



SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

Module 10

Weather monitoring for spraying operations How to assess if conditions are suitable for spraying

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First published February 2017. Revision of some modules August 2023.

ISBN: Online 978-1-921779-32-9

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► More information on spray drift management can be found at <https://grdc.com.au/resources-and-publications/resources/spray-drift>

Module 4:
Drift Management Strategies

Key points

- Use accurate forecast information to help plan spraying activities
- Always measure and record weather parameters at the site of the application before, during and on completion of spraying operations
- Wind direction and wind speed are critical for assessing suitable conditions and potential risks
- Temperature and humidity (or Delta T value) can assist in understanding evaporation and spray-drift risk, but can also identify potential effects on efficacy
- Always follow the label directions for appropriate conditions for spraying, including downwind buffers or no-spray zones that are calculated specific to active ingredient, formulation, application equipment and wind speed
- Consider what weather monitoring equipment will best suit your enterprise

1. Introduction

All applicators need access to accurate weather forecast information to plan where and when to spray.

Apart from being able to anticipate when changes are likely to occur, good weather forecast information allows the operator to consider which paddocks to spray, and when, along with the logistics of keeping operations running smoothly if you need to move to different parts of the farm to continue spraying if a change in wind direction occurs.

The purpose of taking measurements of weather parameters and keeping records during spraying activities is to demonstrate what you did. The more accurate your records are, the more likely they are to be useful for management decisions, to show you complied with label requirements and demonstrate your duty of care.

1.1 Measurements and records for management decisions

Reviewing spray jobs to establish what worked well and what didn't is important to assess suitable application parameters and weather conditions for future spray jobs. It is a good idea to follow up on each spray job and note the level of control obtained on the spray record. Recording good results is just as important as recording bad ones. These records can be useful when evaluating potential trends in efficacy, over one or more seasons.

1.2 Measurements and records for product performance issues

Where a particular product or tank mix does not perform as expected, often off-farm assistance and expertise will be needed to evaluate the product's performance. The first thing the agronomist or product manufacturer will look to is your application records, including how you applied the product and the conditions at the time of spraying. Without this information, it is unlikely you will gain support from the manufacturer to resolve the issue.

1.3 Measurements and records for legal purposes

If there is an incident of damage to a crop or other sensitive area that is suspected to have been caused by a spray-drift event, there may be two possible legal consequences. The first outcome may be a prosecution by the relevant authority under statute law. For a prosecution to occur, the alleged damage and the source need to be proven beyond reasonable doubt.

The second possible outcome is a civil procedure, where a party seeks compensation for damage or loss they allege another party caused. Civil actions for compensation are covered under common law, where the burden of proof required is not 'beyond reasonable doubt', but is based on the balance of probability. Under this definition the person making the claim only has to demonstrate that the alleged person or enterprise is likely to have caused the damage. The defendant then has to demonstrate they acted as a reasonable person and followed their duty of care.

As a spray applicator, having detailed spray records that demonstrate what you did and the weather conditions during the application can be beneficial in such circumstances.



Phenoxy damage to a cotton crop caused by spray drift. ►

Photo: Auscott



2. Important weather parameters for spray operations

Weather influences the outcome of any spray job, in terms of both efficacy and spray-drift risk. Legal requirements, both on the label and in state or territory legislation, also require applicators to record weather parameters during application.

Label requirements

Many product labels (depending on when they were approved) include a requirement for the spray operator to measure, record and comply with directions surrounding wind speed, wind direction, temperature and humidity during the application at the actual application site.

Wind speed and direction are particularly important in determining the risks associated with spray drift, but will also influence how uniform the spray coverage will be.

Temperature and humidity are important for assessing potential impacts on efficacy, as they can affect both the condition of the target plants and the fate of the droplets after they are released by the sprayer.

To comply with the label requirement, it is best to record conditions at the start of spraying and at the end of each tank. Recording the weather conditions at regular intervals can help to identify if, or when, conditions may have changed, which can be important to meet record-keeping requirements in individual states.

2.1 Wind speed and wind direction

Wind speed and wind direction are probably the most important factors to consider when making the decision about when to spray and when to stop.

Spraying when the wind is blowing away from sensitive areas is one of the most important strategies for reducing the potential for damage from off-target movement of spray droplets. Ensuring that there is enough air movement to dilute airborne droplets and minimise the risk that an inversion may be present is also key.

Accessing reliable weather forecast information is critical to planning the spraying operation. It is important to pay close attention to expected changes in wind direction and wind speed, and when these changes are likely to occur throughout the day.

Monitoring wind speed and using as many visual clues as possible while you are spraying helps to ensure that wind direction hasn't changed as you move around the farm, or at different times of the day.

2.1.1 Wind direction

Wind direction at a specific location is not difficult to identify at a particular point in time. However, variations in topography may influence local wind direction at different places around the farm. In some locations wind direction can be different from one end of a paddock to the other. This is why it is essential to measure and record the weather conditions at the site of application.



► For a simple explanation of the different versions of 'north' go to: www.maptools.com/product/NorthRefSheet



► For tools to adjust between magnetic north and true north or grid north go to: www.ga.gov.au/oracle/geomag/agrfform.jsp

When recording wind direction, be aware that there are variations between magnetic north, true north and grid north. It is important to be aware of which version of north your measurement is based on.

True north (the axis of the Earth's rotation) and grid north (the top of a map) are generally within degrees of each other. Often the variation between true north and grid north will be indicated on a detailed map.

