delta T chart for predicting droplet size relative to temperature and humidity
(Source: Grains Research and Development Corporation)

→ Key Tips & Tools

- **SPRAY CONDITIONS:**
 - Check the temperature and relative humidity using the Delta T chart.
 - Ensure wind speed is below 15-20 km/hr, referring to chemical label instructions.
- **SPRAY COVERAGE:**
 - Calibrate spray droplet size using a spray card as a guide to measure the percentage of surface area covered.
 - Select your nozzle type and size in accordance with the type of pesticide you are spraying.
- **SPRAY COMPATIBILITY:**
 - Do a jar test to ensure the spray mix is homogenous.
 - Test the water quality to improve spray application and efficacy of the pesticide product.
- **EQUIPMENT CALIBRATION:**
 - Check the label for the application rate.
 - Ensure all application parameters including: speed, swath width and nozzle type/size are set accordingly to achieve the required output volume.



Spray coverage

Quantifying and interpreting spray coverage is important to provide better pest control, reduce the risk of pesticide resistance and optimise spray costs. To maximise spray efficacy, spray droplets must be uniformly distributed on a target surface with minimum losses due to drift, evaporation or run-off. Knowing the importance of the following will help spray operators get the best possible results:

- Droplet size
- Droplet density
- Water rate.

Figure 2 below provides a visual of spray coverage using spray cards as a percentage area to help guide spray droplet calibration, with 1 being the least coverage and 6 being the most. Ideal coverage ranges from 50% to 80% (between 4 and 5), depending on the product’s requirements. 100% coverage (No. 6) indicates the product is likely at the point of run off however this level of coverage is necessary for some insects.

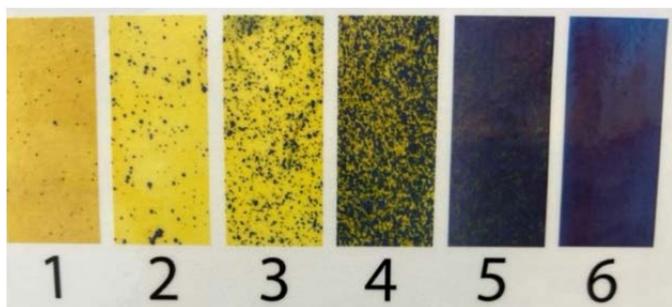


Figure 2. Spray cards showing difference in spray coverage

Spray nozzle selection and size

The below guide (Figure 3) can be used to select spray nozzles based on droplet size.

TeeJet®	BAR										
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
TT11001-VP	C	C	M	M	M	M	F	F	F	F	F
TT110015-VP	VC	C	M	M	M	M	F	F	F	F	F
TT11002-VP	VC	C	C	M	M	M	M	M	F	F	F
TT110025-VP	VC	C	C	M	M	M	M	F	F	F	F
TT11003-VP	VC	VC	C	C	M	M	M	M	M	M	M
TT11004-VP	XC	VC	C	C	C	M	M	M	M	M	M

Figure 3. Teejet Spray guide which shows pressure (bar) along the x axis and nozzle size on the y axis with coverage ratings XC (extra coarse), VC (very coarse), C (coarse), M (medium) and F (Fair)



Photo: AdobeStock/Dusan Kostic

Tools like the **SNAPCARD SPRAY APP** can help predict spray coverage based on conditions and equipment settings.

Droplet size

The below table gives an overview of droplet sizes and percentage spray output recommended for different product types. The percentage spray output indicates the type of coverage required for each agricultural chemical and fertiliser application. This is important particularly with agricultural pesticide products to ensure that even coverage of the active constituent is achieved to protect the crop for pest disease and for herbicides to be absorbed into the plant tissues to improve efficacy of the product. The chemical label will often tell you the chemical application volume and spray droplet size (eg. 50 L/ha at 14-20 km/h using a coarse spray droplet).

RATING	DROPLET SIZE	% OF SPRAY OUTPUT	APPLICATION
Fine	150-250 µm	40 - 50%	Crop protection products
Medium	250-350 µm	< 20%	Herbicides
Coarse	350-450 µm	< 10%	Herbicides/foliar fertilisers
Very coarse	450-550 µm	< 5%	Foliar fertilisers

Table 1. Droplet sizes and percentage spray output recommended for different product types

Common types of nozzles used to apply agricultural chemicals are described in Figure 4 below.

