XTENDFLEX® COTTON

SPRAY APPLICATOR TRAINING GUIDE

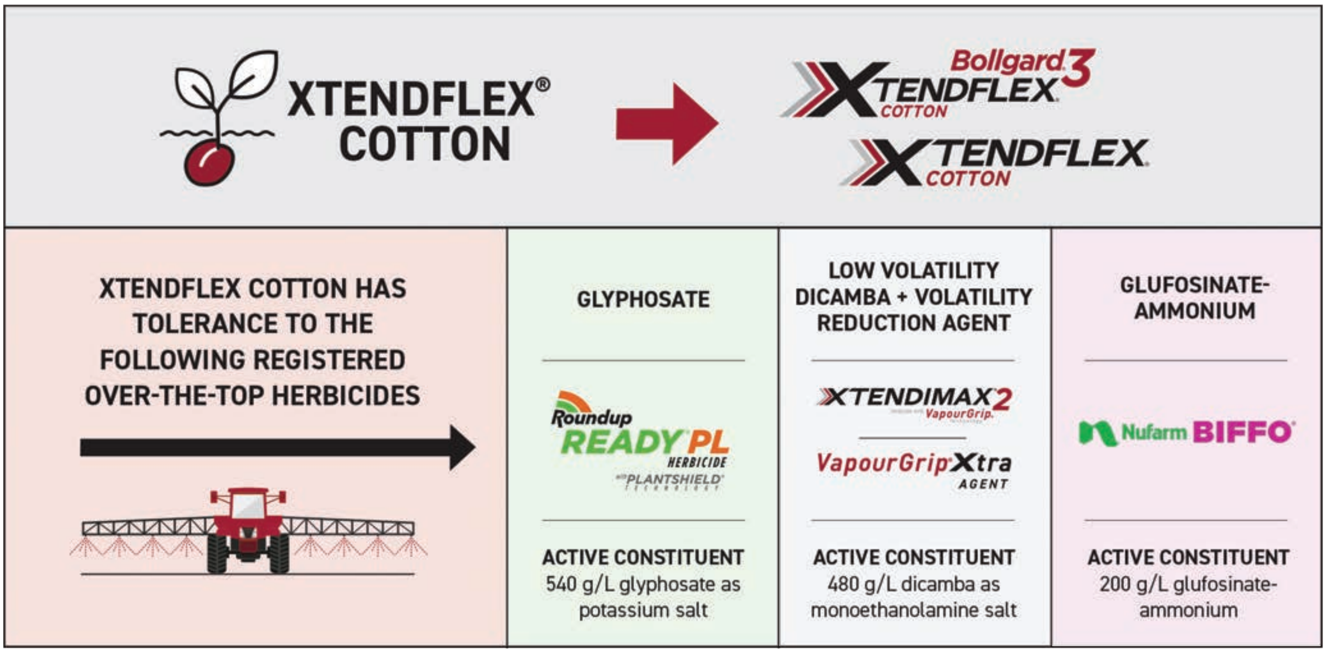
CONTENTS

INTRODUCING XTENDFLEX COTTON

XtendFlex® herbicide tolerant cotton (XtendFlex cotton) provides cotton growers with greater flexibility to use additional herbicide modes-of-action to target glyphosate resistant weed populations and hard-to-kill weed species.

XtendFlex cotton provides over-the-top tolerance to registered glyphosate, dicamba and glufosinate-ammonium herbicides, providing growers with the technology and flexibility to select the best weed management strategies for their farm and weed spectrum. In addition to being tolerant to these three herbicides, the XtendFlex cotton trait will be stacked with the Bollgard® 3 insecticide trait, enabling growers to achieve *Helicoverpa* spp. control. XtendFlex cotton will also be available without the Bollgard 3 trait. Please refer to the Bollgard 3 Resistance Management Plan prior to planting XtendFlex cotton containing the Bollgard 3 insecticide trait.

Figure 1: The XtendFlex cotton trait provides the ability to use over-the-top (OTT) applications of multiple herbicides.



*XtendFlex cotton is not tolerant to other Group 4 Herbicides (eg. 2, 4-D)

For a copy of the Roundup Ready PL Herbicide, XtendiMax 2 Herbicide and VapourGrip Xtra Agent product labels and safety data sheets, please visit the Bayer Crop Science website at www.crop.bayer.com.au/products.

For a copy of the Biffo® product label and safety data sheet, visit the Nufarm Australia website at www.nufarm.com/au/product/biffo

XTENDFLEX SYSTEM OVERVIEW

XtendFlex cotton is tolerant to applications of glyphosate, dicamba and glufosinate-ammonium.

1. Glyphosate#

Roundup Ready® PL Herbicide with PLANTSHIELD® Technology and Roundup Ready Herbicide with PLANTSHIELD are registered for pre-emergence, in-crop and post-harvest application uses in XtendFlex cotton. (Figure 2).

2. Dicamba

XtendiMax® 2 Herbicide with VapourGrip® Technology is registered for application in XtendFlex cotton. VapourGrip technology reduces the volatility of dicamba by preventing the formation of volatile dicamba acid. XtendiMax 2 herbicide is based on a low-volatility form of dicamba, and with the further volatility reduction enabled by the added VapourGrip Technology, it becomes significantly less volatile than other commercially available formulations of dicamba, helping farmers reduce off-target movement when used in accordance with label and stewardship guidelines.

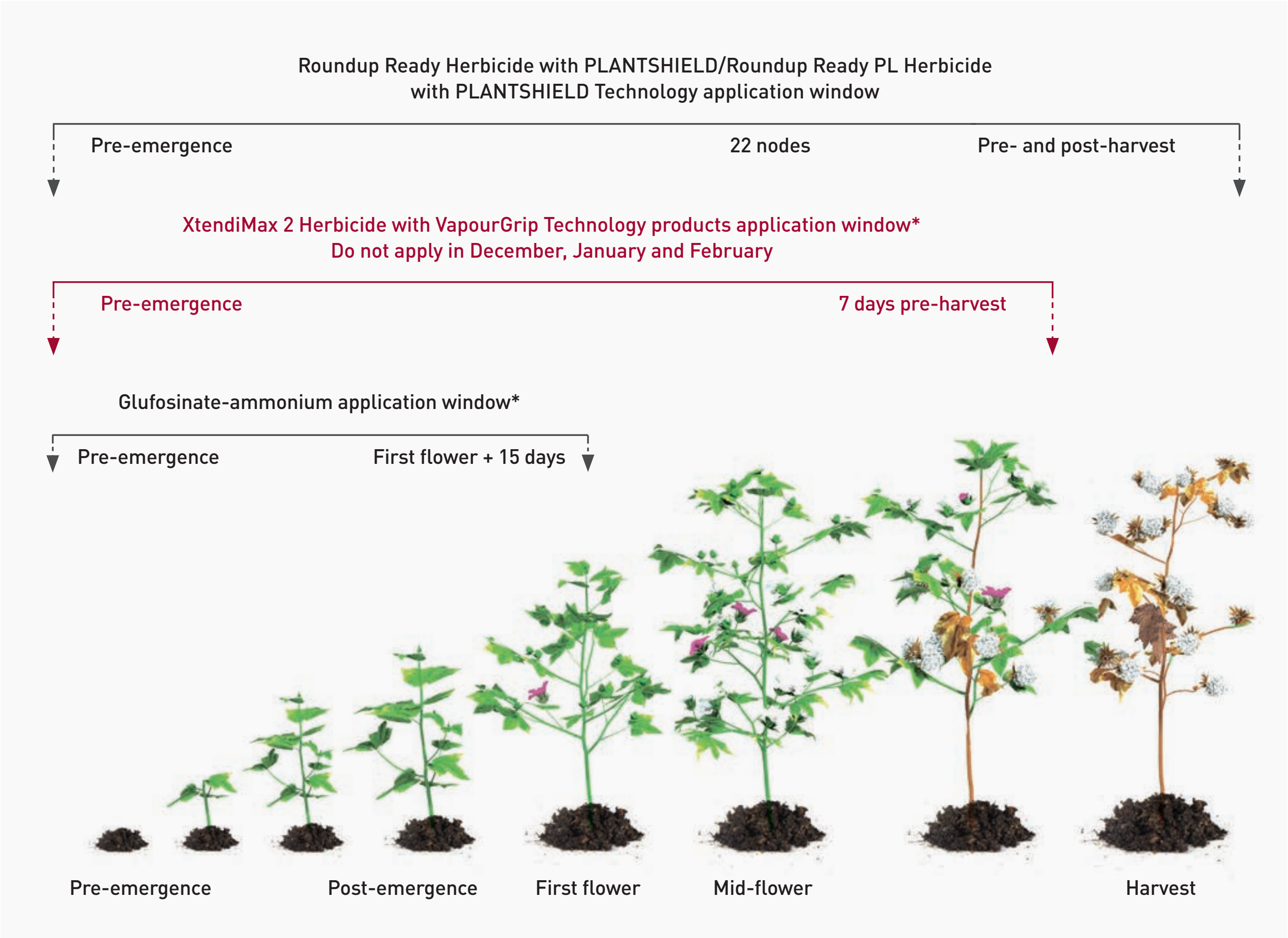
Refer to the chapter 'How does the volatility reduction technology work?' for more detailed information.

3. Glufosinate-Ammonium

Nufarm (Biffo®) Herbicide is registered for use in XtendFlex cotton and provides additional control options for broadleaf and grass weeds.

Refer to the section 'Why is glufosinate an important component of the XtendFlex Crop System' for more detailed information.

Figure 2: Application window for products applied in XtendFlex cotton.



*Observe required plant-back interval before planting cotton.

Roundup Ready Herbicide with PLANTSHIELD and glufosinate-ammonium products contain ammonium ions and therefore cannot be tank mixed with XtendiMax 2 as ammonium ions negate the effectiveness of the volatility reduction technology.

COTTON VARIETIES CONTAINING THE XTENDFLEX HERBICIDE TOLERANCE TRAIT

There are a number of cotton varieties available that contain the XtendFlex herbicide tolerance trait. For information on these varieties contact your local CSD E&D agronomist or Bayer Territory Business Manager.