However, magnetic north (where a magnetic compass points) can vary by several degrees from grid north ('north' on a map) depending on your location, as the compass will be influenced by the Earth's magnetic fields. The difference between the two will also be affected by the date when the map was produced.

When setting up a weather station, or taking wind direction measurements using a magnetic-compass, be aware of the difference between magnetic north and grid north. Always record which 'north' has been used.

If using a GPS-based system to indicate direction, this should take the variations into account.

2.1.2 Measuring wind speed

Wind speed is often difficult to estimate, particularly when it is gusting. Record-keeping requirements on product labels state that wind speed must be measured at the site of application.

For record-keeping purposes, record the average wind speed at two metres above the ground at the application site, along with the time it was recorded. The point where you measure the wind speed should be representative of the application area and should be free of obstructions that may impact the measurement.

From an application point of view, variations in wind speed are also important, as these may affect the uniformity of the spray deposits, particularly when using medium or fine spray qualities.

As a rule of thumb the maximum wind speed (gusts) should not be more than about one-third of the average wind speed above the average wind speed.

For example, if the average wind speed at the site of application is 15 kilometres per hour, then you would not want gusts to be above 20km/h (15km/h + 5km/h).



Measuring weather conditions at the application site is a legal requirement. ►

Photo: Graham Betts

Using a hand-held meter at the application site



If the operator is relying on measurements from a permanent weather station, it should be located within line of site of the sprayed paddock (generally within 2km), and not more than 5km from the site of application.

2.1.3 Bureau of Meteorology records of wind speed and direction

There are a couple of things to keep in mind when relying on Bureau of Meteorology (BoM) forecasts or records for wind speed and direction. The first is the size of the forecast area, which may not fully represent wind speed and direction at the site of application.

The second consideration is the height at which the BoM measures wind speed. Official BoM records of wind speed are generally taken at 10 metres above the ground to avoid surface turbulence.

Wind speed normally increases with height, so measurements of wind speed at 10m above the ground will be greater than what would be experienced at 2m above the ground at the site of application. Other factors such as ground cover and stubble will increase the friction at the surface, further slowing the wind speed close to the surface.

Wind speeds at 2m above the ground in a paddock with good ground cover or crop may be less than 50 per cent of a measurement taken at a height of 10m.



TIP





All downwind buffer distances (no-spray zones) included on product labels are based on a wind speed measured two metres above the ground.

2.1.4 Visual clues of wind speed and direction

Visual observations of what is happening outside the cab are very important while operating the sprayer. While these observations will not meet your legal requirements to measure and record the conditions, they will provide an indication that the weather parameters are either fairly constant or changing, which indicates that it is time to re-evaluate conditions.

The Beaufort wind scale is a useful guide for estimating wind speed, while windsocks and other visual aids are useful for assessing wind direction.

Table 1 the Beaufort Wind Scale

Description	Mean wind speed	Appearance of wind effects		
		On a tree	On land	
Calm	< 1 knot < 1 km/h	Still	Smoke rises vertically	
Light air	< 1 – 3 knots < 1 – 5 km/h		Smoke drifts, wind vanes are still	
Light	< 4 – 6 knots < 6 – 11 km/h	Leaves rustle	Wind felt on face, vanes begin to move	
Gentle	< 7 – 10 knots < 12 – 19 km/h	Leaves and small twigs move	Flags flap	
Moderate	< 11 – 16 knots < 20 – 28 km/h	Small branches move	Dust and loose paper lifted	
Fresh	< 17 – 21 knots < 29 – 38 km/h	Small trees in leaf begin to sway	Flags fully extended	
Strong	< 22 – 27 knots < 38 – 49 km/h	Larger branches shake	Whistling in wires, umbrellas become difficult to use	

The Beaufort wind scale provides a guide to wind speed based on visual clues. ►

Source:
<https://blog.metservice.com/BeaufortWindScale>



► For further information see: www.windsocksaustralia.com.au/shop/

2.1.5 Windsocks and other visual aids

Windsocks are a useful way of assessing wind direction, and may also be useful for estimating wind speed. Some windsocks available are 'calibrated', so that the angle of the sock indicates wind speed. While these devices are very useful for visual observations, they are not a substitute for physical measurements of wind speed using an appropriate instrument.

The image below shows a windsock 'calibrated' for measurements between 3.2km/h and 19.2km/h. As an alternative visual indicator, surveyor's tape or ribbon can be attached to an aerial or a fibreglass rod mounted on the sprayer.



Windsocks mounted on the sprayer are good for estimating wind speed and direction at the site of application. ►

Photo: airportwindsocks.com

2.1.6 Smoke and dust

Any visual clue that moves with the wind, such as smoke or dust, is valuable for determining how the air is moving and mixing.

It is not always practical to have a fire burning near the application site, so many operators have fitted 'smokers' to their sprayers, similar to those used on agricultural aircraft.

Releasing smoke in the paddock allows the operator to assess air movement from the cab.

Generally, this can be set up by using a small tank and low-capacity 12-volt electric pump to inject a paraffinic-oil-based product (such as 'summer spray oil') into the engine exhaust after the header pipe. Windscreen-washer kits from automotive wreckers are ideal for this purpose. Usually the systems are plumbed using fuel-grade lines and fittings.



A 'smoker' can be set up by injecting a summer oil or diesel into the exhaust will create large volumes of smoke wherever the sprayer is. ►

Photo: Graham Betts



TIPS

- Smoke will initially rise, but it should then move with the wind. If it continues to rise conditions may be too unstable, due to excessive surface temperatures.
- Ideally smoke will spread out and appear to dilute or disappear as it moves downwind, with some smoke returning towards the surface.
- If puffs of smoke remain intact and move slowly, the air is not mixing and moving enough to bring airborne droplets back to the surface and it may be too risky to spray.
- Releasing smoke while driving with the wind direction (e.g. wind coming from directly behind the sprayer) allows the operator to judge the wind speed relative to the speed of the sprayer at the time.

