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Reducing herbicide spray drift

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THE PROBLEM

When applying pesticides, the aim is to maximise the amount reaching the target and to minimise the amount reaching off-target areas. This results in:

- maximum pesticide effectiveness
- reduced damage and/or contamination of off-target crops and areas.

In areas where a range of agricultural enterprises co-exist, conflicts can arise, particularly from the use of pesticides. **All** pesticides are capable of drift.
When spraying a pesticide, you have a moral and legal responsibility to prevent it from drifting and contaminating or damaging neighbours' crops and sensitive areas.

MINIMISING SPRAY DRIFT

Before spraying

- Always check for susceptible crops in the area, for example broadleaf crops such as grape vines, cotton, vegetables and pulses if you are using a broadleaf herbicide.
- Check sensitive areas such as houses, schools, waterways and riverbanks.
- Notify neighbours of your spraying intentions.

Under the Records Regulation of the Pesticides Act, when spraying you must record the weather and relevant spray details. Forms are available from http://www.agric.nsw.gov.au/reader/14833

During spraying

- Always monitor weather conditions carefully and understand their effect on 'drift hazard'.
- Don't spray if conditions are not suitable, and stop spraying if conditions change and become unsuitable.
- Record weather conditions (especially temperature and relative humidity), wind speed and direction, herbicide and water rates, and operating details for each paddock.
- Supervise all spraying, even when a contractor is employed. Provide a map marking the areas to be sprayed, buffers to be observed and sensitive crops and areas.
- Spray when temperatures are less than 28ºC.
- Maintain a downwind buffer. This may be in-crop, for example keeping a boom's width from the downwind edge of the field.
- Minimise spray release height.
- Use the largest droplets that will give adequate spray coverage.
- Always use the least-volatile formulation of herbicide available.
- If there are sensitive crops in the area, use the herbicide that is the least damaging.

TYPES OF DRIFT

Sprayed herbicides can drift as *droplets*, as *vapours* or as *particles*.

Droplet drift is the easiest to control because under good spraying conditions, droplets are carried down by air turbulence and gravity, to collect on plant surfaces. Droplet drift is the most common cause of off-target damage caused by herbicide application. For example, spraying fallows with glyphosate under the wrong conditions often leads to severe damage to establishing crops.

Particle drift occurs when water and other herbicide carriers evaporate quickly from the droplet leaving tiny *particles* of concentrated herbicide. This can occur with herbicide formulations other than esters. Instances of this form of drift have damaged susceptible crops up to 30 km from the source.

Vapour drift is confined to volatile herbicides such as 2,4-D ester. Vapours may arise directly from the spray or evaporation of herbicide from sprayed surfaces. Use of 2,4-D ester in summer can lead to vapour drift damage of highly susceptible crops such as tomatoes, cotton, sunflowers, soybeans and grapes. This may occur hours after the herbicide has been applied.

Vapours and minute particles float in the airstream and are poorly collected on catching surfaces. They may be carried for many kilometres in thermal updraughts before being deposited.

Sensitive crops may be up to 10,000 times more sensitive than the crop being sprayed. Even small quantities of drifting herbicide can cause severe damage to highly sensitive plants.

FACTORS AFFECTING THE RISK OF SPRAY DRIFT

Any herbicide can drift. The drift hazard, or off-target potential, of a herbicide in a particular situation depends on the following factors.

- Volatility of the formulation applied. Volatility refers to the likelihood that the herbicide will evaporate and become a gas. Esters volatilise (evaporate) whereas amines do not.
- Proximity of crops susceptible to the particular herbicide being applied, and their growth stage. For example cotton is most sensitive to Group I herbicides in the seedling stage.
- Method of application and equipment used. Aerial application releases spray at 3 m above the target and uses relatively low application volumes, while ground rigs have lower release heights and generally higher application volumes, and a range of nozzle types. Misters produce large numbers of very fine droplets that use wind to carry them to their target.
- Size of the area treated – the greater the area treated the longer it takes to apply the herbicide. If local meteorological conditions change, particularly in the case of 2,4-D ester, then more herbicide is able to volatilise.
- Amount of active ingredient (herbicide) applied – the more herbicide applied per hectare the greater the amount available to drift or volatilise.
- Efficiency of droplet capture – bare soil does not have anything to catch drifting droplets, unlike crops, erect pasture species and standing stubbles.
- Weather conditions during and shortly after application.

