

Efficient Spray Application For Cotton

By **BILL GORDON & GRAHAM BETTS**

Achieving the best outcome from spray application requires the careful consideration of many factors. The aim of spray application is to transfer active ingredients through the atmosphere to the target in an effective manner with minimal off-target losses. Application technique needs to be matched to the target and weather conditions. Movement of spray beyond the target area is undesirable as it represents wastage of product and exposure of non-target sensitive areas to potentially damaging materials.

Always read and follow the label when handling and applying chemicals and be aware of federal and state regulations for chemical application. Staff responsible for handling and applying pesticides must be qualified according to relevant state and federal requirements. There may also be workplace health and safety requirements related to storage and use of hazardous chemicals, which require risk assessments to be completed, in addition to maintaining a manifest and Safety Data Sheets for those chemicals deemed to be hazardous. The *myBMP* program can help growers to understand their legal obligations.

Tips to reduce drift

Source: <http://www.cottonmap.com.au>

Spray drift is a major concern in most agricultural areas today. The presence of sensitive areas located within close proximity to the spray target area introduces the possibility of off-target deposition. It is more important than ever that the agricultural industry demonstrates responsible chemical usage to reduce the need for severe application restrictions.

Plan

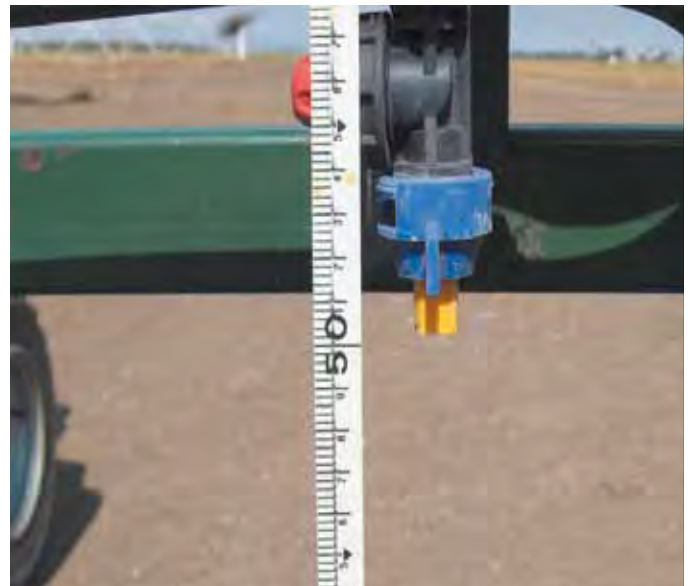
- The development of a comprehensive pesticide application management plan (PAMP) before each season is considered best practice. Having a PAMP in place helps to ensure that everyone involved in pesticide application has a clear understanding of their responsibilities. The PAMP should cover:
 - Farm layout;
 - Identification of sensitive areas, potential hazards and awareness zones;

- Communications procedures;
- Pesticide Management Guidelines; and,
- Accident and emergency procedures.

- Utilise tools such as www.spraywisedecisions.com.au to plan the most appropriate application windows.
- Spraying in a cotton area? Check www.cottonmap.com.au for neighbouring fields prior to application.
- Read the product label.
- Communicate with neighbours.
- Upskill by attending a Nufarm Spraywise training course or one run by specialist application consultants such as Bill Gordon, Graham Betts, Craig Day.
- Remember the 6 P's = Perfect Planning Prevents Poor Pesticide Performance.

Boom height/false target

- Boom height needs to be adjusted to the height of the false target (stubble height) or the height of the target – whichever is greater.
- Keep boom height to a minimum (ie 50cm above target/false target for 110o nozzles at 50cm nozzle spacing).
- Increasing the boom height from 50cm to 70cm may increase the amount of driftable fines up to 4 times, and a boom height increase from 50cm to 100cm multiplies them up to 8 times!!



Spray quality

- A COARSE to VERY COARSE spray quality must be used when applying 2,4-D products – EXTREMELY COARSE may be warranted if night spraying.
- Choose the nozzle producing the coarsest spray quality without compromising efficacy. Refer to Nufarm's Boom Spray Application Guide for a full range of recommended water rates and spray qualities for all Nufarm products.
- If needed, include drift-reducing adjuvants such as LI 700®, Activator® or Bonza®.