VOLATILITY REDUCTION TECHNOLOGY

Many post-emergent herbicide active ingredients are weak acids, meaning they don't hold on strongly to their hydrogen ions (H^+). This means the H^+ ions can be displaced into solution. These herbicides are often formulated as a salt of the parent acid rather than the acid itself, because it improves solubility, compatibility and stability. Dicamba acid has a higher vapour pressure than many other herbicide active ingredients in use in Australia, and therefore is considered to be more volatile (can turn to a gas or vapour and move from one place to another under ambient conditions). The volatility of dicamba and other herbicides is also influenced by formulation.[2]

When dicamba salts dissolve in water they separate (dissociate) into a dicamba anion (Dc^-) and a counterion, which is commonly ammonium (NH_4^+). The Dc^- anions can combine with any available H^+ ions in solution to form the volatile dicamba acid (DcH). As the pH of the solution becomes more acidic, there are more H^+ ions in solution and therefore available for the Dc^- anions to combine with. When the starting pH reaches 5.0, only a very small fraction (0.1%) remains as DcH.[2]

In older dicamba formulations, such as those based on the dimethylamine (DMA) salt, the Dc^- anions are present in solution and so can easily combine with H^+ ions to form DcH (Figure 4). Low-volatile formulations are engineered to reduce the amount of dicamba disassociating to the parent acid, thereby preventing Dc^- anions from combining with H^+ ions, which then significantly reduces its volatility.[3]

(Figure 5)

Figure 4: For dicamba formulations without volatility reduction technology, there is the potential for dicamba acid (DcH) to form in solution and increase the volatility of dicamba after spraying, increasing the risk of off-target

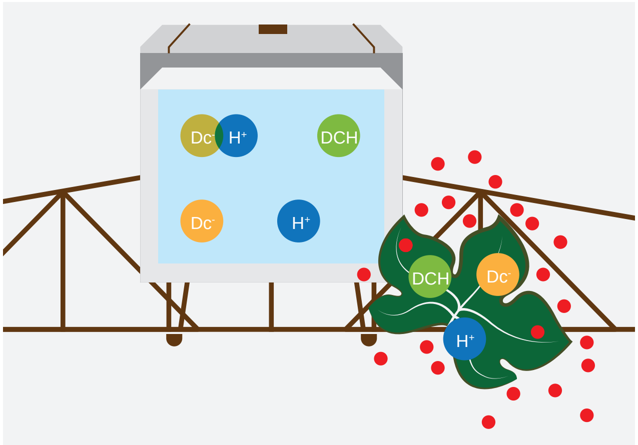
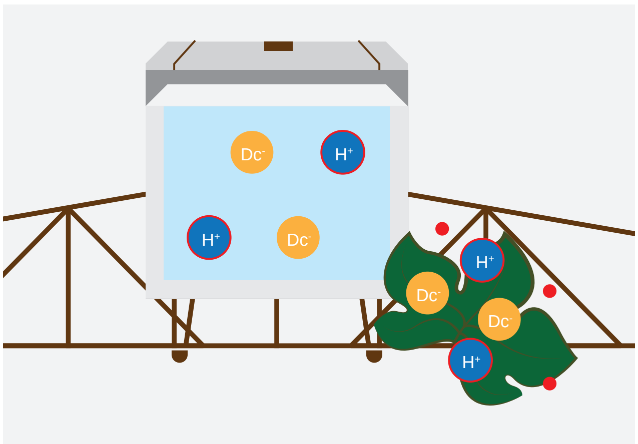


Figure 5: The volatility reduction technology in VapourGrip reduces the formation of dicamba acid (DcH) in solution, minimising the volatility of dicamba after spraying,



2. Hartzler, 2017. 3. Bayer.ca, 2019

WHY DO WE NEED THE XTENDFLEX COTTON SYSTEM?

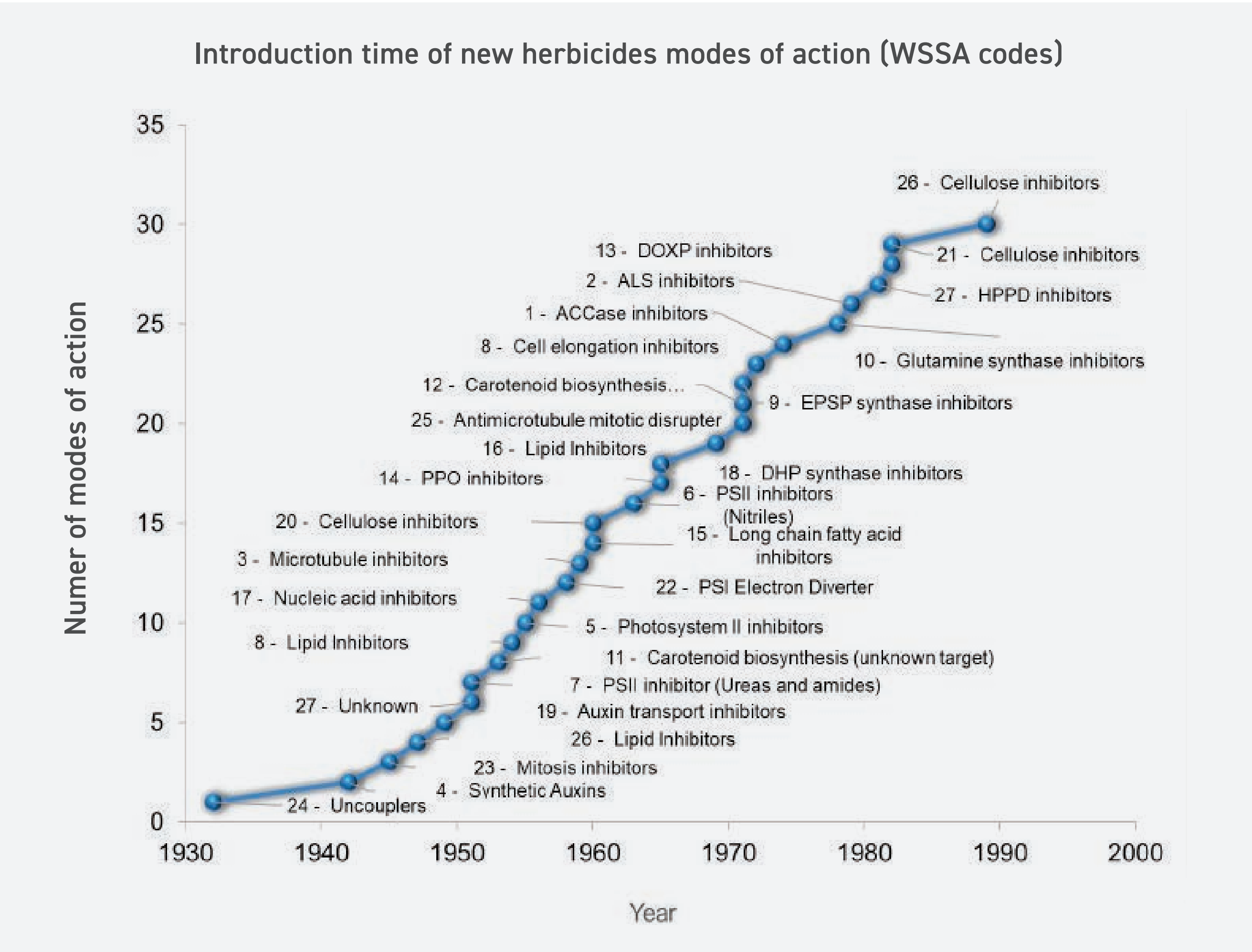
As herbicide resistance increases and weeds become more difficult to control, growers will need to diversify weed management practices. There are two key features which make it a valuable integrated weed management (IWM) tool;

- **1. Protecting glyphosate**
- **2. Ability to use multiple herbicide modes of action (MOA).**

Protecting glyphosate

With such a broad pattern of use across a large number of crops, the continued performance of glyphosate is important to the ongoing success and efficiency of Australian agriculture. Since the first discovery of a glyphosate resistant weed population in 1996, the prevalence of glyphosate resistance has increased and is a major concern for the entire industry.

Figure 6: The last new herbicide mode of action was introduced globally 30 years ago, so it is imperative we protect the herbicides we have.[4]

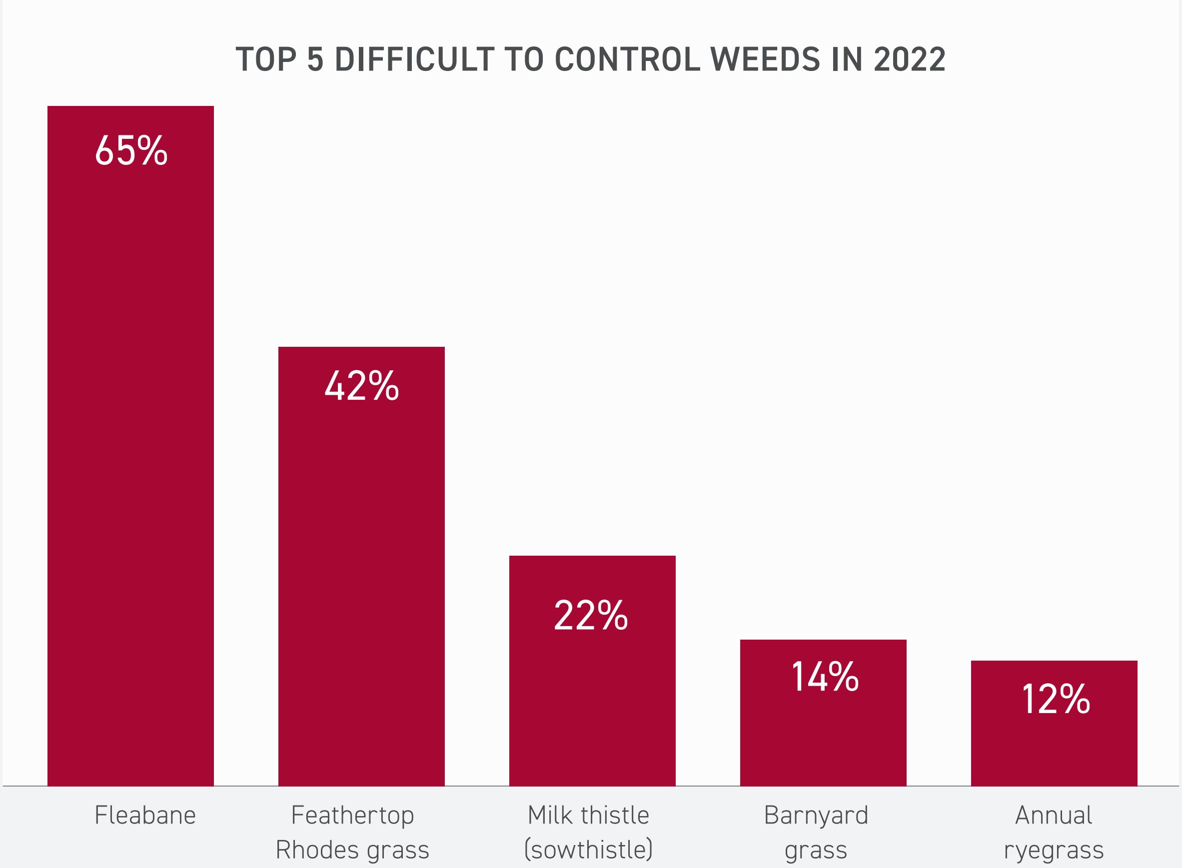


4. Heap, 2019

Every three years Bayer conducts an IWM survey of cotton farmers to understand weed management challenges and current weed management techniques. The 2022 survey was conducted with 58 growers and 7 consultants. Key findings from the survey include;

- 88% of growers rated the efficacy of glyphosate used in their cotton crop as excellent or good
- The top five difficult to control weeds include both grass and broadleaf species. (Figure 7)

Figure 7: The top five difficult to control weeds identified in Bayer's 2022 IWM survey include both grass and broadleaf weeds as rated by growers.



Three herbicide modes-of-action (MOA)

The three herbicide MOAs (products from Groups 9, 10 & 4) that will be able to be used over the top of XtendFlex cotton offer more options to control a broader range of weeds than in other summer crops and the existing Roundup Ready Flex system. XtendFlex cotton offers growers more flexibility to select herbicide(s) on a paddock-by-paddock basis to target specific weed populations. The ability to use new herbicide combinations in rotation with existing integrated weed management practices, will help growers achieve greater weed control, and thus yield potential. Table 2 provides trial results highlighting improved control of hard-to-kill weeds such as fleabane, feathertop Rhodes grass, and barnyard grass.