  Changing weather conditions can increase the risk of spray drift.

Volatility

Many ester formulations are highly volatile when compared with the non-volatile amine, sodium salt and acid formulations.

Table 1 (opposite) is a guide to the more common herbicide active ingredients that are marketed with more than one formulation.

MINIMISING DRIFT VERSUS GOOD COVERAGE

A significant part of minimising spray drift is the selection of equipment to reduce the number of small droplets produced. However, this in turn may affect coverage of the target, and therefore the possible effectiveness of the pesticide application.

This aspect of spraying needs to be carefully considered when planning to spray.

As the number of smaller droplets decreases, so does the coverage of the spray.

A good example of this is the use of air-induction nozzles that produce large droplets that splatter. These nozzles produce a droplet pattern and number that are unsuitable for targets such as seedling grasses that present a small vertical target.

SPRAY RELEASE HEIGHT

- Operate the boom at the minimum practical height. Drift hazard doubles as nozzle height doubles. If possible, angle nozzles forward 30° to allow lower boom height with double overlap. Lower heights, however, can lead to more striping, as the boom sways and dips below the optimum height.
- 110° nozzles produce a higher percentage of fine droplets than 80° nozzles, but they allow a lower boom height while maintaining the required double overlap.
- Operate within the pressure range recommended by the nozzle manufacturer. Production of driftable fine droplets increases as the operating pressure is increased.

SIZE OF THE AREA TREATED

When large areas are treated relatively large amounts of active herbicide is applied and the risk of off-target effects increases due to the length of time taken to apply the herbicide. Conditions such as temperature, humidity and wind direction may change during spraying.

Applying volatile formulations to large areas increases the chances of vapour drift damage to susceptible crops and pastures.

CAPTURE SURFACE

Targets vary in their ability to collect or capture spray droplets. Well grown, leafy crops are efficient collectors of droplets. Turbulent airflow normally carries spray droplets down into the crop within a very short distance.

Fallow paddocks or seedling crops are poor catching surfaces. Drift hazard is far greater when applying herbicide in these situations or adjacent to these poor capture surfaces.

The type of catching surface between the sprayed area and susceptible crops should always be considered in conjunction with the characteristics of the target area when assessing drift hazard.

WEATHER CONDITIONS TO AVOID

Midday turbulence

- Up-drafts during the heat of the day cause rapidly shifting wind directions. Spraying should be avoided during this time of day.

High temperatures

- Avoid spraying when temperatures exceed 28°C.

Humidity

- Avoid spraying under low relative humidity conditions, i.e. when the difference between wet and dry bulbs (Delta T, ΔT) exceeds 10°C.
- High humidity extends droplet life and can greatly increase the drift hazard under inversion conditions. This results from the increased life of droplets smaller than 100 microns.

Wind

- Avoid spraying under still conditions.
- Ideal safe wind speed is 7–10 km/h, a light breeze. (Leaves and twigs are in constant motion.)
- 11–14 km/h (a moderate breeze) is suitable for spraying if using low drift nozzles or higher volume application, say 80–120 L/ha. (Small branches move, dust is raised and loose paper is moving.)

Inversions

The most hazardous condition for herbicide spray drift is an atmospheric inversion, especially when combined with high humidity.
Do not spray under inversion conditions.