- Use nozzles at appropriate pressure: conventional nozzles 1.5-3 bar, pre-orifice nozzles 2-4 bar, Low-pressure air induction nozzles 3-5 bar, high-pressure air-induction nozzles 4-8 bar.

Inversions

DANGER – DO NOT spray when a low-level inversion exists.

- During those inversions distinct, isolated layers of air have formed close to the ground. As a result driftable fines are not subject to dilution with the atmosphere.
- Low-level inversions frequently form in the late evening and strengthen overnight - they are strongest near sunrise.
- Use visual indicators such as moisture, smoke or dust to determine if a low-level inversion is present.
- Rule of thumb: the greater the difference between daily maximum and minimum temperatures, the stronger the low-level inversion.

Refer to: *The influence of surface temperature inversions on spray operations.*

Night spraying

- The advent of GPS self-steer and a desire to work within appropriate Delta Ts has seen an increasing trend towards night spraying, particularly during the summer months. Spraying at night dramatically increases the chance of applying product in adverse conditions.
- Night spraying can strongly favour conditions that can trap and move the applied product far from the target area (see inversions). Be particularly vigilant 1 hour either side of sunrise.
- Be aware that the rainfall period will be longer.
- Obtain forecast and monitor for still or low-level inversion conditions.

Wind speed and no-spray (buffer) zones

- It is best to apply pesticides when the wind is blowing away from sensitive areas and crops. Wind speed must be steady between 3 km/hr and 15 km/hr.
- If the wind stops blowing at night – stop spraying immediately (see inversions below).
- Always read the label to see if a mandatory wind speed requirement exists, or if a No-spray zone is required for any of the products you plan to use.
- Rule of thumb: most directional wind changes in Australia will occur in an anti-clockwise direction.

Spray weather summary

- Avoid calm, variable or gusty wind (calm conditions give no positive indication of droplet displacement).
- Be aware of local topographic and convective influences on wind speed and direction.
- At night the cool (heavier) air behaves like water and drains to lower points (waterways, frost-prone paddocks) taking any fine droplets suspended in the air with it as well.
- Record on-site weather conditions at the start and finish of every pesticide application.

The influence of surface temperature inversions on spray operations

Source: GRDC's Surface Temperature Inversions and Spraying Fact Sheet http://www.grdc.com.au/uploads/documents/GRDC_FS_Spray%20drift%20temp%20inversions1.pdf

Acknowledgements: Graeme Tepper, MicroMeteorology Research and Educational Services; Bill Gordon, Bill Gordon Consulting Pty Ltd.

In cooling night conditions airborne pesticides can concentrate near the surface and unpredictable winds can move droplets away from the target. Understanding weather conditions can help spray applicators avoid spray drift

Surface temperature inversions

Inversion conditions can differ significantly from the broader forecast weather patterns. During the night the ground loses heat and the low level air cools (Figure 2). This results in air temperature increasing with height and the temperature profile is said to be inverted. When this occurs close to the ground it is called a surface temperature inversion. In a surface temperature inversion the point where the temperature stops increasing and begins to decrease is the top of the inversion layer. When a strong surface temperature inversion has established, it can act like a barrier, isolating the inversion layer from the normal weather situation, especially the normal wind speed and direction (Figure 3).

During daylight hours the temperature of the soil surface gradually increases. Air in contact with the ground also warms (Figure 2). In this situation the air temperature normally becomes cooler with height. Wind speeds during daylight hours will generally be more than 3 to 4km/h and the air movement across the surface will tend to be turbulent. Turbulence close to the ground causes the air to mix, due to the rolling motion of the air across the ground surface. Mixing is also caused by thermals, which interrupt airflow. This mixing of the air assists in diluting airborne droplets and helps to drive many of them back towards the ground. When this dilution occurs, a safe buffer distance between the sprayed area and potentially sensitive areas downwind from the application site can be estimated.

Surface temperature inversion conditions are unsafe for spraying as the potential for spray drift is high. Under a surface temperature inversion:

- Air movement is much less turbulent so the air does not mix in the same way as during the day;
- Airborne droplets can remain concentrated in the inversion layer for long periods of time;
- The direction and distance pesticides movement is very hard to predict;
- The movement of airborne droplets will vary depending on the landscape; and,

• Droplets or their remnants can move in different ways. Research supported by the GRDC is further investigating the development and implications of temperature inversions in relation to spray application.