3. Temperature and humidity



► For more information on interactions between weeds, the product and the conditions, go to Module 2: Product requirements

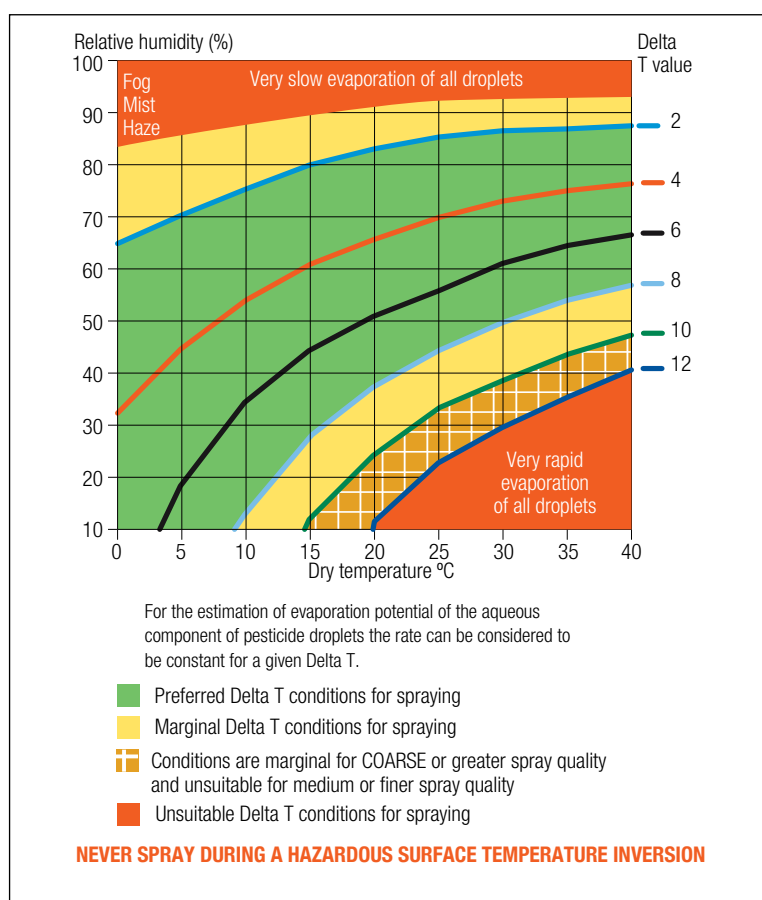
Temperature and humidity can affect droplet survival (due to evaporation), as well as the ability of the product to enter or translocate within the target plant (due to stress).

Droplet survival is affected by the rate of evaporation of water from the droplets, which causes them to reduce in size. As droplets reduce in size, their ability to settle towards the ground is greatly reduced and the potential for spray drift to occur increases. To an extent, selecting large enough droplets (such as a coarse spray quality or larger) and a high enough water rate can help overcome some of the impacts of high evaporation rates.

The evaporation rate of water-based droplets can be estimated by looking at the difference in temperature between a wet bulb thermometer and a dry bulb thermometer, often referred to as 'Delta T'.

Common Delta T values recommended for spraying are highlighted in Figure 1.

Figure 1 The relationship of Delta T to relative humidity and temperature. A common spray guideline is to spray when Delta T is between 2 and 8 and with caution below 2 or above 10.



Source: Adapted by Graeme Tepper (2012), originally sourced from Nufarm's spraywise decisions chart (2012)

3.1 Where to measure temperature and humidity

How and where you should measure temperature and humidity will depend on what you require the information for: is it purely for record-keeping, or is it also for efficacy and decision-making?

3.1.1 For record-keeping purposes

For record-keeping purposes, temperature and humidity should be measured in a shaded position at 1.25 metres above the ground at the site of application.



TIPS

- If using a hand-held weather meter in the paddock, be sure the meter has had enough time to acclimatise to the situation (especially if it has been in a vehicle).
- If mixing at the application site, leave a weather meter hanging in a shaded position so it is already acclimatised when you want to use it.
- Ensure that temperature and humidity sensors are not receiving direct radiation from the sun, as this may affect the accuracy of the measurements. It may be useful to turn the weather meter 'side on' to the direction of the sun, so the sensors are shaded.

3.1.2 For assessing condition of the target and decision-making

Air temperature and relative humidity at 1.25m above the ground will give an indication of droplet survival of airborne droplets. Under wind conditions suitable for spraying, applying a Coarse or larger spray quality should result in more than 90 per cent of droplets reaching the target or the soil. Assessing Delta T at the target may assist in understanding conditions that may affect pesticide leaf uptake.



TIPS

- When using a coarse spray quality or larger, if Delta T values in the air approach values of about 10 to 12, it is time to assess the condition of the target plants or weeds.
- If the operator compares the Delta T value measured in the air with a measurement at the target plants or weeds, this can provide information about the condition of the weeds and about droplet survival.
- Delta T values measured lower at the target than those measured in the air can indicate that plants may be transpiring, or that there is good soil moisture present, which suggest plants are not likely to be heat-stressed and droplet survival should be suitable.