Table 2: Agronomic Services trial results 2019-2024 demonstrating control achieved using different herbicide strategies on hard to kill weeds in cotton.

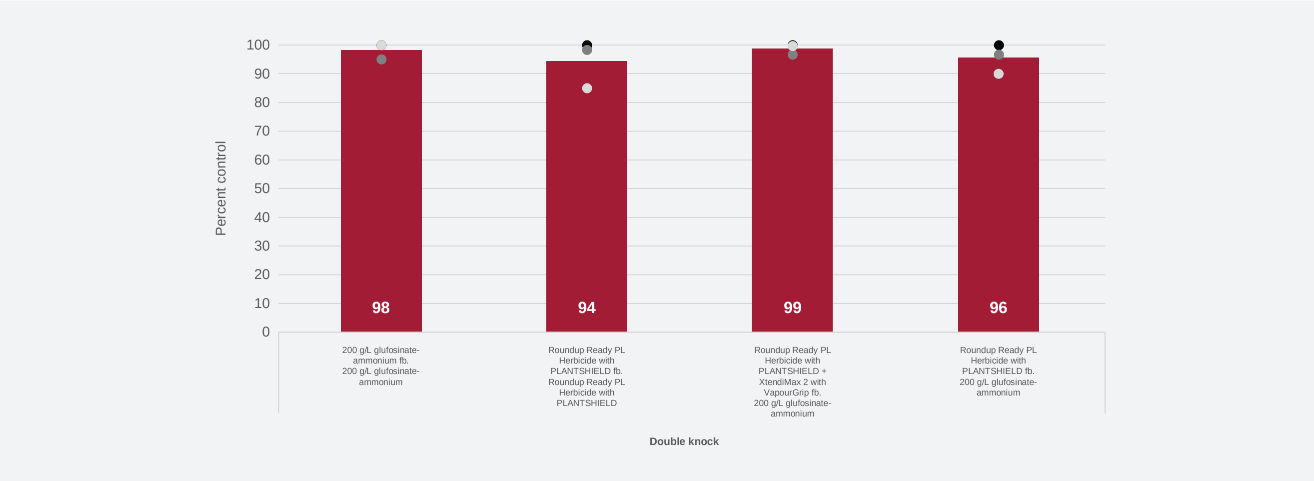
		Single application			Double-knock			
Common name	Scientific name	Roundup Ready PL Herbicide with PLANTSHIELD	Glufosinate-ammonium 200 g/L (Biffo)	Xtendimax 2 Herbicide with VapourGrip Technology	Roundup Ready PL Herbicide with PLANTSHIELD fb. Glufosinate-ammonium 200 g/L (Biffo)	Glufosinate-ammonium 200 g/L (Biffo) fb. Glufosinate-ammonium 200 g/L (Biffo)	Roundup Ready PL Herbicide with PLANTSHIELD fb. Roundup Ready PL Herbicide with PLANTSHIELD	Roundup Ready PL Herbicide with PLANTSHIELD + XtendiMax with VapourGrip fb. Glufosinate-ammonium 200 g/L (Biffo)
Flaxleaf fleabane	*Conyza bonariensis*	NR	38.3 (2)	NR	75.0 (1)	91.7 (1)	NR	95.0 (1)
Feathertop Rhodes grass	*Chloris virgata*	NR	90.0 (1)	NR	95.7 (1)	100.0 (1)	NR	-
Barnyard grass	*Echinochloa colona*	70.8 (8)	86.6 (2)	NR	94.4 (6)	97.0 (5)	97.2 (6)	98.8 (3)
Peachvine	*Ipomoea lonchophylla*	NR	46.6 (2)	96.7 (1)	85.0 (2)	100.0 (1)	NR	-
Common sowthistle	*Sonchus oleraceus*	65.8 (2)	80.8 (3)	NR	90.0 (1)	80.0 (1)	67.5 (2)	-
Caltrop	*Tribulus terrestris*	91.5 (2)	99.6 (2)	100.0 (2)	99.8 (2)	100.0 (1)	98.4 (2)	100.0 (1)

<60% control
60-80% control
80-90 % control
90-100% control

(x) indicates the number of trial results
NR = Not registered
Note: All treatments across all trials were applied at full label rates.

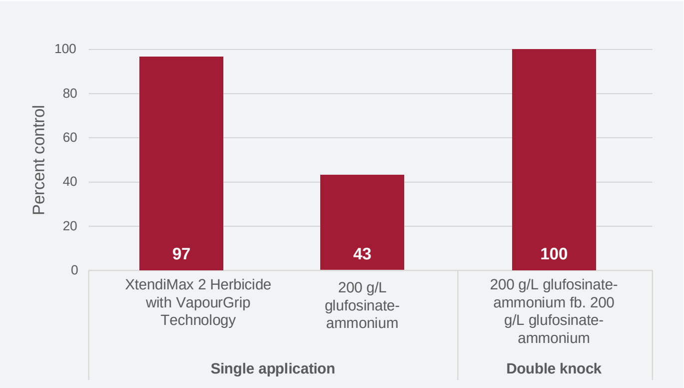
Trial ID's: QJ02, QJ06, QJ07, QJ12, QJ13, QJ18, QJ21, QJ27, QJ29, NA 32, NA52, NA53, NA55, NC01, NC02, NC03, NC04, NC05, NC06, NC07, NC08, NC10

Figure 8: Barnyard grass (*Echinochloa colona*)



Note: full label rates were used for all treatments

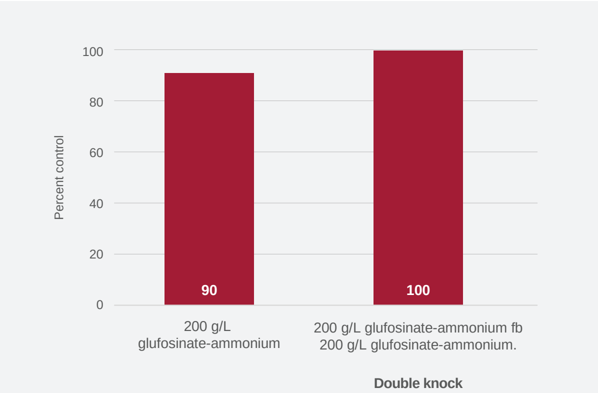
Figure 9: Peachvine (*Ipomoea lonchophylla*)



Trial ID: NC01

Note: full label rates were used for all treatments

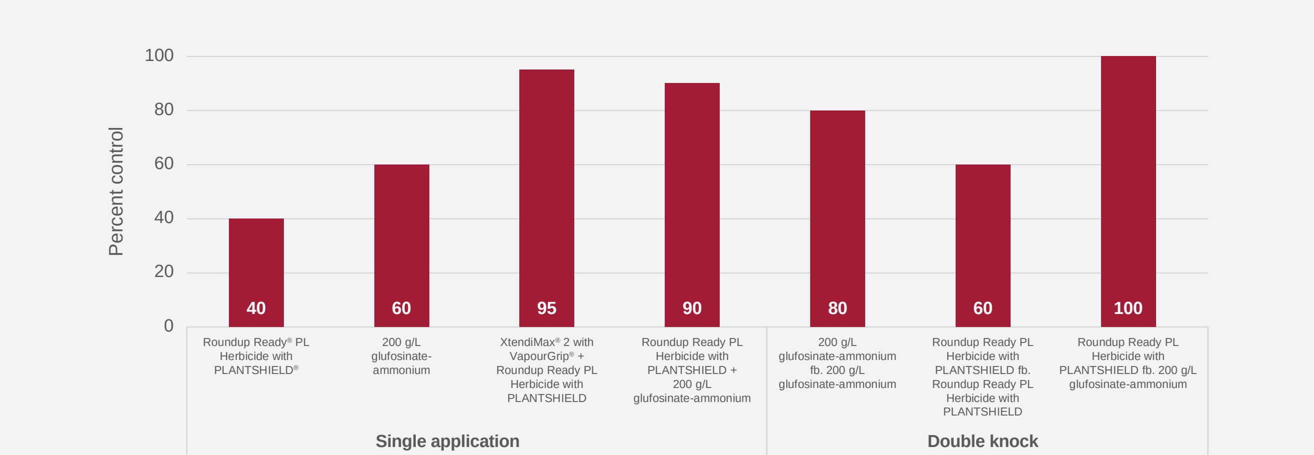
Figure 10: Feathertop Rhodes grass (*Chloris virgata*)



Trial ID: QJ27

Note: full label rates were used for all treatments

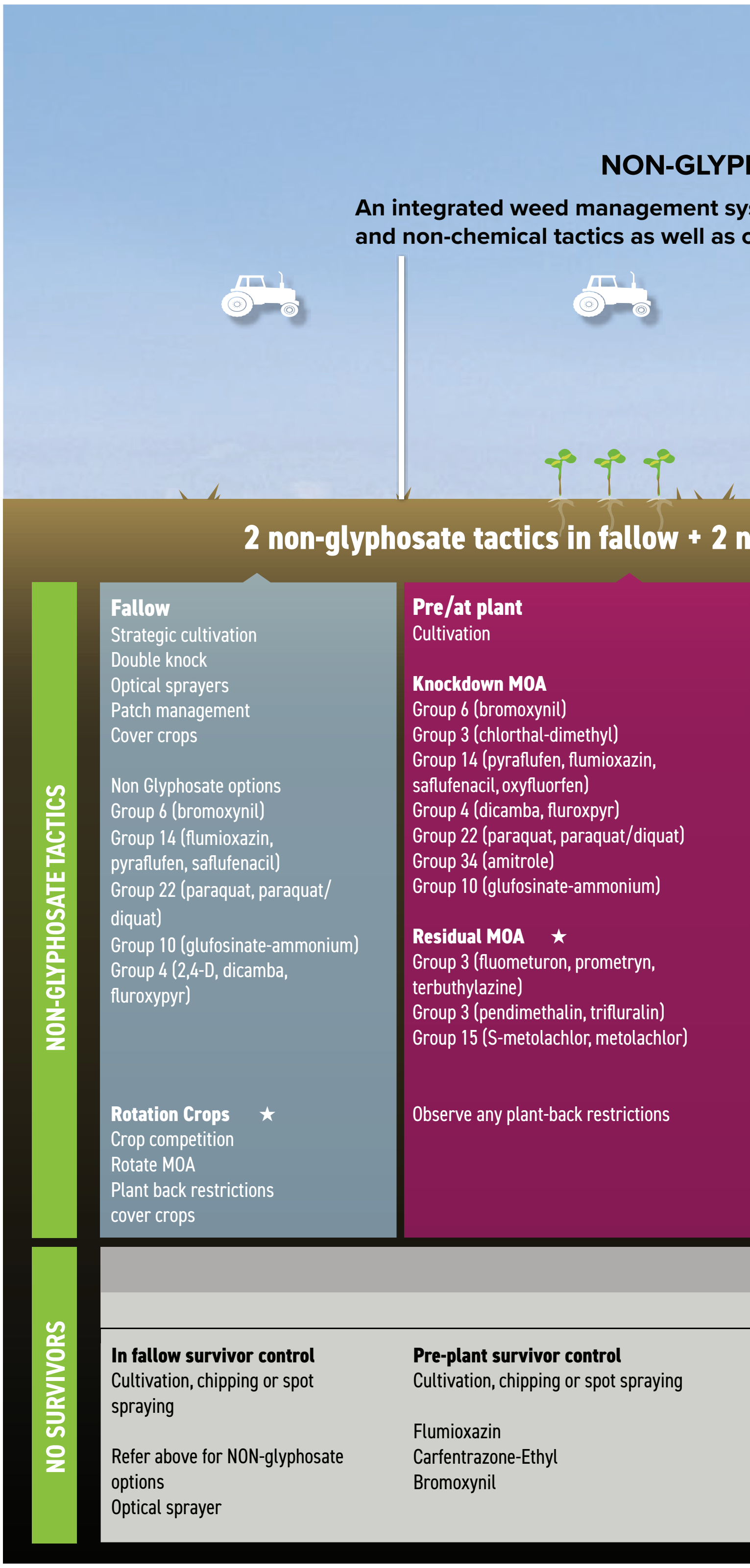
Figure 11: Common sowthistle (*Sonchus oleraceus*)



