Department of Primary Industries

primefact

Avoiding spray drift from air-blast sprayers in vine and tree crops

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Introduction

An effective spray application will deliver the right amount of product to the desired target. However, if any part of the spray equipment is not set up or calibrated appropriately, the target could be missed, or spray might drift to non-target areas. This Primefact will briefly describe the main points you should consider before going out to spray your tree and vine crops.

Type of sprayers used

Axial air-blast sprayers

The axial air-blast sprayer (Figure 1) is more prone to missing the target than multi-head and tower sprayers, but by carefully following the instructions included herein, many of the off-target risks can be reduced.

As trees grow it can become harder to achieve adequate spray coverage with crop protectants. Spray equipment available today is generally inefficient above 8 m.

Figure 1. An axial air-blast sprayer.
Photo: Melinda Simpson.

Multi-head or wrap-around sprayers

Multi-head or wrap-around sprayers (Figure 2) are effective at covering a lot of ground quickly. When they are set up well, these sprayers provide good coverage with limited drift.

Figure 2. A multi-head sprayer.
Photo: Marcel Guidolin, Guidolin Agrimac.

Recycling sprayers

Recycling sprayers (Figure 3) are multi-head or wrap-around sprayers with an added recycling system. Recycling sprayers can be very effective, provided they are properly set up and the canopy is not too dense. For more dense canopies, low-profile radial sprayers might be more effective, or if using the Cropliner shown in Figure 3, removing the recycling system.

The air and spray output from recycle sprayers must be effectively off-set to maximise the potential for the spray to penetrate the canopy and for any spray droplets that pass through the canopy to make it to the recycling screens.

While recycling sprayers can be effective, they can also redistribute fungal diseases if the tank mix does not control particular spores.

Figure 3. A recycling sprayer.
Photo: Dave Farmer, Croplands.

Tower sprayers

Tower sprayers (Figure 4) tend to provide more uniform coverage as the spray goes up the canopy. The tower moves the air and nozzles closer to the target compared to conventional air-blast sprayers. This increases the likelihood of depositing spray on the canopy.

Figure 4. TPD assist tower sprayer.
Photo: Paul Blasutto, Tornado Sprayers.

Many growers report savings when switching from conventional air-blast to tower sprayers because the towers are more efficient at depositing the spray, therefore sprayer volumes need to be reduced to prevent run-off (Deveau 2015).

Coverage using tower sprayers will be affected by sloped plantings or uneven inter-rows as the boom can sway and roll. This results in missing the tops with a roll then over spraying on the reverse roll. This effect is made worse with increasing tower height.

Tower sprayers can also suffer from pressure drop restrictions at the top of the boom. They need to be set up to slightly overshoot the canopy and this setting will depend on the unevenness of the ground.

Most spray suppliers can supply aftermarket kits to convert conventional axial air-blast sprayers to tower sprayers.

Targeting tower sprayers

Targeting tower sprayers (Figure 5) offer all the benefits and problems of straight towers on uneven ground but have the added benefit of greater flexibility in nozzle positioning. Targeting towers can be used to direct the spray at a canopy that is much higher than the top of the tower.

Figure 5. An Air SERGII Tower sprayer.
Photo: Paul Blasutto, Tornado Sprayers.

As much as 60% of the applied spray can end up either on the ground or drifting away if spray equipment is not set up properly, resulting in significant waste and cost.

Nozzle selection

While broadacre booms have the same nozzles right across the boom, air-blast operators distribute their output unevenly over the boom to optimise spray coverage, usually with coarser spray droplets in the upper nozzles that are aiming higher in the canopy.

Coarser droplets are preferable when spraying near sensitive areas (always follow the label recommendations). Combining coarse spray quality and appropriate surfactant will significantly reduce the risk of off-target drift. Some product labels state the size of the spray droplets required and/or nominated no-spray zones; both must be followed.