Table 1. Relative herbicide volatility

Form of active	Full name	Product example
NON-VOLATILE		
Amine salts		
MCPA **dma**	dimethyl amine salt	MCPA 500
2,4-D **dma**	dimethyl amine salt	2,4-D Amine 500
2,4-D **dea**	diethanolamine salt	2,4-D Amine 500 Low Odour®
2,4-D **ipa**	isopropylamine salt	Surpass® 300
2,4-D **tipa**	triisopropanolamine	Tordon® 75-D
2,4-DB **dma**	dimethyl amine salt	Buttress®
dicamba **dma**	dimethyl amine salt	Banvel® 200
triclopyr **tea**	triethylamine salt	Tordon® Timber Control
picloram **tipa**	triisopropanolamine	Tordon® 75-D
picloram **tea**	triethylamine salt	Tordon® Granules
Other salts		
MCPA **Na salt**	sodium salt	MCPA 250
MCPA **Na/K salt**	sodium & potassium salt	MCPA 250
2,4-D **Na salt**	sodium salt	Not available
2,4-DB **Na/K salt**	sodium & potassium salt	Buticide®
dicamba **Na salt**	sodium salt	Cadence®
SOME VOLATILITY		
Ester		
MCPA **ehe**	ethylhexyl ester	LVE MCPA
MCPA **ioe**	isooctyl ester	LVE MCPA
2,4-D **ioe**	isooctyl ester	Low Volatile Ester 400
triclopyr **butoxyl**	butoxyethyl ester	Garlon® 600
picloram **ioe**	isooctyl ester	Access®
HIGH VOLATILITY		
Ester		
2,4-D **ee**	ethyl ester	Estericide® 800
2,4-D **ie**	isobutyl ester	2,4-D Ester® 800
2,4-D **nbe**	n-butyl ester	AF Rubber Vine Spray®

From Mark Scott, Agricultural Chemicals Officer, NSW Agriculture

Table 2. Nozzle selection guide for ground application

Distance downwind to susceptible crop	< 1 km	1 to 30 km	> 30 km
Risk	High	Medium	Low
Preferred droplet size (British Crop Protection Council) (to minimise risk)	coarse	medium	fine
Volume median diameter (microns)	310	210	135
Pressure (bars)	2.5	2.5	2.5
Flat fan nozzle size #	11008	11004	11002
Recommended nozzles (examples only)	*Raindrop* Whirljet® *Air induction* Yamaho Turbodrop® Hardi Injet® AI Teejet® LurmarkDrift-beta®	*Drift reduction* DG TeeJet® Turbo TeeJet® Hardi® ISO LD 110 Lurmark® Lo-Drift	*Conventional* XR TeeJet® Hardi® S3110, Hardi® S4110 Hardi® ISO F series Lurmark® Fan Tip
CAUTION	Can lead to poor coverage and control of grass weeds. Require higher spray volumes	Suitable for grass control at recommended pressures. Some fine droplets.	High proportion of 'driftable' droplets. Temperature and humidity critical.

Volume Median Diameter (VMD): 50% of the droplets are less than the stated size and 50% greater.

Refer to manufacturers' selection charts as droplet size range will vary with recommended pressure. Always use use the lowest pressure stated to minimise the small droplets. (Adapted from P. Hughes, DPI, Queensland.)

An inversion exists when temperature increases with altitude instead of decreasing. An inversion is like a cold blanket of air above the ground, usually less than 50 m thick. Air will not rise above this blanket; and smoke or fine spray droplets and particles of spray deposited within an inversion will float until the inversion breaks down.

Inversions usually occur on clear, calm mornings and nights. Windy or turbulent conditions prevent inversion formation. Blankets of fog, dust or smoke and the tendency for sounds and smells to carry long distances indicate inversion conditions.

Smoke generators or smoky fires can be used to detect inversion conditions. Smoke will not continue to rise but will drift along at a constant height under the inversion 'blanket'.

ALWAYS READ THE LABEL

Users of agricultural or veterinary chemical products *must always* read the label and any permit, before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this publication.

DISCLAIMER

The information contained in this publication is based on knowledge and understanding at the time of writing (December 2003). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Agriculture or the user's independent adviser.

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