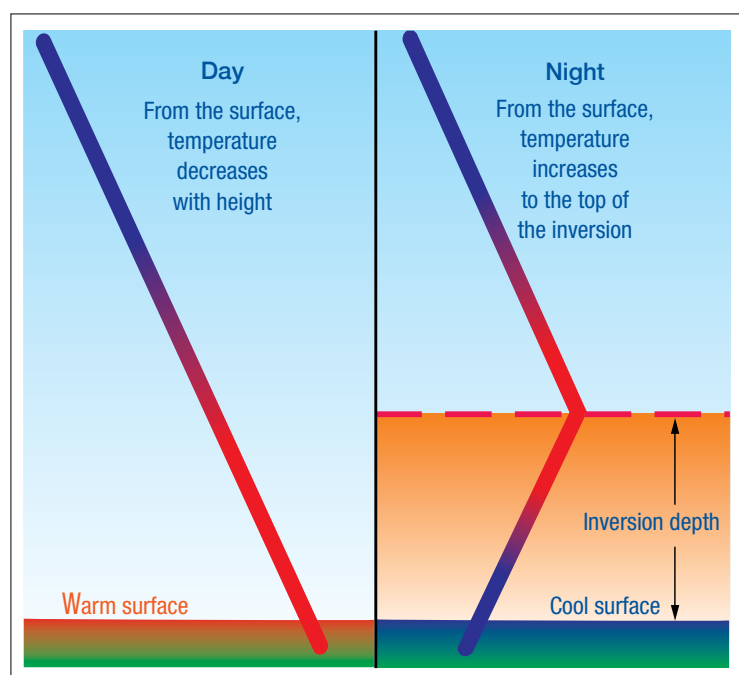
4. Surface temperature inversions

During the day the sun heats the Earth's surface, which in turn warms the air in contact with the ground. As the distance from the surface increases the air temperature normally reduces.

When an inversion is present the opposite situation exists: A layer of cool air can develop near the ground surface that is cooler than the air immediately above this layer. There are a number of ways an inversion can form, but most often they form from 1-2 hours before sunset as the surface temperature cools, which in turn cools the air in contact with it, so that air temperature appears to increase with height. Surface temperature inversions may remain in place until 1-2 after sunrise.

Figure 2 Typical vertical temperature profiles for a point in time during the night and day. The day profile typically cools with height and the night profile typically warms with height to a depth that constitutes the surface temperature inversion layer. The point where the temperature stops increasing is the top of the surface temperature inversion layer.

Source: Graeme Tepper



When an inversion is present it can block a location from the normal weather pattern (synoptic winds). Once this situation exists, air movement in a particular area is driven by local effects, such as the shape of the landscape and cold air drainage patterns. The air movement under inversion conditions can be quite different to the normal 'daytime' situation, as the air may not mix and move in the same way, which prevents airborne droplets from diluting, or being brought to the surface by turbulence.

When an inversion occurs close to the ground, it is referred to as a surface temperature inversion. For the purpose of spray decision making, a surface



► For more information on surface temperature inversions and monitoring see: <https://grdc.com.au/resources-and-publications/resources/spray-drift>

temperature inversion is determined as the vertical temperature difference (VTD) and is measured by subtracting the temperature at 2m above the ground from the temperature at 10m above ground level. If the outcome is positive, a surface temperature inversion is in place.

However, for pesticide application, inversions can be further defined as hazardous or non-hazardous. A non-hazardous inversion occurs where the temperature difference between 2m and 10m indicates an inversion but adequate turbulence remains to ensure atmospheric mixing is still occurring. Identification of non-hazardous inversion conditions requires access to a monitoring station that can measure both temperature at 2 and 10m and turbulence. Product labels typically prohibit spraying when a hazardous surface temperature inversion is present.

From the spray applicator's perspective, there is no way to determine how far droplets trapped in a hazardous inversion may travel, or where they may land.

DO NOT apply if there are hazardous surface temperature inversion conditions present at the application site during the time of application unless there is a recognised inversion monitoring weather station which aligns with and reflects weather conditions at the site of application, that indicates that the inversion is non-hazardous.

"A surface temperature inversion is likely to be present if:

- **mist, fog, dew or frost have occurred**
- **smoke or dust hangs in the air and moves sideways, just above the ground surface**
- **cumulus clouds that have built up during the day collapse towards evening**
- **wind speed is constantly less than 11 km/hr in the evening and overnight**
- **cool off-slope breezes develop during the evening and overnight**
- **distant sounds become clearer and easier to hear**
- **aromas become more distinct during the evening than during the day.**

When application occurs in an area not covered by recognised inversion monitoring weather stations, all surface temperature inversion conditions are regarded as hazardous." (Australian Pesticide and Veterinary Medicines Authority (APVMA))

What we do know from Australian research is that spraying during hazardous inversion conditions at night, even with reasonable wind speeds, can increase the amount of spray that remains in the air by up to 5 times more than spraying with the same set-up during daylight hours (after the sun has risen above the horizon enough to start heating the ground to cause the air to mix due to turbulence).



► For more information about identifying inversion conditions, and their impact on spraying, see: <https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/hazardous-inversion>

<https://grdc.com.au/resources-and-publications/all-publications/publications/2022/meteorological-principles-influencing-pesticide-application>

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HAZARDOUS INVERSION FACT SHEET

Hazardous surface temperature inversion

Pesticide applications during hazardous surface temperature inversions can lead to spray drift causing severe damage up to several kilometres off target. Current regulations prohibit spraying of agricultural chemicals when hazardous temperature inversions exist.