Over time, all nozzles suffer from wear and tear, causing their orifices to get bigger, increasing the desired or calibrated output. When nozzles are producing up to 10% difference in the desired output, they should be replaced. Uneven wear can cause poor spray patterns and poor control; both potentially causing crop damage. Regularly cleaning nozzles will improve delivery rates by removing debris (Figure 6).

Rules of thumb with nozzles:

- Hollow cone nozzles produce smaller droplets and less size range than solid cone nozzles
- Wide-angle nozzles produce smaller droplets than narrow-angle nozzles
- Lower output nozzles produce smaller droplets than higher output nozzles of the same type, model and angle.

Figure 6. Nozzles should be cleaned regularly. Photo: Melinda Simpson.

Direct the sprayer output towards the target canopy

The main risk when spraying is failing to hit the target. To assess your spray output, park the sprayer in a block to be treated. Look at which nozzles should be turned on and what proportion of the output is directed to the different plant zones (Figure 7). Using water-sensitive paper or fluorescent tracer dyes and ultraviolet lights will help you assess the coverage (see page 7).

An observer should monitor leaf movement to ensure sprayer-generated air is displacing the air within the canopy. If you want to know if the spray will penetrate a canopy, you should be able to see the trunk. You should also be able to see sunlight through the shadow at midday. If the inter-row is too narrow, pruning is needed.

Make sure you turn off the sprayer at the ends of the rows when turning. When spraying outside rows of a block, use single-sided spraying i.e. turn off nozzles not directed at the crop row.

Figure 7. Assessing the sprayer output is towards the canopy. Photo: Melinda Simpson.

Manage travel speed

Travel speed is a compromise between completing the job in good time and achieving thorough coverage.

Research has shown that by increasing travel speeds from 2.1 km/h to 7.7 km/h while keeping all other settings the same, the deposition rate of chemical halves in axial air-blast sprayers (Celen et al. 2008). Sprayer speeds can have a significant effect on spray distribution, i.e. increasing sprayer speed can increase drift.

Sprayer speed and the effect on spray drift is a very complex subject, therefore many factors need to be taken into consideration including weather conditions, droplet size, type of sprayer, air speed, tree canopy density and height.

Use deflectors

Radial fans on conventional air-blast sprayers without deflectors make the air go up on one side and down on the other (Figure 8).

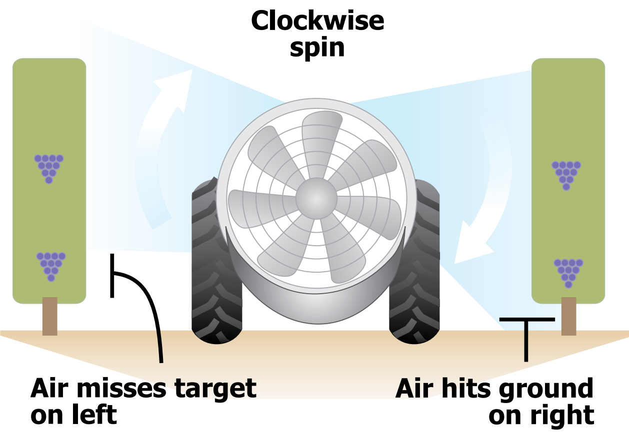

Figure 8. Radial fans without deflectors can cause poor air distribution. Photo: Jason Deveau, Sprayers 101.

When using axial air-blast sprayers, deflectors (Figure 9) can be used to channel air into the target rather than over or under the target. Deflectors help to compress the air from sprayers into a tighter stream, making it easier to reach and penetrate the canopy.

Figure 9. Deflectors on an air-blast sprayer. Photo: Jason Deveau, Sprayers 101.

To check where the air is going from your sprayer, attach 25 cm lengths of strong ribbon to each active nozzle position. This will show where the air and spray are being aimed (Figure 10). Adjust the nozzles and deflectors so that the air stream is directed into the canopy. Note, most manufacturers can supply aftermarket deflectors.

Figure 10. Using ribbons to work out where the air is being directed from the sprayer. Photo: Jason Deveau, Sprayers 101.