Figure 4. Common types of nozzles used to apply chemicals

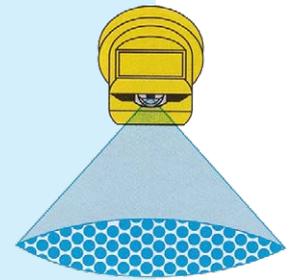
Hollow cone nozzles

A popular nozzle for applying insecticides and fungicides. They generally produce a smaller droplet size than most other nozzle types. The characteristic hollow cone shaped spray output is produced when the liquid is forced through slots in the swirl plate (within the nozzle body) then emitted through a narrow orifice



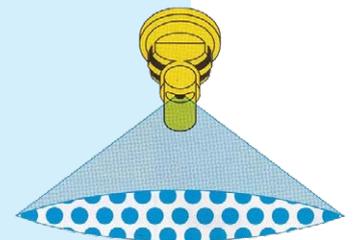
Flat fan nozzles and double flat fan nozzles

Flat fan nozzles are the most common type of nozzle and can be suitable for many different purposes. These nozzles have a rectangular or lens shaped orifice which produce a tapered distribution of droplets across the nozzle swath. Uniform coverage is achieved by overlapping each nozzle 30% with the nozzle each side of it. There are many sizes of flat fan nozzles that can operate under various pressures with a wide range of droplet sizes. Double flat fan nozzles produce two spray swaths from the one nozzle body. These nozzles offer the advantage of the spray being directed from two different angles to improve coverage. These nozzles are suitable for applying insecticides and fungicides if the correct size and pressures are used.



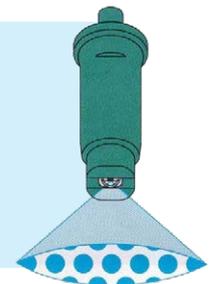
Turbo and double turbo fan nozzles

Turbo types are also a common type of nozzle and suitable for broadcast spraying. These nozzles have a tapered edge to give a wide angle flat spray pattern. Uniform coverage is also achieved by overlapping each nozzle 30% with the nozzle each side of it. There are also many sizes of these nozzles that can be operated under various pressures to produce a wide range of droplet sizes. The double fan nozzles also produce two spray swaths from the one nozzle so the spray can be directed into the target from two different angles. These nozzles produce a larger droplet size than most other nozzle types when operated at the same pressure.



Air induction nozzles

Air induction nozzles produce large air filled droplets. The air inclusion is usually by venturi action and produce large bubbly droplets. These droplets tend to shatter on impact, further distributing the smaller droplets into the canopy. The main advantage of these nozzles is to reduce drift and allow the operator to spray in windier conditions.



Droplet density

Droplets not only need to be uniformly distributed over the target area but the density also needs to be sufficient to achieve good results. Different types of chemicals require a different level of droplet density. Systemic type chemicals require a droplet density as low as 20-30 droplets/cm². When targeting mobile insects or using contact fungicides, a higher density of 70-100 droplets/cm² is recommended. The droplet density required will vary with the type of chemical being used. Table 2 (to the right) gives a guide to the droplet densities required to ensure adequate levels of control.

PRODUCT TYPE	DESIRED 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

Table 2 (right). Desired droplet size by pesticide product type

Water quality

The quality of water used when spraying agricultural chemicals can significantly impact chemical efficacy. It is always advisable to use clean rainwater where possible. This is not always possible and usually water has to be sourced from other places including bores, dams, channels and rivers. The quality of water available from these other sources can be variable and may cause significant application problems. When spraying:

- Use clean, neutral pH water
- Avoid water with high salt content or hardness, which can affect chemical efficacy
- Test for pH and electrical conductivity (EC).