KEY POINTS

- Spray applied at dawn, dusk and during the night is likely to be affected by surface temperature inversions.
- During hazardous inversions, air movement is much less turbulent than during the day.
- Weak turbulence leads to the accumulation of drift close to the surface.
- Airborne droplets can remain concentrated in the inversion layer for long periods of time.
- The direction and distance airborne droplets will move within a hazardous inversion is unpredictable and will vary depending on the surrounding landscape.

During a hazardous inversion, very weak turbulence supports the transport of drift over long distances and widespread deposition at high concentrations. When a hazardous inversion has established, it acts like a barrier, trapping the inversion layer from the normal weather situation, especially the normal wind speed and direction (Figure 1).

Wind effects

In the cool and dense air of hazardous inversions, drift can be captured in laminar winds that glide smoothly down slopes, weave around obstacles, flow parallel to contours and generally flow towards low-lying areas where they

"When application occurs in an area not covered by recognised inversion monitoring weather stations, all the surface temperature inversion conditions are regarded as hazardous."

Source: APVMA

Figure 1: Typical vertical temperature profiles.

During the day, temperature decreases with elevation (red dashed line). Winds flow across the landscape (light blue arrows). Turbulence is active in several thousand metres above the surface.

During the night, temperature increases with elevation (light blue dashed line). Turbulence is weak, intermittent and confined to narrow layers near the surface when hazardous inversions exist.

Source: Graeme Tepper

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WEATHER ESSENTIALS

FOR PESTICIDE APPLICATION

GROWER EDITION

By Graeme Tepper
MicroMeteorology Research and Educational Services

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4.1 Attempting to determine if a surface temperature inversion is present by measuring temperature difference over height

It is possible to determine if a surface temperature inversion exists by measuring the difference in temperature at two different heights, usually at 2 metres and 10 metres. However, this requires very sensitive weather instruments to detect a difference over a relatively short distance, and even if you can measure such a difference, it will not tell you whether it is really safe to spray i.e. is the inversion hazardous or not. To understand if the inversion is 'hazardous' will also require measurement of air turbulence.

If we consider the typical change in temperature that can occur with height above the ground, known as the adiabatic lapse rate, there are two common lapse rates quoted in scientific literature, known as the dry lapse rate and the saturated lapse rate.

Adiabatic lapse rate (dry and saturated)

In dry air: the air temperature normally drops by about 1°C per 100 metres (0.1°C over 10 metres, or 0.08°C over 8 metres).

In saturated air: the air temperature normally drops by about 0.6°C over 100 metres (0.06°C over 10 metres and 0.048°C over 8 metres).

For the purpose of this exercise, assume an average value for the lapse rate of about 0.5°C over 100 metres (0.05°C over 10 metres and 0.04°C over 8 metres).

The kinds of temperature sensors required to detect a difference would need to have an accuracy of well below 0.1°C, and ideally about 0.02°C or less.

Such instruments need to be matched for accuracy, and will generally be too expensive for growers or spray applicators to consider. They may also be difficult to maintain, including regular calibration to ensure accuracy.

Warning

Even if you can detect a temperature difference over a relatively small difference in height above the surface, this will not tell you whether it is safe to spray. In fact, using temperature difference at two heights alone to provide an indication of inversion presence may actually stop an operator spraying when it may be safe to spray (when the amount of turbulence is suitable), and will perhaps encourage spraying when it is not safe (when a lack of turbulence favours droplets remaining airborne).

Determining 'safe' spraying conditions must take into account how the air is moving and mixing. This requires accurate measurements of several parameters (not just temperature differences with height) and sophisticated modelling of how the air is moving at a location and over a district.

Until such methods and models have been fully developed and validated, extreme caution needs to be exercised in trying to relate temperature differences over height with safe conditions for spraying.

Recently, technology suitable to determine the presence or absence of a hazardous inversion has become available.

COTL maintain an extensive mesonet of base stations covering large areas of agricultural land across the mid-North, Mallee and Riverland regions of South Australia. <https://cotl.com.au/>

Across key geographic regions from southern NSW to central Queensland, the WAND network of base stations is operated by GoannaAg via a joint GRDC/CRDC investment. <https://www.goannaag.com.au/wand-app>

These networks provide users with current weather measurements critical for spray decisions, along with both a current, and two hour future predication of the presence/absence of a hazardous surface inversion.

For applicators to have confidence in the base station data and the applicability to their location they should select the closest location, while also ensuring that there are no substantial topography barriers within direct line of site to the base station.

While base station technology required to provide this level of information is typically expensive to install, calibrate and maintain it is possible for a grower, or group of growers, to invest in their own base station should a suitable network location not be available.