When and why do surface temperature inversions occur?

Surface temperature inversions usually develop overnight and can persist well into the next day. They can result from a number of processes that cause the air closest to the ground to become cooler than the air above. The three main reasons experienced in broadacre agriculture are:

1. Radiation inversions (created by radiation cooling)

Radiation inversions can form at any time during the night when wind speed is less than about 11km/h and cloud cover does not severely restrict surface cooling. In calm and clear sky conditions they may form just before sunset. Once the sun has set and has stopped heating the ground, heat radiates back into space, causing the ground to cool. In turn, the air in contact with the ground becomes cooler than the air higher in the atmosphere. This generates the surface temperature inversion. Radiation inversions are the most dangerous for spraying operations as they cause airborne droplets to remain concentrated at a low level for long periods. Winds within the inversion can carry these droplets long distances. On gentle slopes, concentrated droplets can be transported many kilometres by drainage winds towards the lowest point in the catchment. Under an inversion, where water runs from a property, droplets can move.

2. Inversions created by advection (cool or warm air movement)

Cooler, denser air can move into an area and slide under layers of less dense, warm air. This can happen when a cold front moves into an area, or a sea breeze pushes cooler air inland. It can also happen when denser cool air moves down a slope and slides underneath layers of warm air in lower parts of the catchment. If this occurs, the intensity of a radiation inversion increases. Warm air can move over cool surfaces; some of the air closest

FIGURE 1:

Effect of atmospheric stability

Smoke	Condition	Notes	Spray?
	NEUTRAL (e.g. morning)	Cool breeze (4–15 km/h) Optimum spray conditions.	✓
	UNSTABLE (e.g. afternoon)	Hot. Low windspeed, thermal activity. Risk of upward movement of fine droplets.	✗
	INVERSION (e.g. night)	Low windspeed. Hot during day. Risk of significant off-target deposition of fine droplets.	✗
	STABLE (e.g. dusk)	Low windspeed. Risk of off-target spray deposition.	✗

to the ground becomes cooler while the higher air stays warmer.

3. Inversions created by vegetation

Vegetation and crops can shade the ground underneath them. The air in contact with the ground will stay cooler than adjacent areas where there is less groundcover. This often occurs just after sunrise. The air moving above the vegetation or crop may be warmer than the air below the vegetation. This can allow airborne droplets to travel over, rather than through, vegetation. Transpiration from a dense crop canopy on a hot day can form a cool layer of air just above the crop. Later in the day (when wind speeds tend to reduce) this layer of cooler air can act like an inversion over the crop, making penetration of smaller spray droplets into the canopy very difficult and increasing the risk of off-target movement.

Recognising a surface temperature inversion

The scientific method for detecting a surface temperature inversion requires the accurate measurement of the air temperature close to the ground and at a height of at least 10m. On-farm, this is usually not practical, so most spray applicators must rely on visual clues.

Visual clues

A surface temperature inversion is likely to be present if:

- Mist, fog, dew or a frost have occurred;
- Smoke or dust hangs in the air and moves sideways, just above the surface; and
- Cumulus clouds that have built up during the day collapse towards evening.

Other clues

A surface temperature inversion is likely to be present if:

- Wind speed is constantly less than 11km/h in the evening and overnight;
- Cool, off-slope breezes develop during the evening or overnight;

FIGURE 2:

Typical vertical temperature profiles for a point in time during the night and day. At low levels, the day profile typically cools with height and the night profile typically warms with height. Little change occurs at elevated altitudes. (Source Graeme Tepper)