Consider fan speed

A well-maintained axial air-blast sprayer can operate for 25 years. Older axial sprayers were designed for much larger trees than are commonly kept today, so they are overpowered relative to their targets. However, by altering the driving speed, fan speed and deflector settings to restrain their air energy, we can reduce off-target spray and improve spray coverage.

Throughout the season it is important to adjust fan settings to produce the most effective air speed. This is important because the air carries the chemical and if the air speed is too fast or too slow, the chemical will end up in the next row, on the ground or drifting away.

To estimate the required air speed, tie 25 cm lengths of ribbon to the top, middle and lower parts of the plant on the opposite side of the vine or tree. Drive past the canopy and note where the ribbons are being directed; this will tell you if you have the correct air speed for spraying (Figure 11).

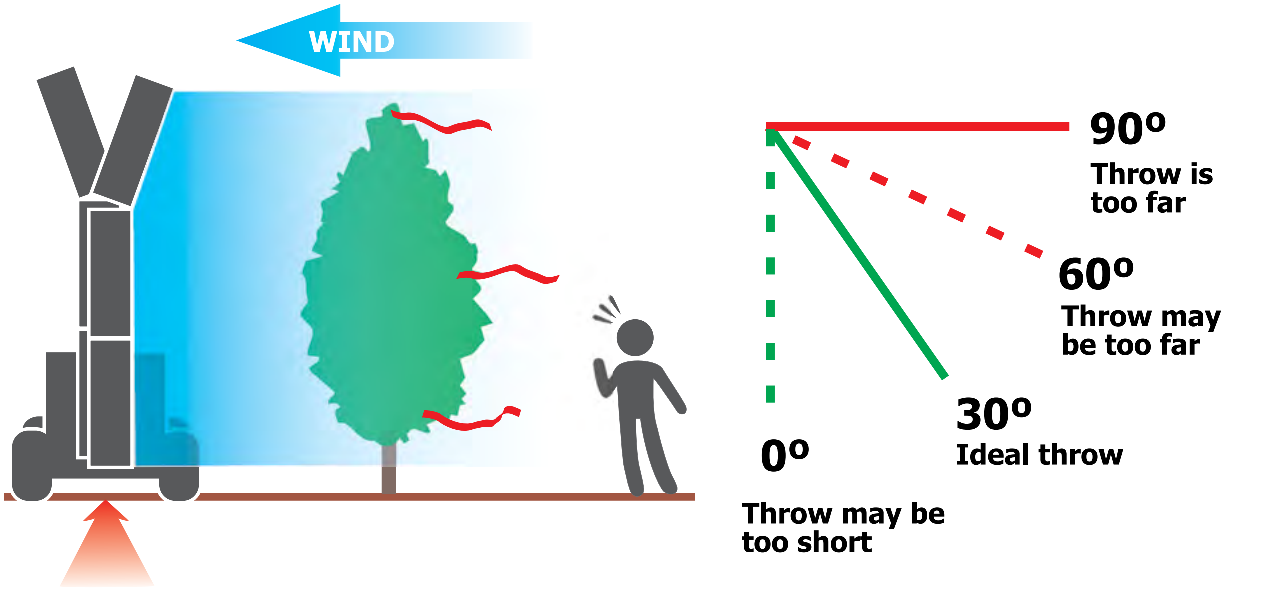

Figure 11. Using ribbons to determine adequate air speed for spraying. Source: Jason Deveau, Sprayers 101.

How to reduce air speed

Many sprayers have gearboxes that allow you to change your fan speed. Consider using gear up throttle down (GUTD) to do this. If you go to a higher gear and reduce your throttle speed to around 1,500 rpm, you will slow your fan speed. It will also give you the added benefit of reducing fuel use by approximately 40%. Note, GUTD will only work if you have piston, diaphragm or roller pumps; it will not work with centrifugal pumps.

How to increase air speed/volume

- change fan gear
- reduce speed but remember the sprayer volume will need to be recalibrated.

Remember, if the canopy is too dense, it might need thinning.