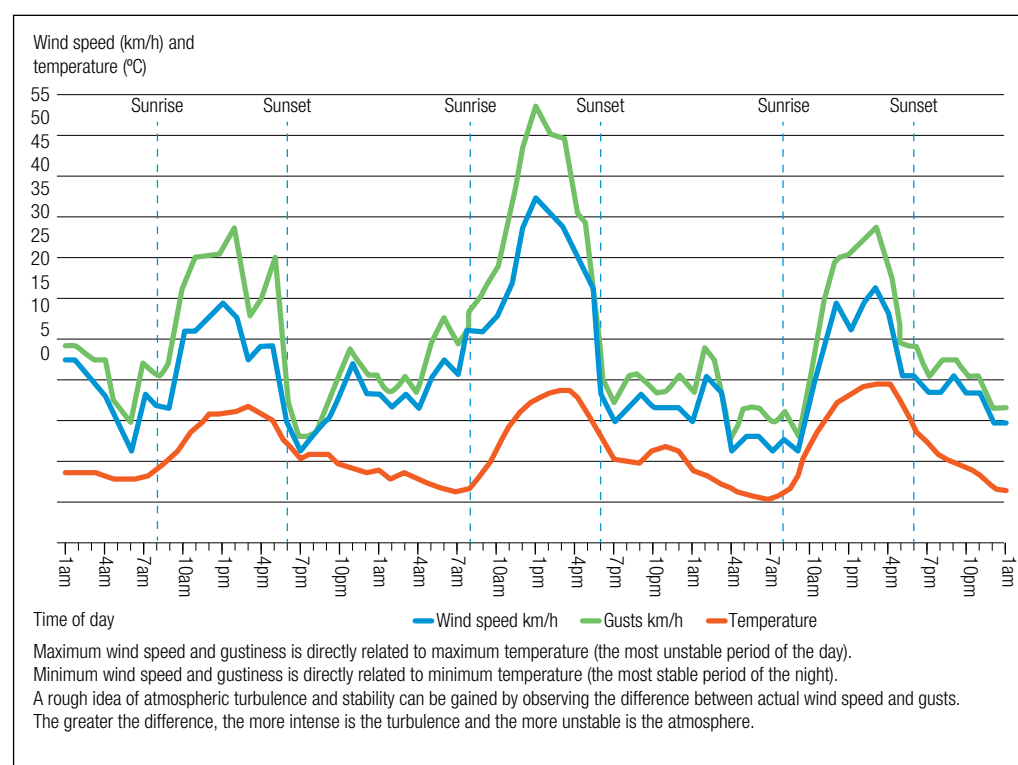
► For more information
Goanna Ag WAND network: <https://www.goannaag.com.au/wand-network>

COTL Mesonet: <https://cotl.com.au/existing-mesonets.html>

5. Using forecast information for planning spraying activities

Applicators need to be able to anticipate the changes in temperature, humidity, wind speed and wind direction that normally occur at different times during the day and night, known as the diurnal variation, as well as the seasonal changes to the diurnal variation that may occur at their location.

Figure 3 Relationship between temperature, wind speed and gustiness over a three-day period, Horsham, Victoria, 24 to 26 May 2007.



Source: Graeme Tepper

Accessing reliable weather forecast information is essential for planning spraying activities. The general Bureau of Meteorology forecast for inland areas of Australia has traditionally been based on a 25km² area, whereas the coastal forecasts and certain other areas tend to be a little more specific, based on a 12km² forecast area. However, this situation is rapidly changing as access to improved models becomes available. Spray applicators should always confirm the accuracy of the weather forecast for their location against measurements at the site of application.

While the available scale of the forecast area may be reasonable in many districts, in others there may be local variations in wind direction and wind speed due to landscape features. These differences need to be evaluated to determine the accuracy of the forecast at various locations, before relying on the information provided.



► For further information on the MetEye service, go to www.bom.gov.au/australia/meteye/

The WAND and COTL networks provide more detailed, localised and real-time information to assist spraying decision where there is a base station in appropriate proximity to the application site.

Weather forecast information should always be regarded as a planning tool, it is not a substitute for measuring and recording the weather conditions at the site of application.

5.1 Examples of weather forecasting websites for agriculture

There are a number of free services, such as those provided by the BoM, as well as some subscription-based services that utilise some or all of the same models that the BoM uses.

Some of the subscription services reduce the forecast area to areas as small as 1km², which can greatly improve the forecast accuracy for an individual farm, or for several farms.

5.1.1 Free services

BoM MetEye

This service can provide forecasts based on your latitude and longitude, with wind speed and direction forecasts provided at 3-hourly intervals.

Another free forecasting service, provided by Syngenta, the Syngenta Weather site which provides hourly forecasts to 5 days in advance, specific to the location..