Trial ID: NC01

Note: full label rates were used for all treatments

It would be a distinct advantage for growers to incorporate these options where appropriate to help maintain effective integrated weed management (IWM). The industry recommendation is for growers to use 2 non-glyphosate weed control tactics in fallow and 2 non-glyphosate tactics in crop to target no survivors (2+2=0). These may be products with other herbicide modes of action or timely cultivation. It is also important to remember that the +2 in fallow need to be different from the +2 in crop. Refer to www.cottoninfo.com.au/weed-management for further information.



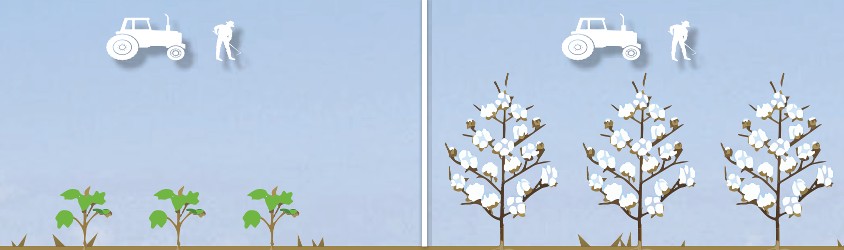
Always refer to and follow product label instructions and permits prior to use.

5. CRDC and Cotton Info, 2019

Integrated weed management tactics[5]

HOSATE WEED TACTICS FOR THE COTTON FARMING SYSTEM

stem relies on a large number of interrelated, complementary components including both chemical cultural practices such as rotation, crop competition, farm hygiene, and crop scouting.



on-glyphosate tactics in crop & NO SURVIVORS

Post-emergent #
In-crop cultivation
Manual chipping
Rogueing

Post-emergent OTT MOA
Group 1 * (clethodim, butroxydim, propaquizafop, haloxyfop)
Group 15 (S-metolachlor**)
Group 0 (MSMA)

Lay-by, directed or shielded spray
Group 6 (fluometuron, prometryn, terbuthylazine, diuron)
Group 3 (pendimethalin, metolachlor)
Group 14 (flumioxazin**)

Survivor control
Aim for 100% control
Cultivation, chipping or spot spraying

Comments

Survivors MUST be controlled by another tactic prior to seed set

Read and follow label directions

Rotate herbicide Mode of Action

Come Clean. Go Clean. to stop weed seeds.

Scout fields to look for weed survivors

Keep accurate field records

Ensure effective volunteer/ratoon management

DO NOT rely on glyphosate to control weeds in non-field areas

Weed management requires a farming systems approach, winter, summer and non-field areas.

* Group 1 herbicides already exhibit widespread resistance in several species. Controlling survivors is essential.

Mix full rates of different MOA, and rotate to alternative MOA in following years

★ Refer to label for plant back restrictions to following crop

**Limited formulations are registered for this use. Please check label.
13460, 12941

Survivor control

Aim for 100% control

Post-emergent
Inter-row cultivation, chipping or spot spraying

Post harvest
Root cutting for crop destruction
Cultivation, chipping or spot spraying

Carfentrazone-Ethyl
Bromoxynil
Fluroxypyr

CRDC Cotton Research and Development Corporation
CottonInfo

Field events

Bayer understands it is important for growers and advisors to see the technology first-hand so a number of field events will be organised so growers can see the XtendFlex system performance first-hand. For further details, go to *xtendflex.com.au.*

STEWARDSHIP TRAINING

It is compulsory for all applicators of XtendiMax 2 Herbicide to complete the XtendFlex Cotton Spray Applicator Training. This includes;

- The person who will sign the Technology User Agreement (TUA)
- Any farm employee who mixes or applies XtendiMax 2 Herbicide with VapourGrip Technology
- Any contractor who mixes or applies XtendiMax 2 Herbicide with VapourGrip Technology

Training only needs to be completed once, after completion the trainee will be certified.

TOOLS AND RESOURCES AVAILABLE

Bayer is committed to training and providing growers with the tools required to both successfully use XtendFlex cotton and to ensure its co-existence with other cropping systems. This focus on product stewardship helps to ensure the longevity of the technology.

The XtendFlex cotton website *xtendflex.com.au* is the best place to find resources and tools. It will continually be updated with key information including;

- Recommendations on how to best use the XtendFlex system
- Product labels
- Resistance Management Plans, developed in conjunction with the Transgenic Insecticide Management Strategy (TIMS) Committee - Herbicide-Tolerant Crops Technical Panel
- Refresher training module videos
- The XtendFlex cotton Spray App https://www.crop.bayer.com.au/tools/weather-inversion

CROP SAFETY

- **Applications of products containing dicamba have produced some leaf spotting on XtendFlex cotton.**
- **This spotting has not caused a yield effect in our trials across the USA and Australia.**
- **Trials have demonstrated that the best performance is achieved when weeds are sprayed early at the correct growth stage.**

Spotting on XtendFlex cotton leaves after application of XtendiMax 2 Herbicide with VapourGrip Technology.

Videos

OFF TARGET MOVEMENT OF PESTICIDE

Craig Day (Spray Safe and Save) and Matt Hayes (Bayer) talk about: different types of off target movement, surface temperature inversions and sensitivity of different crops to 2,4-D and dicamba.

THE IMPORTANCE OF A CLEAN SPRAYER

Craig Day (Spray Safe and Save) talks about: the importance of a clean sprayer, how to decontaminate your spray rig and the correct mixing order for herbicides.

ENVIRONMENTAL CONSIDERATIONS

Craig Day (Spray Safe and Save) talks about: specific application requirements (e.g. wind speed), Delta T, surface temperature inversions and the XtendFlex cotton Spray App.

NOZZLE SELECTION

Craig Day (Spray Safe and Save) talks about: different nozzle types and how to select the correct nozzle.

SPRAY PLANNING

Craig Day (Spray Safe and Save) talks about how a spray plan allows for the development of a management strategy for the safe and responsible application of herbicides.

THE IMPACT OF WATER QUALITY

Craig Day (Spray Safe and Save) talks about: the importance of water quality and its impact on the efficacy of herbicides.

SPRAY APPLICATION THEORY: HOW TO MAXIMISE PRODUCT EFFICACY AND STOP OFF-TARGET MOVEMENT (OTM)

Correct application of any herbicide is critical to ensure that the risk of off-target-movement is minimised. It is not only essential to maximise the efficacy of the products but is also critical to reduce the risk of OTM. This chapter outlines some key theories of best practice spray application.

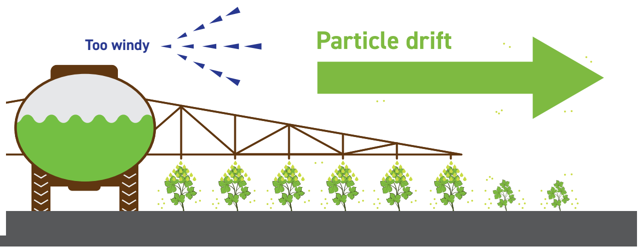
What is physical drift?

Physical drift is the movement of spray particles during application and is the most common and significant type of OTM for any herbicide. It is most common when conditions are too windy and droplets that are too fine are used, as the smaller the droplets, the slower they fall and the further they can drift.

Figure 12: Examples of off-target movement.

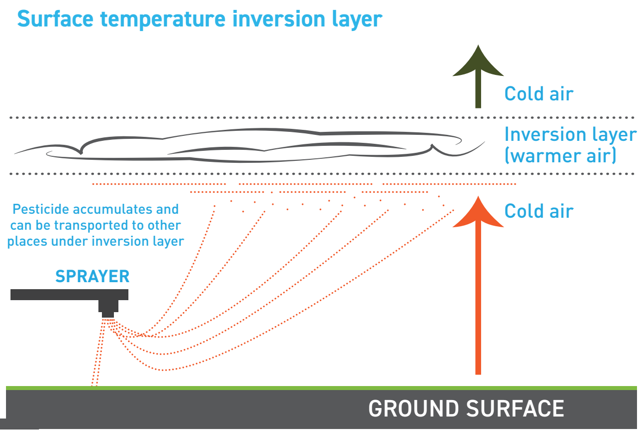
Physical drift

Physical movement of spray particles or dust **during and after** spray application.



Surface temperature inversions

During a surface temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud, rather than dropping to their target. Inversions are more common just before sunset through to one or two hours after sunrise and the inversion intensity varies during the night. They generally disperse as wind speeds increase and when the air warms after sunrise.



Volatility

Movement of pesticide as a gas or vapour **after** application. **Least frequent** type of off-target movement.

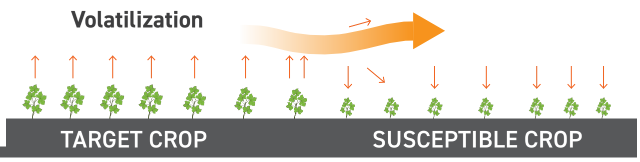
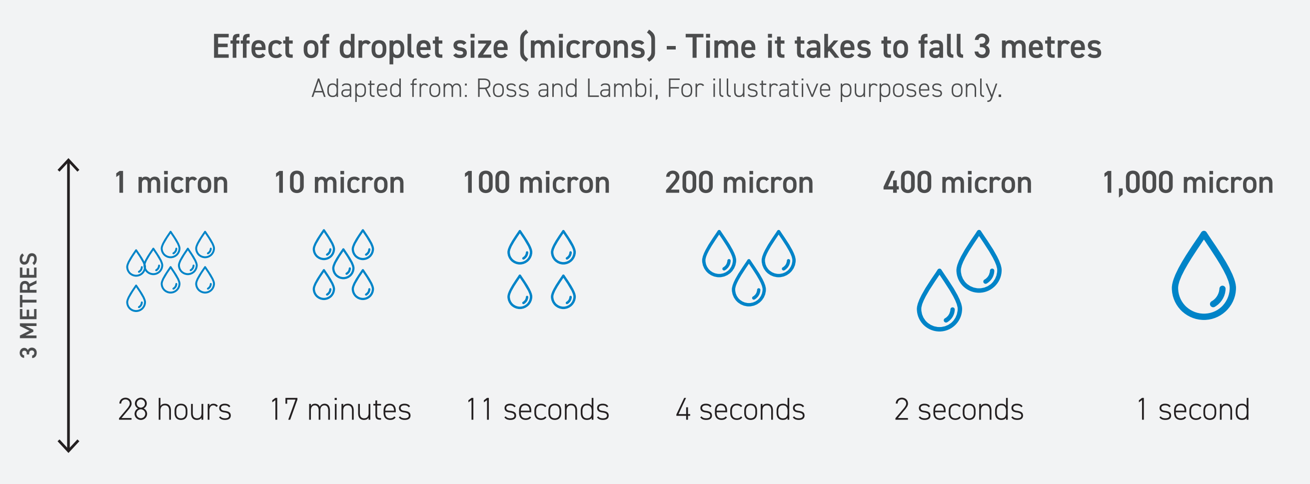


Figure 13: Small droplets take longer to fall than larger droplets and are therefore more likely to drift.