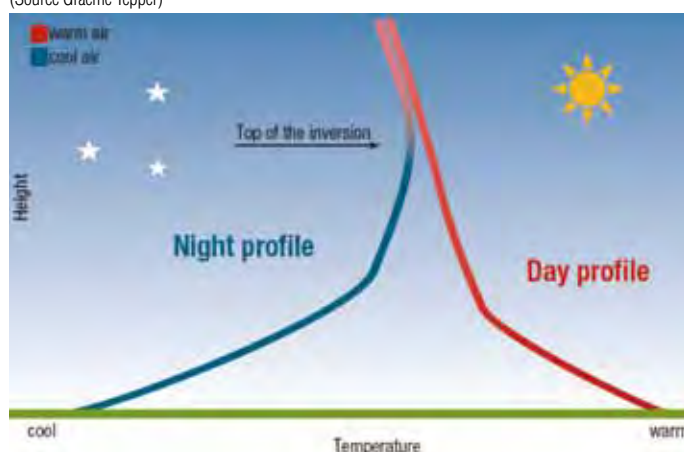
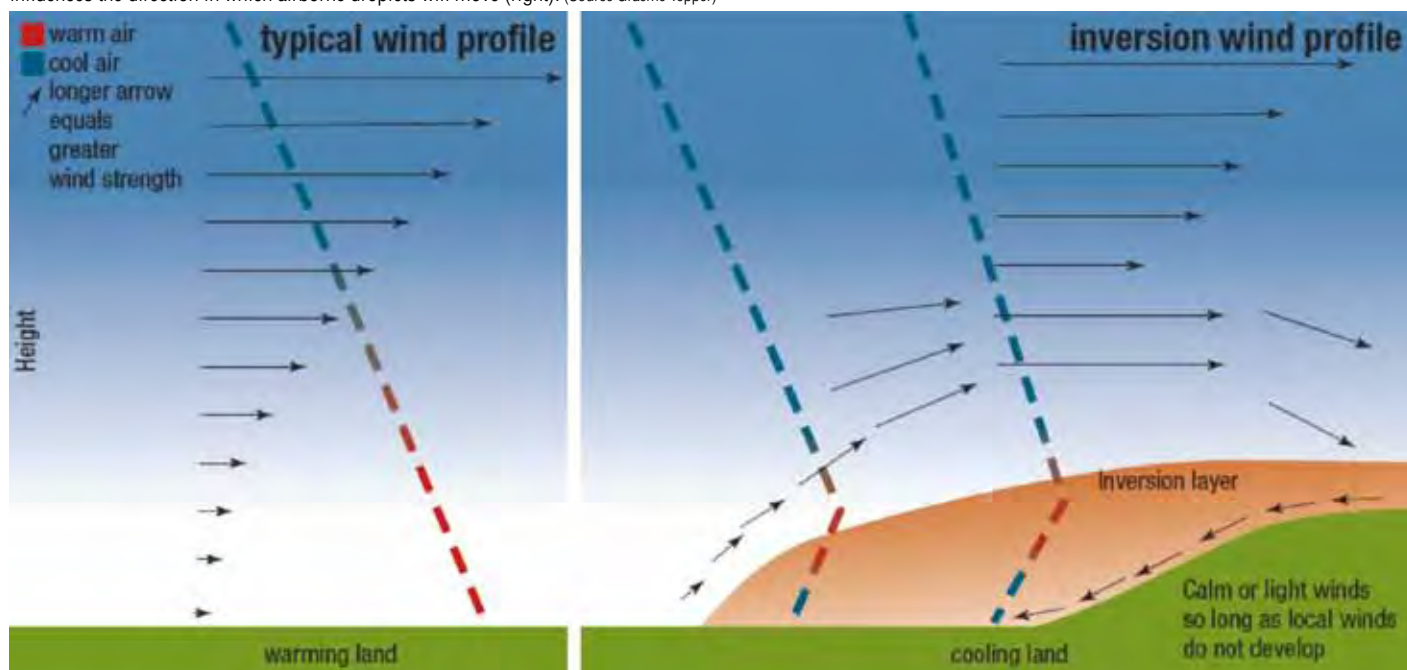


FIGURE 3:

Air movement under a surface temperature inversion differs from a typical wind profile (left). Surface winds de-couple from the surface, accelerate and flow over the inversion. Within the inversion, winds are typically light and often drain down slope, regardless of the overlying wind direction. Under an inversion the shape of the landscape also influences the direction in which airborne droplets will move (right). (Source Graeme Tepper)



- Distant sounds become clearer and easier to hear; and
- Aromas become more distinct during the evening than during the day.

Clues that a surface temperature inversion is unlikely

Applicators should always expect that a surface temperature inversion is most likely to have formed at sunset and will persist for some time after sunrise. However, a surface temperature inversion is unlikely if one or more of the following has occurred:

- Continuous overcast weather, with low and heavy cloud;
- Continuous rain;
- Wind speed remains above 11km/h for the whole* time between sunset and sunrise; and
- After a clear night, cumulus clouds begin to form.