Natural and artificial barriers for spray drift mitigation

An artificial or natural barrier can intercept some airborne droplets and deflect the airflow to reduce spray drift potential by 60–90%. Wind slows and distorts as it travels through porous barriers such as a windbreak.

Windbreaks protect for approximately 10 times their height (Ferber 1974). If the windbreak is 20 m high, the area 200 m beyond it will receive reduced pesticide. The windbreak should have 50% porosity (i.e. you can see through it) as solid windbreaks that allow little or no wind through cause turbulence on the side it is meant to protect.

Artificial barriers

Artificial barriers can be made of a variety of materials including shade cloth with 50% porosity (Figure 12). Advantages of artificial barriers include:

- little or no waiting time is required for them to establish
- they take up very little space
- they do not have any competition for moisture or nutrients (but may shade adjacent crops)
- they work immediately after erection
- they can be part of a fully-netted protection program.

Disadvantages of artificial barriers include:

- they can be relatively costly to establish, especially if very tall or fully enclosed
- they are generally not as high as natural windbreaks, so the protection distance is less.

Vegetative buffers

Vegetation barriers may be planted and maintained on downwind edges of fields and properties adjacent to susceptible areas. Trees and shrubs planted to form buffer zones should be a narrow leaf type, e.g. *Casuarina* (Figure 13) as these are much more effective at capturing droplets than large-leaved species.

Figure 12. An artificial barrier made of shade cloth with 50% porosity. Photo: Andrew Hewitt.

Figure 13. *Casuarina* as a vegetative buffer. These are evergreen and have fine greyish needle-like foliage down to ground level. *Casuarina* requires hedging to be effective. Photo: Sandra Hardy.

Weather conditions affecting spraying

Wind

Avoid spraying when the wind is blowing towards a non-target sensitive area or during calm or still conditions as this is when droplets are more likely to remain suspended in the air.

The ideal safe wind speed is 7–10 km/h. Leaves and twigs are in constant motion (a light breeze). Wind speeds of 11–14 km/h (moderate breeze) are suitable for spraying if you are using low drift nozzles or higher volume application (80–120 L/ha per nozzle).

Avoid spraying when wind speed is too low (< 4–5 km/h) or too high (> 15 km/h) and wind direction is towards sensitive areas. Also avoid spraying when wind speed is < 10 km/h when the wind direction is towards the coast and the sun is less than 20 degrees above the horizon.

Be aware that drainage winds and morning land breezes do not mix the air the way that synoptic winds do (BOM predicted direction). Drainage winds and land breezes can transport droplets far from the application site.

High temperatures

Avoid spraying when temperatures exceed 28 °C.

Humidity

Avoid spraying when relative humidity is low, i.e. when Delta T (the difference between wet and dry thermometers; Figure 14) exceeds 10 °C. Spraying when Delta T is between 8 and 10 °C is marginal. High humidity extends droplet life and can greatly increase the drift hazard from fine droplets under local surface temperature. This results from an increased life of droplets smaller than 100 microns.

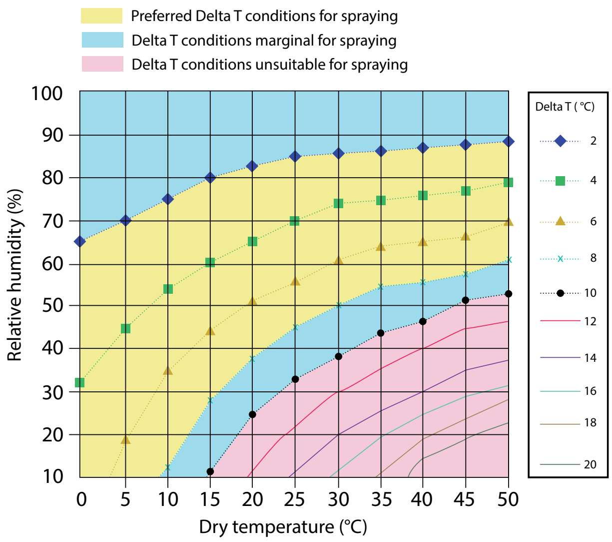

Figure 14. Delta T chart indicating appropriate conditions for spraying.