Drift can be minimised by;

When using any herbicide be sure to:

- **Use the correct nozzle type and pressure:** Nozzle selection is one of the most important parameters to reduce drift. Nozzle type and spray pressure affect the droplet size and percentage of driftable fines (<141 microns) - see Figure 11. Ensure correct setup so spray droplets are compliant with the herbicide label.
- **Avoid spraying when conditions are too windy:** Always refer to the product label for the required wind speed during application and observe the minimum distances between the application site and downwind sensitive areas.
- **Using a Drift Reduction Agent (DRA):** A DRA may be used to further reduce fine droplets. Not all drift reduction additives are compatible with every nozzle type and pesticide/adjuvant combination, so it is best for the grower to check with the additive manufacturer if the additive will work with their specific situation. Ammonium-based products are not to be mixed with XtendiMax 2 Herbicide. Refer to page 36 for further information. Refer to Figure 12.

Avoiding surface temperature inversions

Surface temperature inversions occur when the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud, rather than dropping to their target. They are more common just before sunset through to one or two hours after sunrise and the inversion intensity varies during the night. They generally disperse as wind speeds increase and when the air warms after sunrise. The most common scientific method for detecting a surface temperature inversion requires the accurate measurement of the vertical temperature profile. This is not practical on farm, so applicators must rely on visual and other clues.

An 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 ground surface
- Cumulus clouds that have built up during the day collapse towards evening
- Wind speed is constantly less than 11 km/h 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.

A strong surface temperature inversion is unlikely to exist if;

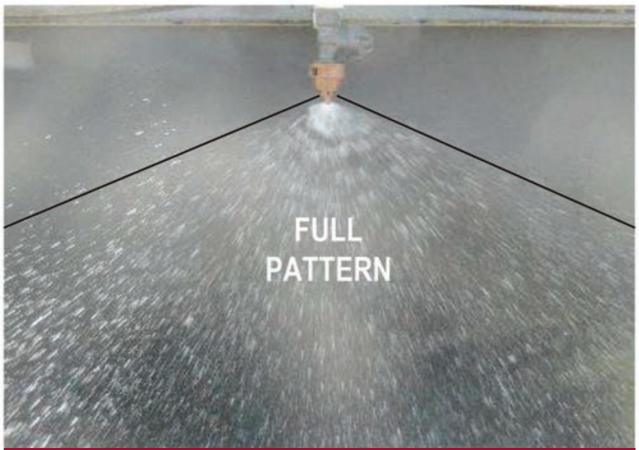
- There is continuous low and heavy cloud
- There is drizzle or rain
- Wind speed is greater than 11 km/h between sunset and sunrise
- Cumulus clouds exist.

TTI 11002 Yellow nozzle at variable operating pressure range

Both pressures shown below are within the recommended operating range for the nozzle; yet higher pressure improves coverage.

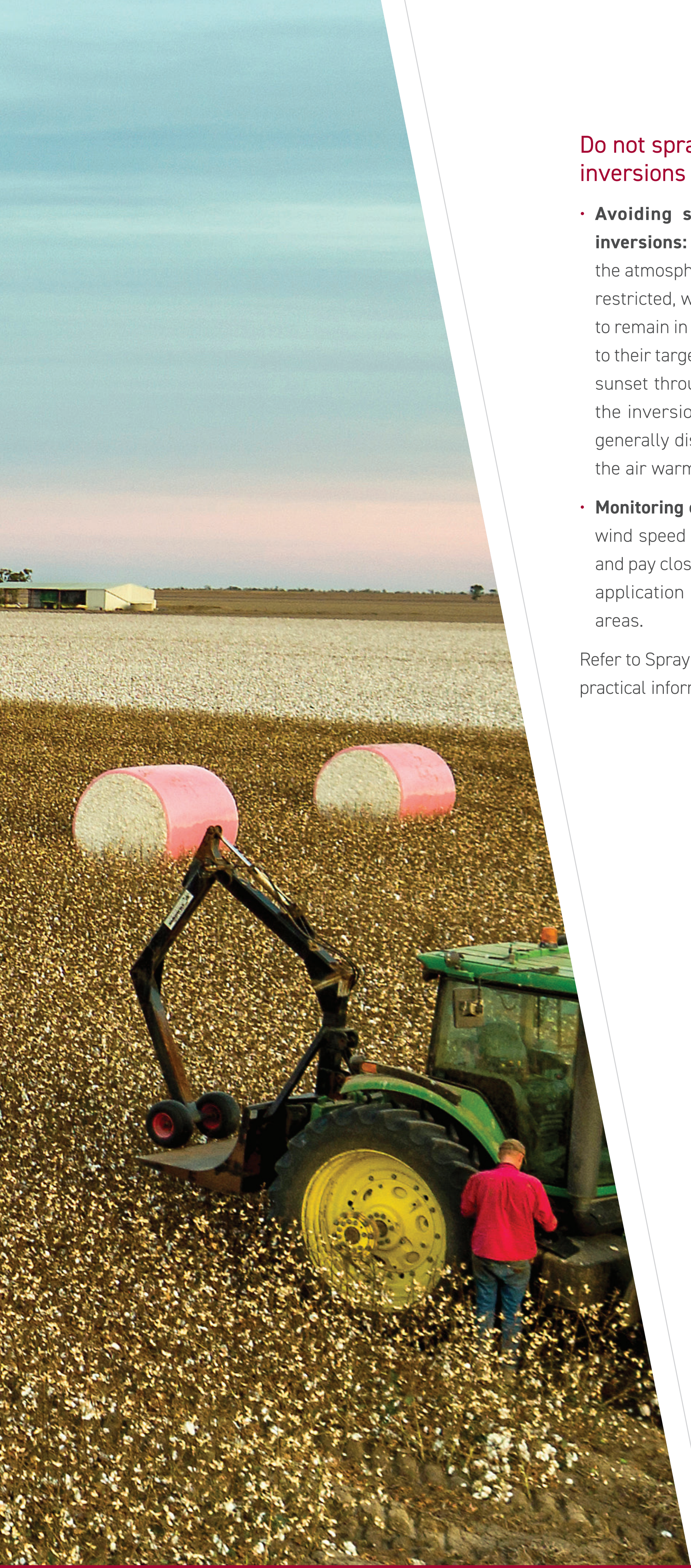
Figure 14: The combination of nozzle type and spray pressure determines droplet size and lower pressures don't always give the best result.[1]

138 kPa



414 kPa

1. Roundup Ready Xtend, 2020



Do not spray during surface temperature inversions

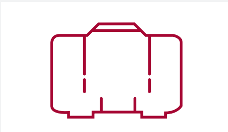
- **Avoiding spraying during surface temperature inversions:** During a surface temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud, rather than dropping to their target. Inversions are more common just before sunset through to one or two hours after sunrise and the inversion intensity varies during the night. They generally disperse as wind speeds increase and when the air warms after sunrise.
- **Monitoring conditions at the site of spraying:** Monitor wind speed and temperature at the site of application and pay close attention to wind speed, temperature and application timing to minimize exposure to sensitive areas.

Refer to Spray Application Best Practice, page 34 for more practical information on surface temperature inversions.

Contamination

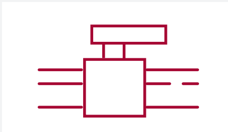
Contamination occurs in spray units when herbicide residues have not been thoroughly cleaned between applications of different products. If not cleaned thoroughly, herbicide residue can remain in parts of the sprayer and be unintentionally applied to sensitive crops in the next herbicide application. Figure 13 explains where the sprayer should be checked and cleaned.

Figure 15: Areas of the sprayer that should be checked and cleaned to prevent contamination.



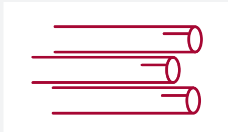
TANK

- Welded seams (steel tank)
- Material adsorption (poly tanks)
- Baffles
- Agitation paddles and jets, sparger tubes
- Corners (flat botttom tanks)
- Sump
- Lid and tank rim



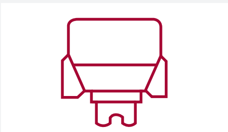
VALVES

- All valves should be cycled during flushing and cleaning
- Front and side loading ports
- Flowmeters and associated lines/hoses



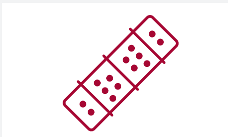
LINES/HOSES

- "U" bends can serve as traps that hold spray solutions and allow pesticides to seperate
- Cracks and rough edges can trap residues
- Imperfections on interior surfaces inherent to material type



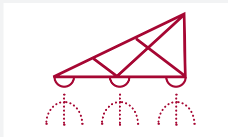
NOZZLE TIPS

- Unused nozzle bodies and pressure check valves
- Nozzle turrets



SCREENS

- Inline strainers before and after pump
- Suction filters at front and side-fill ports
- Nozzle screens



BOOM

- Dead ends and end caps
- Large booms can hold as much as 130 L of solution

Refer to the After Spray Cleaning section on page 36 for the correct procedure to avoid contamination from the herbicides used in XtendFlex cotton.

Plantback periods

A herbicide's plantback period is the period of time that is required to pass for the applied herbicide to no longer be persistent in the soil at a concentration that would impact the following crop or pasture. Herbicides break down in the soil via two main pathways; microbial activity, hydrolysis, or a combination of both.

There are a number of factors that influence the persistence of a herbicide in the soil;

- **1. Soil microbial activity:** All herbicides require soil microbes for their degradation. Often different microbial families are required to breakdown different herbicides.
- **2. Moisture:** This is the most critical factor, as adequate soil moisture is required for microbial degradation to break down the herbicide. Plantback periods described on labels assume normal rainfall periods, so if conditions have been drier than usual then using a longer plantback period is advised.
- **3. Time of application/temperature:** Assuming adequate soil moisture, herbicide degradation is fastest in the warmer months than colder months.
- **4. Soil type/properties:** Herbicides applied to soils higher in organic matter and heavier soils are bound tightly by the soil and are less available for degradation.
- **5. Soil structure:** If soils have physical impediments, such as hard pans, herbicides can accumulate in these areas and degradation is reduced.
- **6. Stubble:** Some herbicides will bind to crop residue and other organic material, making it unavailable for soil microbial degradation.
- **7. Herbicide chemical properties:** The chemical structure of a herbicide determines how soluble it is in water, how tightly it binds to the soil, its breakdown pathway and how quickly it degrades. The soil half-life of a herbicide is a good indicator of how persistent a herbicide is.