*Sometimes the overnight wind speed can pick up from virtually calm to speeds greater than 11km/h during a surface temperature inversion. This is why the wind speed must be constant all night to ensure the air continues to mix and prevent airborne droplets from becoming concentrated and moving away from the sprayed area.

Further information can be found on the GRDC 2013 Weather Essentials for Pesticide Application booklet www.grdc.com.au/GRDC-FS-SprayInversions

Calculating banded sprays

By **BILL GORDON & GRAHAM BETTS**

Often people want to know the actual application rate and how much chemical to put in the tank (based on green ha or sprayed ha), how far a tank will go (based on paddock ha) and what rate to put in the spray controller. Others want to know what nozzles they should use to achieve a recommendation they have received from their advisor.

The Ispray Banded Spray Calculator for Cotton allows the user to determine suitable nozzle size, flow rates and rate controller settings for banded applications to cotton. Users can adjust speed and application volume to adjust the setup to determine optimum settings for their application. Works for standard booms and banded setups on solid plant or skip row configurations. It is



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– Sean Boland

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or Call 1800cotton

available for download as an App on the Google Play Store for Android devices or from the Apple App Store on iPhone and iPad devices.

There are often big differences between the consultant's recommendation, the applicator's instincts and what the machine can actually do with the nozzles available. The main reason for a banded application is to place the recommended rate of the product onto an area smaller than the whole field (this way we use less chemical over the whole field, but still apply the equivalent rate/ha to the actual target area).

To work out the true application rate we need to know the sprayed width, or average sprayed width for each nozzle, this allows us to calculate the litres per sprayed ha (L/sprayed ha sometimes called L/green ha). Label rates are always given as L/sprayed ha. Advisors should always give recommendations as L/sprayed ha. To apply the correct L/sprayed ha there are two main things to work out:

How much chemical to put in the tank, which is based on L/sprayed ha.

What to put into a controller, which is based on paddock ha per tank, (unless you want to play around with section widths).

Formula

(The following are a selection, there are many that work.)

Band width in metres: **eg 0.7m band** \div 1 m row spacing = band width (m) \div row spacing (m).

Sprayed width per nozzle (m): = **band width (m)** \div **number nozzles per band** (eg 3 nozzles per 70% band of a 1 m row = $0.7 \text{ m} \div 3 = 0.23\text{m}$).

The application rate = **L/sprayed ha**: **L/sprayed ha** = **L/min/nozzle** \times **600** \div **speed (km/h)** \div **sprayed width per nozzle (m)**.

L/sprayed ha applies to each band (row), whether you spray 1 band (row), or many rows, whether it is a solid plant, single skip or double skip.

Number of sprayed ha per tank = **Tank size (L)** \div **L/sprayed ha**.

Amount of chemical to add per tank = **Sprayed ha per tank** \times **chemical rate/ha**.

Paddock ha per tank (solid plant): = **Sprayed ha per tank** \div **band width (m)**.

Paddock ha per tank (Skip Row Configurations): eg Double Skip on 1m row spacing (only planted 1 out of every 2 rows), this would be the same as only spraying 12 \times 1m rows with a 24m boom.

Paddock ha per tank (skip) = **Sprayed ha per tank** \div **the band width (m)** \times **width of boom** \div **row width (m)** \div **number of planted rows under the boom**.

Rate to put in the Controller: = **Tank Size (L)** \div **Paddock ha per tank**

*this works if you don't want to change the section widths in the controller.