Methods to assess coverage

Water-sensitive paper

Water-sensitive paper (Figure 15) is an effective and economical way to monitor spray distribution. To test your coverage, place six pieces of water-sensitive paper per plant, locating them on the top, middle, bottom and on underside and top of the leaf surface, for multiple plants along a row. Generally, 85 fine to medium-sized droplets per square centimetre, with about 15% total surface coverage, should be adequate for most foliar applications. Be prepared to make changes to your sprayer set up and calibration to compensate for plant height, canopy density and weather conditions throughout the season.

Using water-sensitive paper takes some time and effort but is far more accurate than looking over your shoulder for leaf residue. Take photos of the set up you use for future reference to see if changes have improved deposition and coverage.

Folding the water sensitive paper in half before placing in the canopy can provide an opportunity to look at upper and lower leaf coverage. With your smartphone, you can use the SnapCard App to quantify spray coverage from a water-sensitive spray card.

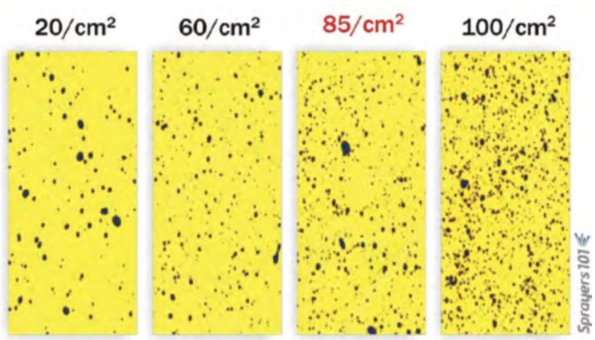

Figure 15. 85 droplets per square centimetre provides the appropriate coverage.
Photo: Jason Deveau, Sprayers 101.

Clay markers

Spraying with clay markers such as kaolin clay shows coverage over the entire canopy as well as in detail. Clay markers are also effective at picking up uneven banding or shading in the canopy as well as excessive run-off (Figure 16).

The clay droplets need to dry to become visible and it is advisable to wait 20 minutes after applying them before assessing the coverage.

If using clay markers, make sure you clean your tank and nozzles afterwards as the clay can clog up nozzles and could deactivate some products if not completely removed from the tank.

UV dyes

There are commercially available, water-soluble, non-toxic fluorescent dyes that can be used to assess where sprays are deposited. The dyes highlight where individual droplets have landed within the crop or inter-row. To be able to see the individual droplets requires a black light ultraviolet (UV-A) torch or hand-held UV-A lamp that causes the individual droplets to glow in the dark (Figure 17).

Figure 16. Using clay markers to demonstrate coverage. Photo: Jeremy Bright.

Figure 17. Using fluorescent dyes to demonstrate coverage. Photo: Jeremy Bright.

Summary

Ensuring your spraying equipment is set up correctly will help reduce the risk of spray drift. Always adjust the spray water volume to match the canopy size and select the right nozzle for the job. Use ribbons to assess sprayer output and adjust the nozzles until the output is directed towards the target area.

If necessary, use a deflector (if using an axial air-blast sprayer) to channel the air into the target rather than over or under the target.

Make sure you travel at the most appropriate speed to get the desired coverage. Fan speed must also be adjusted to produce the most effective air speed so that the chemical is carried to the target. Using the 'ribbon method' is an easy way to assess this. Remember though, any changes made to the travel or fan speed might require recalibration of the sprayer volume.

Physical barriers can be used to help prevent spray drift and these can be either natural (e.g. a tree line) or artificial (e.g. shade cloth).

Only apply sprays in suitable weather conditions such as when the wind is between 7–10 km/h and away from sensitive areas, the temperature is below 28 °C and Delta T is within the preferred range. Finally, you should assess the coverage using either water-sensitive paper, clay markers or UV dyes.

References

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