Spray compatibility

To achieve effective spray coverage the product used, be it an adjuvant, fertiliser, biological or chemical product, must be properly mixed in water. Incompatible mixtures can lead to poor performance, such as separation, sedimentation, or excessive foaming, which compromises efficacy and may damage plants. Conducting compatibility tests before application helps avoid these issues and ensures that the pesticide works as intended.

Equipment calibration

Chemicals need to be applied at the correct rate in the appropriate amount of water. To achieve this, all spraying equipment needs to be calibrated.

Spray tank calibration

1. **Set the water application rate:** Determine the required water application rate in litres per hectare (L/ha).
2. **Determine swath width:** Measure the swath width in metres.
3. **Calculate driving speed:** Use the formula (distance driven (m) × 3.6) / time taken (sec) to find the speed in km/hr.
4. **Select nozzle type and size:** Choose the nozzle that provides the required water output.
5. **Select operating pressure:** Refer to the manufacturer's nozzle chart to select the appropriate pressure.
6. **Calculate total water output:** Determine the total water output from all nozzles in litres per minute (L/min).
7. **Calculate actual water application rate:** Use the formula $(600 \times \text{total flow from all nozzles}) / (\text{swath width} \times \text{tractor speed})$ to calculate L/ha.
8. **Compare actual vs. required water rate:** Adjust tractor speed, pressure, or nozzle size if necessary to match the actual rate with the required rate. To reduce the water rate you can increase tractor ground speed, reduce pressure or select smaller nozzles. Remember, changing pressure affects droplet size.
9. **Calculate spray tank chemical mix:** Calculate how much chemical to put in the spray tank. Recommended label rate (L or kg) × amount of water in spray tank (L) = 'Actual water application rate (L/ha)'.

Jar Test

Perform a jar test to check for physical compatibility of mixed products. Follow these steps:

1. Add 70% water to a clean jar.
2. Add the pesticide and shake.
3. Add any adjuvants and fill the jar to 100%.
4. Invert the jar 10 times and observe for separation or sediment.

If the mixture separates but can be remixed the mixture should be able to be sprayed with good agitation. If there is sediment, separation, sludging or excessive foaming in the solution the mixtures are incompatible and should be sprayed separately.



Figure 5 (above). Jar test showing separation on the left and a successful mixing with water on the right (<https://www.country-guide.ca/crops/pest-patrol-the-importance-of-doing-a-jar-test-with-your-herbicides/>)



Knapsack/backpack calibration¹

- Determine application rate:**
 - Record the desired water application rate and chemical rate from the product label.
 - Note the nozzle type, size, and operating pressure (if required).
 - Record the equipment's tank size and hand-held height above the target.
- Measure and test:**
 - Measure a 10 m × 1 m area (10 m²).
 - Time how long it takes to spray this area at the required pressure. Walk at a medium to slow pace and try to do it on a dark surface (eg. dirt or tarmac) to see the coverage.
 - Spray into a measuring jug for the same time to determine the output in litres.
 - Multiply this output by 10 to get the water application rate per 100 m² or by 1,000 to get the rate per hectare (L/ha).
- Check compliance:**
 - Compare the calculated water application rate with the label requirements.
 - If the rate doesn't comply, adjust factors like walking speed, nozzle type, or pressure to match the label's recommendations.



Figure 6. Knapsack sprayer and calibration equipment (<https://www.aces.edu/blog/topics/forestry-wildlife/the-1-128-calibration-method-for-backpack-sprayers/>)

Spray application differences

Depending on the aim of the chemical control, tailoring the approach to each setting ensures optimal pesticide performance and minimizes potential negative impacts.

Knapsack sprayers

- Ideal for small-scale, targeted applications
- Requires careful manual calibration and monitoring
- Focus on minimising drift within enclosed spaces/protected cropping applications



Boom sprayers

- Suitable for large areas with adjustable settings for nozzle types and droplet sizes
- Calibration for larger volumes and swath width is critical
- Manage drift and runoff with attention to environmental conditions



¹ <https://www.dpi.nsw.gov.au/biosecurity/weeds/weed-control/herbicides/spray-equipment-calibration-methods>

This fact sheet has been developed by RMCG as part of a Storm and Flood Industry Recovery project to reduce chemical use in the NSW cut flower industry.



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Australian Government