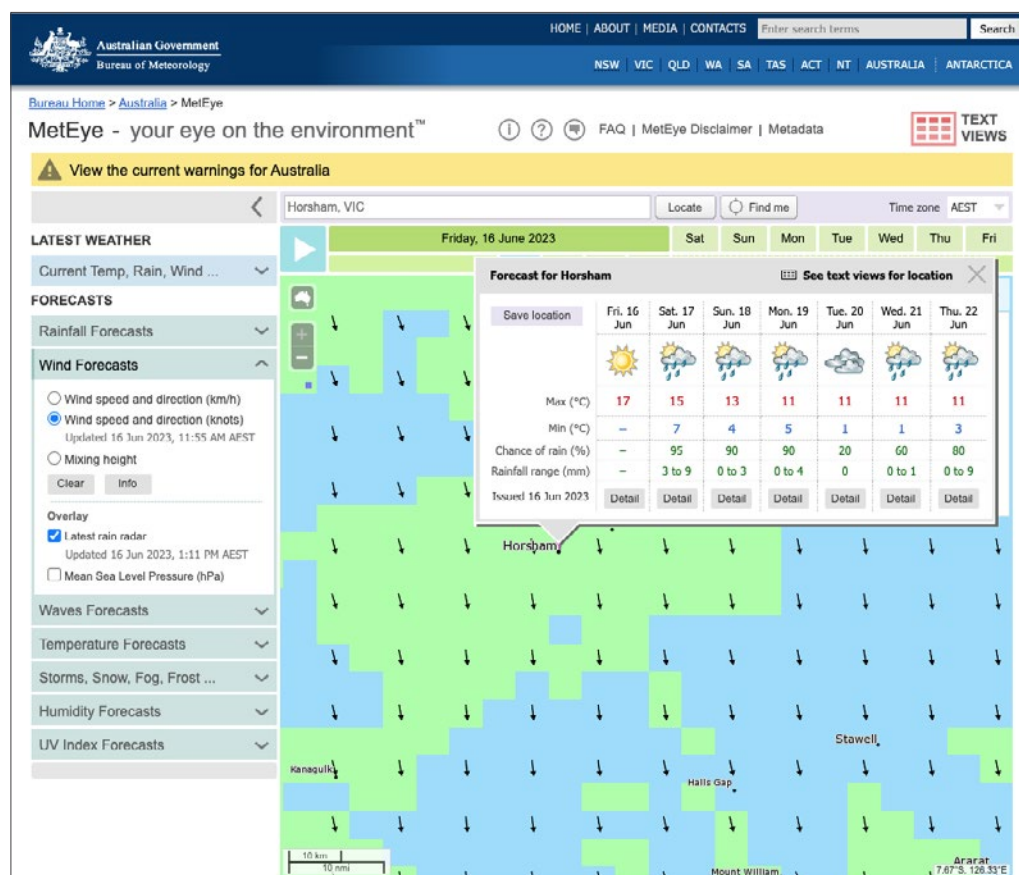
Output from the MetEye website



MetEye is a free service that provides forecasts based on location or latitude and longitude. ►



► For more information about Agricast, go to www.syngenta.com.au/weather



Source: BOM

5.1.2 Subscription-based services

Many subscription-based services charge a monthly or annual fee for access, but for this price they tend to provide additional services, or an increased level of forecast accuracy for specific locations.

Before signing up to a particular service, if they offer a free trial period take advantage of this to check the accuracy of the forecast for the locations where you conduct spraying activities.

Use the trial period to regularly measure the conditions at your location and compare these to the forecast provided. During the trial period, it is worthwhile comparing various forecasting services with each other and with the free services to determine if you gain a better forecast for your location.

Some of the subscription-based services, such as Nufarm SprayWise® Decisions, provide indications of suitable conditions for spraying by highlighting parameters such as wind speed, Delta T and inversion risk.



The SprayWise® Decisions planning tool uses a traffic light system of red, green and yellow, based on the suitability of the weather conditions for spraying. ►

► **For more information about the SprayWise Decisions website, visit:**
www.spraywise-decisions.com.au

Source:
spraywisedecisions.com.au

Nufarm SprayWise® Decisions

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Subscription Features

- Spray planning guide**
5 day spray planner identifying the suitable times to spray based on forecast conditions and Delta T.
- Recent weather**
View the previous 14 days of weather for your chosen locations anywhere within Australia.
- Weather forecasts**
Advanced 14 day forecasts at chosen locations. Detailed 3 hourly information with a 7 day forecast.
- Weather maps**
Recent and forecasted weather maps (as individual images or animated sequences).
- Radar & cloud maps**
Recent atmospheric conditions (as individual images or as an animated sequence).
- Seasonal guides**
View similar seasons from history to compare to the current season. This provides a guide to the possible climatic conditions based on historical outcomes.

TODAY'S FORECAST:
Our weather site will revolutionise your decision making

Welcome to Spraywise Decisions

- Innovative service helping rural landholders and contractors to better plan and match the timing of agrochemical sprays to prevailing local weather conditions
- Also accessible from your mobile or tablet for information on the go
- Sponsored by **Nufarm** for its Australian customers, distributors and agronomists
- Subscriptions can also be purchased using Nufarm **Top Croppers** points
- Maintained under contract by **FluroSat**

A virtual weather station in your own backyard

SprayWise Decisions from Nufarm allows you to review weather conditions for the last 14 days or predict forthcoming weather up to 14 days in advance. It has the unique ability to generate property specific meteograms for the nearest 1 sq km grid cell anywhere in Australia.

Locate your property using GPS co-ordinates, physical address search or find your property using Google Maps satellite imagery.

Data is updated every 12 hours to deliver the most current forecast. SprayWise Decisions is the ultimate decision support tool to determine when and where to spray to achieve optimum results safely. It's just another example of how Nufarm is helping you grow a better tomorrow.

6. Weather-monitoring equipment



Weather monitoring using a hand held meter

Visual clues for assessing wind speed and direction are important for monitoring weather conditions but they are not a substitute for physically measuring wind speed, wind direction, temperature and humidity at the application site.

Measurements of weather parameters should always be taken using an appropriate instrument, such as a weather meter.

6.1 Hand-held weather meters

The most commonly used instrument for measuring and recording weather data on-farm is a hand-held weather meter.

There are a variety of makes and models available, from basic wind speed or temperature sensors, through to systems that display and record wind speed, direction, temperature, humidity and Delta T.

Some of the more advanced models can log and store data, and transfer this in real time to a tablet, smartphone or computer.

Agricultural compare chart



A range of hand-held weather meters is available. ▶

Photo: kestrelmeters.com.au

6.2 Permanent weather stations on-farm

Permanent weather stations are particularly useful for capturing and recording long-term weather and climate data, which can be used to analyse on-farm trends.

Permanent weather stations at the farm or enterprise are also useful for comparing measurements with forecast data and historical records to evaluate their accuracy and relevance for your site.

Many permanent weather stations offer remote access via mobile phone or web-based access, which can eliminate the need to physically download data from the station itself. Some will also offer wireless links to a monitor in the sprayer, which can be useful if the weather station is close to the site of application.