Table 4: For irrigated cotton, wait for the following plantback periods before planting the corresponding crops into soils or soil that have grown crops sprayed with XtendiMax 2 Herbicide.

	Plantback period (days)#				
Rate/ha	Barley	Canola	Chickpeas	Oats	Wheat
1170 mL	35	56	56	35	35

#Plant back period only commences once a minimum of 15 mm of rainfall or irrigation has been received following application.

Planting crops following applications to dryland cotton may require longer plant back periods and/or interim rainfall. In some situations, there may be significant crop biomass reductions when winter crops are planted back after application of the product in dryland cotton.

Dicamba is a very water soluble herbicide, so it may cause some reduction in crop vigour if waterlogging occurs after sowing. Care should also be taken to prevent runoff which could damage sensitive off-target and aquatic species. Therefore, treated crops must not be flood irrigated or irrigated to the point of field run-off for at least 3 days after application, unless run-off can be captured on farm.

Boom sprayer calibration

Calibrating the boom sprayer is important to ensure the correct dose is delivered to the target. Also, it addresses the legislative requirements of every spray operator to minimise the potential for off-target movement of chemicals.

Before the calibration process begins, it is important to;

- **1.** Ensure the sprayer has been thoroughly cleaned both internally and externally, including the nozzles and filters
- **2.** Select appropriate personal protective equipment (PPE)
- **3.** Check and record tyre pressures (i.e. tractor drive tyres in a tractor pulled boom situation)
- **4.** Fit the appropriate nozzles
- **5.** Record all controller settings: flow meter constant, speed constants, boom width/nozzle count per section.

When calibrating a boom spray there are a number of areas to be checked;

- **1.** Speed
- **2.** Nozzle pressure
- **3.** Flow meter
- **4.** Induction hoppers
- **5.** Inflow/tank filling meters
- **6.** Tank
- **7.** Fence line jets.

Following the calibration process in the order listed above is important as often you can't calibrate one individual part of the sprayer without calibrating others.

Calibrating boom speed

Start the process by operating the sprayer with three quarters of a load of water at the desired operating speed with the sprayer pump engaged, nozzles running and agitation occurring. There are two approaches to calibrating boom speed; using a formula, or if the sprayer has a wheel speed sensor or radar, by ensuring the rate controller speed is the same as the accurate GPS speed.

Using a formula to calculate speed

$$\text{Speed in km/h} = \frac{\text{distance travelled (metres)} \times 3.6^{\#}}{\text{time taken in (seconds)}}$$

#'3.6 in the calculation is a conversion factor to convert m to km (m ÷ 1000) and seconds to hours (seconds ÷ 3600)

= D/1000 ÷ S/3600 = D/1000 x 3600/S = D/S x 3600/100 = D/S x 3.6)

For example, the boom travels 100 m in 18 seconds.

$$\text{Speed in km/h} = \frac{100 \times 3.6}{18}$$

Speed = 20 km/h

Matching the rate controller speed to the GPS speed

This approach also uses formulas, where the correct formula depends on whether the speed constant is in pulses per unit (PPU) or unit per pulse (UPP). It also allows the operator to quickly calibrate speed when paddock conditions change (i.e. spraying worked ground). Once calibrated, record the new speed constant and the gear, RPM and tyre pressure that was used in the calibration process.

Formula 1: For rate controllers where the constant is in PPU:

$$\frac{\text{rate controller speed km/h}}{\text{GPS (actual) speed km/h}} \times \text{speed constant PPU}$$

Formula 2: For rate controllers where the constant is in UPP:

$$\frac{\text{GPS (actual) speed km/h}}{\text{rate controller speed km/h}} \times \text{speed constant UPP}$$

Other speed considerations

- **1. Boom wingtip speed:** Operators should avoid sharp turns while spraying because of the reduced dose that occurs on the extremity of the outer wing. A 20 m wide boom travelling at 20 km/h has a wingtip speed of approximately 36 km/h when going around a corner. This means about 50% of the dose rate is being applied.

- **2. Tractor transmission issues:** Because constant speed equals consistent dose rate, before speed can be calibrated the tractor needs to be driven to ensure the desired operating speed is not between clutch packs and preferably that the minimum and average speed can be achieved within the same clutch pack. This is an issue with electronic command gearboxes, full power shifts and sprayers that have automatic transmissions.

- **3. New sprayer:** Often when a new sprayer has been purchased with a larger capacity, a larger tractor is also required. It is recommended to check the operating speed of the new system before purchasing nozzles to ensure the nozzles are operated correctly.

Calibrating nozzle pressure

Nozzles have the biggest potential impact on chemical performance and are often overlooked, possibly not changed or adjusted to suit the requirements of the chemical being applied. It is critical to match the right droplet size and type to the chemical being applied and the canopy being penetrated.

Before calibrating nozzle pressure, ideally start by installing a new set of nozzles (and keep one after the process for future reference). The following items are handy for the calibration process;

- Calibrated measuring containers
- Calibrated pressure gauge
- Tape measure
- Accurate scales that can be tared as graduations on a jug may be inaccurate
- One dollar coin (reference weight = 9 grams)
- Nozzle chart.

Step 1: Fold out boom

Fold out the boom and operate the entire boom section. If fitted, adjust proportional return taps.

Step 2: Check pressure

Check pressure in each boom section at inlet and extremity. If only using one calibrated testing gauge, set the pressure, for example, to 3 bar. Mark the spray unit's master gauge with a permanent marker and this will ensure the same pressure is achieved when moving the test gauge from section to section.

Step 3: Collect water from nozzles

If pressure is uneven, check for restrictions in flow such as kinked hoses, delamination of hoses and blocked filters. Make required repairs and continue on.

When pressure is even, set at the desired operating pressure. Record litres per minute (L/min) from the rate controller display. Without turning the spray unit off, collect water from four nozzles per section for one minute.

Step 4: Check for wear and uniformity

If checking an existing set of nozzles, install one new nozzle (same brand, type and size as the one to be checked) and use this as a reference. Check the flow of this nozzle at the spray pressure. Calculate the maximum tolerated average flow = flow for new nozzle + 10% = L/min for new nozzle x 1.10. Check all nozzles and calculate the average = sum of nozzle flow/number of nozzles.[6]

Calculate the maximum and minimum accepted limits for individual nozzle flows: +/- 5% of the average measured above. Check that all measured flows for the individual nozzles are within the limits. If one or more nozzles have higher deviations than + or – 5% from the manufacturer's specifications, then all nozzles should be changed.[6]

6. Andersen, 2010

Step 5: Check for accuracy of the flow meter

Use a known test weight, such as a one dollar coin (9 grams) to check the scales for accuracy. Weigh the collected samples on the calibrated scales and compare results to the nozzle chart. If the flow rates are consistent, take an average and multiply that by the number of nozzles on the sprayer. This will give you total L/min (actual). Compare the actual weighed L/min with the controller's L/min This will indicate the accuracy of the flow meter (see below).

Calibrating the flow meter

Flow meter calibration should be carried out at least once every twelve months or when a replacement flow meter is installed. Calibration is also recommended when increasing the L/min consumed by the spray unit as a result of fitting significantly larger nozzles, for example, going from 0.2 to 0.4 capacity.

All flow meters come with a factory calibration number tag figure. For example, a tag figure of 120 PPU indicates the number of pulses which come from the flow meter while 1 litre of liquid passes through. The adjustment of this flow constant can be achieved by fine tuning following these steps:

Step 1: Measure the nozzle pressure

As previously described.

Step 2: Record the flow meter constant

Step 3: Record the L/min from the rate controller

Operate the boom at the desired pressure and record the total L/min for the entire boom from the rate controller.

Step 4: Compare the result

Compare the rate controller read out to the actual L/min already calculated from weighing the nozzle output.

Step 5: Fine tune the rate controller

If there is a difference between actual L/min and rate controller L/min, use the following formula to fine tune the spray meter:

Formula 1 – PPU

rate controller L/min / actual (measured weight) L/min	x	flow constant PPU	=	new constant PPU

Formula 2 – UPP

actual (measured weight) L/min / rate controller L/min	x	flow constant UPP	=	new constant UPP

Other flow meter calibration considerations

The density of the solution being sprayed can affect the accuracy of the flow meter as flow meters are factory calibrated using water. Some rate controllers enable the operator to determine a density factor.

To determine the density factor manually;

- Accurately weigh 1 L of water
- Mark the container used and then fill to the same level with spray solution from the agitated spray tank
- Weigh this sample and record density in kg/L. For example, the spray solution has a density of 1.2 kg/L. As per Table 5, the conversion factor is 1.10.

Table 5: Conversion factors for rate controllers to take into account different densities of spray solutions.[7]

Density kg/L	Conversion factor
0.84	0.92
0.96	0.98
1.00 - WATER	1.00
1.08	1.04
1.2	1.10
1.28 – 28% Liquid nitrogen fertiliser	1.13
1.32	1.15
1.44	1.20
1.68	1.30

For a rate controller without density settings, use the conversion factor to manipulate the application rate. For example, if the required application rate is 100 L/ha, mix the spray solution at 100 L/ha but set the rate controller to deliver 110 L/ha. (100 L/ha x 1.1 conversion factor = 110 L/ha)

Note if rate controller settings are adjusted for density, it must be readjusted at the completion of the specific application.

Also, when spraying liquids heavier than water, note that the pressure gauge sits higher than would normally be the case.

Calibrating the induction hopper

Never assume that the graduations on the induction hopper are correct. To calibrate the graduations on the induction hopper;

- Use a 1 L or 5 L calibrated jug (1 L = 1 kg)
- Add a full jug of water at a time to the hopper, marking the level after each jug has been added
- Continue filling until the total capacity, to the point of overflow has been determined.

The total volume for the hopper capacity can be used to check inflow meter accuracy when connecting to different water sources.

Calibrating the inflow/tank filling meters

Once the rate controller has been calibrated and fine-tuned, it can be used as the calibration standard for the inflow meter by following the steps below;

Step 1: Drain the spray tank until empty

Step 2: Pump in 1000 L of water

Via the inflow meter. Mark the location of the accelerator (i.e rpm) on the petrol pump and record the volume per minute from the meter. This allows the consistency of supply over time to be checked.

Step 3: Record the calibration number

Or the tag figure of the inflow meter.

Step 4: Operate the sprayer until it is empty

In the tractor cab, clear the total litres sprayed on the rate controller and then operate the boom until it is empty. Record the total volume of water pumped out of the rate controller.

Step 5: Recalculate a new constant for the inflow meter

Using the following calculation.

$$\frac{\text{inflow meter total L}}{\text{accurate rate controller total L}} \times \text{inflow meter constant PPU} = \text{new PPU constant}$$

For example, inflow metre 1000 L; accurate rate controller pumped out 990 litres; inflow meter constant 650 PPU.

$$\frac{\text{1000 L (inflow)}}{\text{990 (rate controller)}} \times \text{650 (inflow constant)} = \text{656.56 (new PPU constant)}$$

7. Teejet Technologies, 2014

Step 6: Final check

Drain the sprayer again and add 20 L into the spray tank, which is to stop the sprayer sucking air for the final check. Use the inflow meter to add 1000 L. Use the same rpm as in Step 2 and check that the volume per minute is also the same. Clear the rate controller total volume and operate the boom until 1000 L has been applied. Drain the sprayer and 20 L should be recovered.