Spraywise Boom Spray Hygiene – Cleaning Procedures

GROUP	CHEMISTRY	PRODUCTS	CLEANING PRODUCT
A	Dims	Sequence	Tank and Equipment Cleaner
	Fops	Nugrass	
B	Imidazolinones	Midas® Arsenal Xpress, Spinnaker Intervix®, Raptor®	Small amount of Tank and Equipment Cleaner or water
	Sulfonyl Ureas	Associate®, Lusta®, Monza® Nugran®, Sempra	Chlorine Bleach
C	Triazines	Nu-Trazine 900 DF Convoy® DF Diuron 900 DF	
		Flowable Diuron, Flowable Simazine	
		Nu-Tron 900 Df, Prometyrn 900 DF, Simazine	
	Benzonitriles	Bromicide 200	
D	Dinitroanilines	TriflurX, Rifle 440	
F	Phenoxynicotinanilides	Paragon, Nugrex	
G	Diphenyl Ethers Triazolones	Striker, Affinity®, Hammer®	Alkaline Detergent 'Omo®' or 'Spree®'
I	Benzoic Acids	Kamba 500, Comet 200, Conqueror	Tank and Equipment Cleaner
		Invader 600	
	Phenoxy Acetic Acids		
	Mcpa (Dimethylamine)	Agritone 750	Cloudy Ammonia followed by Tank and Equipment Cleaner
	Mcpa (Ethyl Hexyl Ester)	Bromicide MA, Nugrex, Paragon	Tank and Equipment Cleaner
	Mcpa (Iso-Octyl Ester)	Broadside, Agritone LVE	
	Mcpa (Potassium Salt)	Trooper®	
	2, 4-Db	Buttress®	Cloudy Ammonia followed by Tank and Equipment Cleaner
	2, 4-D (Dimethylamine And Diethanolamine)	Surpass 475, Amicide 625	
	2, 4-D (Dimethylamine)	Baton®, Kamba M, Surpass 475	
2, 4-D (Ethylhexyl Ester)	Estericide Xtra	Tank and Equipment Cleaner	
Pyridines	Archer		
J	Thiocarbamates	Avadex® Xtra	Small amount of Tank and Equipment Cleaner or water
K	Chloroacetamides	Bouncer	
L	Bipyridils	Revolver, Nuquat 250	
M	Glyphosate	Roundup, Roundup Biactive Roundup CT Roundup PowerMAX®, Roundup Ready Herbicide with PLANTSHIELD, Weedmaster Duo	Water
Q	Triazoles	Amitrole, Illico®	Small amount of Tank and Water Equipment Cleaner or water
Z	Arylamino propionic Acids	Mataven 90	

A first rinse with cloudy ammonia will clean hard deposits in filter and lines. After flushing the tank, a second rinse with Tank and Equipment Cleaner should be used as a follow up.

Selecting the correct nozzle size for a particular job

To work out what size nozzles you need to get a particular L/sprayed ha, you need to know what the required flow rate of each nozzle (L/min/nozzle) should be. If all nozzles are the same size this is relatively easy, as the flow rate will be the same for each nozzle.

For example the average sprayed width per nozzle if you had 5 nozzles per 1 m row at 100% band would be $1\text{m} \div 4 = 0.2\text{m}$.

If you had 4 nozzles per 1m row and a 70% band, then the average sprayed width would be $0.7\text{m} \div 5 = 0.14\text{m}$.

To calculate the required flow rate of each nozzle, the formula you need to use is: **L/min/nozzle = L/sprayed ha \div 600 x speed (km/h) x average width of each nozzle (m)**

If you are using different combinations of nozzle sizes, you can still use the same formula, but it helps to work out the total flow rate for each band (or row), to do this, change the average width per nozzle to the band width or spray width per band (row) to get the total flow required per band (or row) and select nozzles with flow rates that add up to that total (all at the same pressure). Once you have calculated the required L/min/nozzle use a nozzle flow chart to identify appropriate nozzle sizes and pressures, and don't forget to check the spray quality produced to ensure it is consistent with the product label.

Bill Gordon has worked closely with the cotton and grains industry for many years and runs workshops for farmers and trainers. Contact Bill Gordon Consulting 0429 976 565 E:bill.gordon@bigpond.com

The myBMP Pesticide application module

NuFarm Australia Ltd: 03 9282 1000, www.nufarm.com.au

For more information the following resources and tools are available at https://www.mybmp.com.au/auth_user/grower_tools_and_resources.aspx

Cotton pest management guide

GRDC factsheets on:

- Spray Mixing Requirements
- Spray Water Quality
- Preseason check and Controller Settings

Information on weather:

Weather essentials for pesticide application, Graeme Tepper, GRDC.

GRDC Fact Sheet on Weather Monitoring Equipment

Information on weather forecasting tools:

Spraywisedecisions.com.au

– Syngenta.com

– Agricast

Information on pesticide application:

– Spraywise Broadacre Application Handbook, Dr Jorg Kitt, Nufarm Australia

Information on nozzle selection tools:

– Teejet Nozzle Selection App

– Hardi Nozzle App

– Ispray.com.au Nozzle selection tools

– Ispray banded spray calculator for cotton – available on Google Play store for android and the app store for iPhones and iPads.