A well set-up and located permanent weather station on-farm



Permanent weather stations can collect long-term weather data as well as current conditions, but must be close to the application site for record-keeping purposes. ►

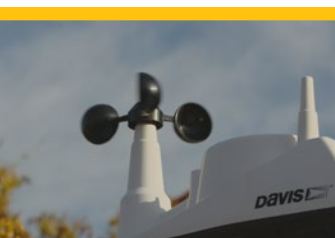
Photo: Goanna Telemetry



Locating a permanent weather station

Several factors should be considered when installing a weather station on-farm. Make sure that:

- the site is representative of the area that you would be using the weather data for (consider factors such as the elevation compared to the rest of your property);
- the vegetation around the site is consistent with the wider monitoring area;
- the site is not vulnerable to flooding, fires or lightning strikes;
- the site is protected from livestock and vermin;
- the site is in an area of reliable communication (e.g. Ultra high frequency or mobile phone);
- the site is a suitable distance from structures or obstructions – as a general rule the station should be located a distance at least 10 times the height of the obstruction away from the obstruction (preferably more);
- the site is level; and
- the orientation of the station is noted, e.g. aligned with grid north or true north.



Drift Reduction Technology – weather stations

6.3 Portable weather stations

A portable weather station is usually very similar to a permanent station, but instead are usually mounted on a tripod. This means they can be relocated from one paddock to another.

A portable weather station



Portable stations need to be correctly set up at the application site. ►

Photo:
www.campbellsci.com.au

6.4 Local weather station networks

Several growing areas throughout Australia have set up local networks of permanent weather stations that provide remote access for growers and subscribers via UHF radio, mobile phone or the internet.

The benefit of having access to a local network is the ability to compare wind speed and direction at various sites, which can give an indication of when a change is coming through an area. Networked stations are also useful for comparing historical data for an area with official BoM data to identify possible variations.

Users of weather data obtained from this type of network need to be aware that, depending on where they are located, they may not be regarded as being at the site of application. Hence, the spray operator still needs to measure and record conditions at the application site.

The WAND network (Qld and NSW) <https://www.goannaag.com.au/wand-app> and the COtL network (SA) <https://cotl.com.au/> are currently the most geographically extensive networks operating across agricultural production areas of Australia.

These networks provide specific and detailed information on hazardous inversion conditions at the site.

6.5 Onboard weather stations

The most useful weather monitoring instrument for spray applicators is one that allows you to measure the weather parameters in real time at the site of application – while you are driving. Weather stations are available that can be mounted on the sprayer that provide live weather data while you are driving the sprayer.

The Airmar on board weather station



On-board weather stations can provide live weather data to the operator while the sprayer is moving. ►

Photo: Airmar

Some sprayer manufacturers, such as John Deere, are starting to offer these onboard weather stations as options when you order the sprayer, others can be purchased as standalone, portable units that will work on any vehicle.

These systems use an in-built GPS system to determine the sprayer's position, heading and speed, and ultrasonic sensors to gather the weather data. Using this information, the onboard stations can accurately determine the wind speed and direction, as well as other weather parameters, such as temperature, humidity and DeltaT, while the sprayer is moving. However, without the ability to measure temperature and wind at 10m these systems cannot accurately predict hazardous inversion conditions.



TIPS

- When mounting an onboard weather station, make sure it is placed in a location where it can get clear airflow, and will not be impacted by obstructions or machinery exhaust emissions.



For more information about onboard weather stations go to <https://www.airmar.com/Catalog/WeatherStation-Instruments> and www.specmeters.com/weather-monitoring/weather-stations/sprayer-station/



In key cotton growing regions, users can enter paddock details of what crops are growing at any point in time. This allows other operators to be able to see what crops are downwind of their application. For more information <https://satacrop.com.au/>

7. Weather data and forecasts for planning and conducting spraying operations

Making the most of good conditions for spraying can help to improve productivity and efficacy. The ability to access good forecast information is critical for planning spraying operations and to help predict when changes are likely to occur. Once the operator is in the paddock, access to weather data at the site of application also improves the decision-making process.

To fully plan spraying operations requires knowledge of what products are likely to be applied, the label requirements for downwind buffers or no-spray zones, and what sensitive areas may exist adjacent to the areas to be sprayed and within the local catchment area. Having detailed farm maps for your enterprise, and copies of what your neighbours have planted, or are planning to plant, is essential for determining how and when to spray each of the paddocks at your enterprise.

Having knowledge of likely wind direction and wind speed will help the spray applicator plan which paddocks are likely to be able to be sprayed at different times throughout the day or week. Many forecasting services can offer reasonably accurate information about wind speed and direction up to seven to eight days in advance, with the first three days of that period generally being the most accurate. Even when a forecast is provided for several days, it should still be checked for updates on a daily basis.

8. Summary

- Use accurate forecast information to help plan spraying activities.
- Always measure and record weather parameters at the site of the application before, during and on completion of spraying operations.
- Wind direction and wind speed are critical for assessing suitable conditions and potential risks.
- Temperature and humidity (or Delta T values) can assist in understanding evaporation and spray-drift risk, but can also identify potential impacts on efficacy.
- Always follow the label directions for appropriate conditions for spraying, including downwind buffers or no-spray zones that are related to wind speed.
- Consider what weather-monitoring equipment will best suit your enterprise.
- DO NOT spray under hazardous inversion conditions. While surface temperature inversion conditions can occur at any time, they are present most nights from around 1-2 hours before sundown until about 1 hour after sunrise. To understand if an inversion is hazardous or not, advanced meteorological weather stations will be required and these must be located within reasonable proximity to, and without substantial changes in terrain between the weather station and the application location.

SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

Module 11 Pumps, plumbing and components How they can work together