Calibrating the tank

Before calibrating the tank, make sure it is on even ground and that two people are available, so that a constant supply of water can be used to check the tank.

Step 1: Add water to the spray tank

Using the same supply pump rpm, water source and volume per minute.

Step 2: Mark the tank

As the other person calls the volume from the flow meter in 100 L increments.

Other tank calibration considerations

Inflow meters can vary in their accuracy when connecting to different water sources. The flow meter accuracy can be checked by running water to the point of runoff into the calibrated mixing hopper.

Calibrating fence line jets

It is common for fence line jets to not be adjusted accurately, which often results in underdosing. High flow jets, such as XP (TeeJet) or XT (Hypro) have the capacity to throw a significant distance and supply a high volume of water. However, when attached to the end boom section, they can reduce the operating pressure of this boom section, resulting in reductions in efficacy near the edge of the paddock.

Follow the steps below to calibrate a high flow fence line jet;

Step 1: Set boom to operating height

As operators often drive more slowly along fence lines as a precaution, set the pressure to represent the operating situation. This can be achieved by entering a test speed and application rate into the controller to simulate paddock conditions.

Step 2: Check with calibrated testing gauges

Turn the end jet on and with the gauge, check for a pressure drop in the end boom section. Test the pressure at the fence line jet and record the figure.

Step 3: Weigh the output

Catch and weigh the volume per minute (L/min)

Step 4: Measure the throw width

Of the end jets spray throw (m).

Step 5: Calculate the L/ha

Using the following formula;

L/ha = L/minute per nozzle x 600# ÷ width (m) ÷ km/h

#The 600 conversion factor is calculated by converting L/min to L/hr (minutes x 60), and kilometres to metres (km x 1000), then square metres (m x km x 1000 = m^2) to hectares (m^2 ÷ 10000)

= 60 ÷ 1000/10000 = 60 ÷ 1/10 = 60 x 10 = 600.

For example: What is the L/ha applied by a XP 10R nozzle at 3 bar pressure, boom height of 70 cm, throw width 1.5 m (measured) that is travelling at 18 km/h?

Answer: 3.95 L/min x 600 ÷ 1/5 m ÷ 18 km/h = 87.77 L/ha.

Figure 14: The boom height (Y) and spray width (W) for right (R) and left (L) nozzles for use in Table: 6.

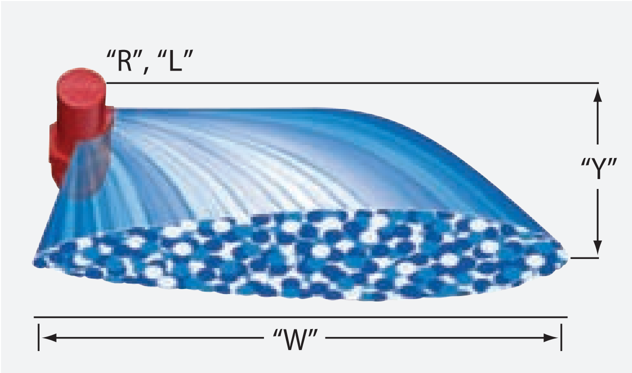


Table 6: New standard - Nozzle charts

Droplet Size Data Based on ISO 25358 Standard

Nozzle	bar	110°XR/XRC 1-4 bar	TT 1-6 bar	TTJ60 1,5-6 bar	AIXR 1-6 bar	AI3070 1,5-6 bar	AITTJ60 1,5-6 bar	110°AI/AIC 2-8 bar	TTI60 1,5-7 bar	TTI 1-7 bar	l/min	l/ha 50 cm: 5 km/h	6 km/h	7 km/h	8 km/h	10 km/h	12 km/h	16 km/h	20 km/h	25 km/h	30 km/h	35 km/h
01 TT XR (100)	1,5	F	C	—	—	—	—	—	—	—	0,28	67,2	56,0	48,0	42,0	33,6	28,0	21,0	16,8	13,4	11,2	9,6
	2,0	F	C	—	—	—	—	—	—	—	0,32	76,8	64,0	54,9	48,0	38,4	32,0	24,0	19,2	15,4	12,8	11,0
	3,0	F	M	—	—	—	—	—	—	—	0,39	93,6	78,0	66,9	58,5	46,8	39,0	29,3	23,4	18,7	15,6	13,4
	4,0	VF	M	—	—	—	—	—	—	—	0,45	108	90,0	77,1	67,5	54,0	45,0	33,8	27,0	21,6	18,0	15,4
	5,0	—	F	—	—	—	—	—	—	—	0,50	120	100	85,7	75,0	60,0	50,0	37,5	30,0	24,0	20,0	17,1
	6,0	—	F	—	—	—	—	—	—	—	0,55	132	110	94,3	82,5	66,0	55,0	41,3	33,0	26,4	22,0	18,9
	7,0	—	—	—	—	—	—	—	—	—	0,60	144	120	103	90,0	72,0	60,0	45,0	36,0	28,8	24,0	20,6
015 AI AIC AIXR AI3070 TT TTI XR XRC (100)	1,5	F	VC	—	VC	VC	—	—	—	UC	0,42	101	84,0	72,0	63,0	50,4	42,0	31,5	25,2	20,2	16,8	14,4
	2,0	F	C	—	C	VC	—	XC	—	UC	0,48	115	96,0	82,3	72,0	57,6	48,0	36,0	28,8	23,0	19,2	16,5
	3,0	F	M	—	C	C	—	VC	—	XC	0,59	142	118	101	88,5	70,8	59,0	44,3	35,4	28,3	23,6	20,2
	4,0	F	M	—	M	C	—	VC	—	XC	0,68	163	136	117	102	81,6	68,0	51,0	40,8	32,6	27,2	23,3
	5,0	—	M	—	M	M	—	C	—	VC	0,76	182	152	130	114	91,2	76,0	57,0	45,6	36,5	30,4	26,1
	6,0	—	F	—	M	M	—	C	—	VC	0,83	199	166	142	125	99,6	83,0	62,3	49,8	39,8	33,2	28,5
	7,0	—	—	—	—	—	—	C	—	VC	0,90	216	180	154	135	108	90,0	67,5	54,0	43,2	36,0	30,9
02 AI AIC AIXR TT TTI TTI60 XR XRC (50) AI3070 AITTJ60 TTJ60 (100)	1,5	M	VC	C	VC	XC	XC	—	XC	UC	0,56	134	112	96,0	84,0	67,2	56,0	42,0	33,6	26,9	22,4	19,2
	2,0	F	C	C	VC	VC	VC	XC	XC	UC	0,65	156	130	111	97,5	78,0	65,0	48,8	39,0	31,2	26,0	22,3
	3,0	F	M	M	C	C	VC	VC	VC	XC	0,79	190	158	135	119	94,8	79,0	59,3	47,4	37,9	31,6	27,1
	4,0	F	M	M	M	C	C	VC	VC	XC	0,91	218	182	156	137	109	91,0	68,3	54,6	43,7	36,4	31,2
	5,0	—	M	M	M	M	C	C	C	VC	1,02	245	204	175	153	122	102	76,5	61,2	49,0	40,8	35,0
	6,0	—	F	M	M	M	M	C	C	VC	1,12	269	224	192	168	134	112	84,0	67,2	53,8	44,8	38,4
	7,0	—	—	—	—	—	—	C	C	VC	1,21	290	242	207	182	145	121	90,8	72,6	58,1	48,4	41,5
025 AI AIC AIXR TT TTI TTI60 XR XRC (50) AI3070 AITTJ60 TTJ60 (100)	1,5	M	VC	VC	VC	XC	XC	—	XC	UC	0,70	168	140	120	105	84,0	70,0	52,5	42,0	33,6	28,0	24,0
	2,0	M	C	C	VC	VC	VC	XC	XC	UC	0,81	194	162	139	122	97,2	81,0	60,8	48,6	38,9	32,4	27,8
	3,0	F	M	C	C	VC	VC	VC	VC	XC	0,99	238	198	170	149	119	99,0	74,3	59,4	47,5	39,6	33,9
	4,0	F	M	M	M	C	C	VC	VC	XC	1,14	274	228	195	171	137	114	85,5	68,4	54,7	45,6	39,1
	5,0	—	M	M	M	C	C	C	C	VC	1,28	307	256	219	192	154	128	96,0	76,8	61,4	51,2	43,9
	6,0	—	F	M	M	M	C	C	C	VC	1,40	336	280	240	210	168	140	105	84,0	67,2	56,0	48,0
	7,0	—	—	—	—	—	—	C	C	VC	1,51	362	302	259	227	181	151	113	90,6	72,5	60,4	51,8
03 AI AIC AIXR AITTJ60 AI3070 TT TTI TTI60 XR XRC (50) TTJ60 (100)	1,5	M	VC	VC	VC	XC	XC	—	UC	UC	0,83	199	166	142	125	99,6	83,0	62,3	49,8	39,8	33,2	28,5
	2,0	M	C	C	VC	XC	XC	XC	UC	UC	0,96	230	192	165	144	115	96,0	72,0	57,6	46,1	38,4	32,9
	3,0	F	M	C	C	VC	VC	VC	XC	XC	1,18	283	236	202	177	142	118	88,5	70,8	56,6	47,2	40,5
	4,0	F	M	M	M	C	C	VC	VC	XC	1,36	326	272	233	204	163	136	102	81,6	65,3	54,4	46,6
	5,0	—	M	M	M	C	C	C	VC	VC	1,52	365	304	261	228	182	152	114	91,2	73,0	60,8	52,1
	6,0	—	F	M	M	C	C	C	VC	VC	1,67	401	334	286	251	200	167	125	100	80,2	66,8	57,3
	7,0	—	—	—	—	—	—	C	C	VC	1,80	432	360	309	270	216	180	135	108	86,4	72,0	61,7
04 AI AIC AITTJ60 AIXR AI3070 TT TTI TTI60 TTJ60 XR XRC (50)	1,5	M	VC	VC	VC	XC	XC	—	UC	UC	1,12	269	224	192	168	134	112	84,0	67,2	53,8	44,8	38,4
	2,0	M	C	C	VC	XC	XC	XC	UC	UC	1,29	310	258	221	194	155	129	96,8	77,4	61,9	51,6	44,2
	3,0	M	M	C	C	VC	VC	VC	XC	XC	1,58	379	316	271	237	190	158	119	94,8	75,8	63,2	54,2
	4,0	F	M	M	C	VC	C	VC	VC	XC	1,82	437	364	312	273	218	182	137	109	87,4	72,8	62,4
	5,0	—	M	M	M	C	C	C	VC	VC	2,04	490	408	350	306	245	204	153	122	97,9	81,6	69,9
	6,0	—	F	M	M	C	C	C	VC	VC	2,23	535	446	382	335	268	223	167	134	107	89,2	76,5
	7,0	—	—	—	—	—	—	C	C	VC	2,41	578	482	413	362	289	241	181	145	116	96,4	82,6
05 AI AIC AITTJ60 AIXR AI3070 TT TTI TTI60 TTJ60 XR XRC (50)	1,5	M	VC	VC	XC	UC	XC	—	UC	UC	1,39	334	278	238	209	167	139	104	83,4	66,7	55,6	47,7
	2,0	M	C	C	VC	XC	XC	XC	UC	UC	1,61	386	322	276	242	193	161	121	96,6	77,3	64,4	55,2
	3,0	M	M	C	VC	VC	VC	XC	XC	XC	1,97	473	394	338	296	236	197	148	118	94,6	78,8	67,5
	4,0	F	M	M	C	VC	VC	VC	VC	XC	2,27	545	454	389	341	272	227	170	136	109	90,8	77,8
	5,0	—	M	M	M	C	C	VC	VC	VC	2,54	610	508	435	381	305	254	191	152	122	102	87,1
	6,0	—	F	M	M	C	C	C	VC	VC	2,79	670	558	478	419	335	279	209	167	134	112	95,7
	7,0	—	—	—	—	—	—	C	C	VC	3,01	722	602	516	452	361	301	226	181	144	120	103
06 AI AIC AITTJ60 AIXR TT TTI TTI60 TTJ60 XR XRC (50)	1,5	M	VC	VC	XC	—	XC	—	UC	UC	1,68	403	336	288	252	202	168	126	101	80,6	67,2	57,6
	2,0	M	C	C	VC	—	XC	XC	UC	UC	1,94	466	388	333	291	233	194	146	116	93,1	77,6	66,5
	3,0	M	M	C	VC	—	VC	XC	XC	XC	2,37	569	474	406	356	284	237	178	142	114	94,8	81,3
	4,0	M	M	M	C	—	VC	VC	VC	XC	2,74	658	548	470	411	329	274	206	164	132	110	93,9
	5,0	—	M	M	C	—	C	VC	VC	VC	3,06	734	612	525	459	367	306	230	184	147	122	105
	6,0	—	F	M	C	—	C	C	VC	VC	3,35	804	670	574	503	402	335	251	201	161	134	115
	7,0	—	—	—	—	—	—	C	C	C	3,62	869	724	621	543	434	362	272	217	174	145	124
08 AI AIC AITTJ60 AIXR TT TTI TTI60 TTJ60 XR XRC (50)	1,5	M	VC	VC	XC	—	UC	—	UC	UC	2,23	535	446	382	335	268	223	167	134	107	89,2	76,5
	2,0	M	VC	C	XC	—	UC	XC	UC	UC	2,58	619	516	442	387	310	258	194	155	124	103	88,5
	3,0	M	M	C	VC	—	XC	XC	XC	XC	3,16	758	632	542	474	379	316	237	190	152	126	108
	4,0	M	M	M	VC	—	XC	VC	XC	XC	3,65	876	730	626	548	438	365	274	219	175	146	125
	5,0	—	M	M	C	—	VC	VC	VC	VC	4,08	979	816	699	612	490	408	306	245	196	163	140
	6,0	—	F	M	C	—	VC	VC	VC	VC	4,47	1073	894	766	671	536	447	335	268	215	179	153
	7,0	—	—	—	—	—	—	VC	C	C	4,83	1159	966	828	725	580	483	362	290	232	193	166

EXTREMELY FINE (XF)	VERY FINE (VF)	FINE (F)	MEDIUM (M)	COARSE (C)	VERY COARSE (VC)	EXTREMELY COARSE (XC)	ULTRA COARSE (UC)

Spray angle	Height (50 cm)
80°	75 cm
110°	50 cm

Tip Spacing	l/min Conversion Factor
35 cm	1.43
75 cm	0.67

LI-TJ378M-R1

8. Teejet Technologies, 2021

Table 7: Previous standard - Nozzle charts

AIXR TeeJet	bar									
	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
AIXR110015VP	VC	C	C	C	M	M	M	M	M	M
AIXR11002VP	VC	VC	C	C	C	M	M	M	M	M
AIXR110025VP	XC	VC	VC	VC	C	C	C	C	C	M
AIXR11003VP	XC	VC	VC	VC	C	C	C	C	C	M
AIXR11004VP	XC	XC	VC	VC	VC	VC	C	C	C	C

Air Induction Turbo TwinJet	bar									
	2	2.5	3	3.5	4	4.5	5	5.5	6	7
AITTJ60-11002VP	VC	VC	C	C	C	M	M	M	M	M
AITTJ60-110025VP	VC	VC	C	C	C	M	M	M	M	M
AITTJ60-11003VP	XC	XC	VC	VC	C	C	C	C	M	M
AITTJ60-11004VP	XC	VC	VC	VC	C	C	C	M	M	M

AI TeeJet	bar										
	2	3	3.5	4	4.5	5	5.5	6	6.5	7	8
AI110015-VS	UC	XC	XC	XC	VC	VC	VC	VC	C	C	C
AI11002-VS	UC	XC	XC	XC	VC	VC	VC	VC	C	C	C
AI110025-VS	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C
AI11003-VS	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C
AI11004-VS	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C

TTI TwinJet	bar									
	2	2.5	3	3.5	4	4.5	5	5.5	6	7
TTI60-11002VP	UC	XC	XC	XC	VC	VC	VC	VC	VC	C
TTI60-110025VP	UC	XC	XC	XC	VC	VC	VC	VC	VC	C
TTI60-11003VP	UC	UC	UC	UC	XC	XC	XC	VC	VC	VC
TTI60-11004VP	UC	UC	UC	UC	XC	XC	XC	VC	VC	VC

Turbo TeeJet Induction	bar									
	2	2.5	3	3.5	4	4.5	5	5.5	6	7
TTI110015-VP	UC	UC	UC	UC	XC	XC	XC	VC	VC	VC
TTI11002-VP	UC	UC	UC	UC	XC	XC	XC	VC	VC	VC
TTI110025-VP	UC	UC	UC	UC	UC	XC	XC	XC	VC	VC
TTI11003-VP	UC	UC	UC	UC	UC	XC	XC	XC	XC	VC
TTI11004-VP	UC	UC	UC	UC	UC	XC	XC	XC	VC	VC

Optimum Pressure = *Ideally try and match the target rate and the average travel speed to this pressure range.*

Droplet size classifications are based on BCPC specifications and in accordance with ASAE Standard S-572.1 at the date of printing. Classifications are subject to change.

8. Teejet Technologies, 2021

NOZZLE SELECTION GUIDE

- XF EXTREMELY FINE
- VF VERY FINE
- F FINE
- M MEDIUM
- C COARSE
- VC VERY COARSE
- XC EXTREMELY COARSE
- UC ULTRA COARSE

Droplet size classifications are in accordance with ISO Standard 25358 at the date of printing, and its standard classification is subject to change.

AIXR TEEJET® (AIXR)

TIP PART NO.	bar 1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
AIXR110015	VC	C	C	C	M	M	M	M	M	M
AIXR11002	VC	VC	C	C	M	M	M	M	M	M
AIXR110025	VC	VC	C	C	M	M	M	M	M	M
AIXR11003	VC	VC	C	C	C	M	M	M	M	M
AIXR11004	VC	VC	VC	C	C	C	M	M	M	M

AIR INDUCTION TURBO TWINJET® (AITTJ60)

TIP PART NO.	bar 2	2.5	3	3.5	4	4.5	5	5.5	6
AITTJ60-11002	VC	VC	VC	C	C	C	C	C	M
AITTJ60-110025	VC	VC	VC	VC	C	C	C	C	C
AITTJ60-11003	XC	VC	VC	VC	C	C	C	C	C
AITTJ60-11004	XC	VC	VC	VC	C	C	C	C	C

AI TEEJET® (AI)

TIP PART NO.	bar 2	3	4	5	5.5	6	6.5	7	8
AI110015	XC	VC	VC	C	C	C	C	C	M
AI11002	XC	VC	VC	C	C	C	C	C	M
AI110025	XC	VC	VC	C	C	C	C	C	M
AI11003	XC	VC	VC	C	C	C	C	C	M
AI11004	XC	VC	VC	C	C	C	C	C	M

TTI TWINJET® (TTI60)

TIP PART NO.	bar 2	2.5	3	3.5	4	4.5	5	5.5	6	7
TTI60-11002	XC	XC	VC	VC	VC	VC	C	C	C	C
TTI60-110025	XC	XC	VC	VC	VC	VC	C	C	C	C
TTI60-11003	UC	XC	XC	XC	VC	VC	VC	VC	VC	C
TTI60-11004	UC	XC	XC	XC	VC	VC	VC	VC	VC	C

TURBO TEEJET® INDUCTION (TTI)

TIP PART NO.	bar 2.5	3.5	4	4.5	5	5.5	6	7
TTI110015	UC	XC	XC	XC	VC	VC	VC	VC
TTI11002	UC	XC	XC	XC	VC	VC	VC	VC
TTI110025	UC	XC	XC	XC	VC	VC	VC	VC
TTI11003	UC	XC	XC	VC	VC	VC	VC	VC
TTI11004	UC	XC	XC	VC	VC	VC	VC	VC

OPTIMUM PRESSURE = Ideally try and match the target rate and the average travel speed to this pressure range.

8. Teejet Technologies, 2023

Pulse width modulation (PWM) spraying systems

PWM sprayers are distinctly different to the traditional flow based spraying system. The key difference is the boom line pressure is constant and therefore fan angle and droplet size are maintained across a potentially wider speed range. In contrast with the flow based spraying system which uses a pressure regulator, regulation in a PWM system is achieved by pulsing of the individual nozzle solenoids. The speed at which the device pulses is called the frequency and is measured in cycles per minute or hertz (Hz). The duty cycle, expressed as a percentage, is the amount of time the device is 'on' during each full cycle. It can be compared to riding a bike, where the duty cycle equals the ratio of pedalling to the total riding time (pedalling + coasting time).

What calculations do I need to do before PWM spraying?

› Step 1: Select the nozzle

Determine the application rate (i.e. 70 L/ha). Measure the nozzle spacing in meters (i.e. 0.508 m), taking care when reading nozzle charts based on half-metre nozzle spacing. Select the optimum operation pressure that delivers the required spray quality (i.e. 3.0 bar with COMBO JET MR 110-04 nozzles achieves a flow rate of 1.6 L/min/nozzle at 100% duty cycle with a droplet size of 370 micron volumetric median diameter (VMD) which equals coarse to very coarse spray quality.) The steps below use this example.

› Step 2: Calculate speed at 100% duty cycle

Operating speed (km/h) = L/min per nozzle x 600 (conversion constant) ÷ L/sprayed ha ÷ nozzle width (m)

Using the example above;

Maximum operating speed (km/h) = 1.6 x 600 ÷ 70 ÷ 0.508 = 26.99 km/h

› Step 3: Calculate the minimum speed and minimum duty cycle

Assume the sprayer is operating at a minimum duty cycle of 35%

L/min per nozzle at 100% duty cycle = 1.6 L/min

Calculate 35% of 1.6 L/min = 0.56 L/min

Minimum operating speed (km/h) = 0.56 x 600 ÷ 70 ÷ 0.508 = 9.44 km/h

› Step 4: Calculate the optimal speed range

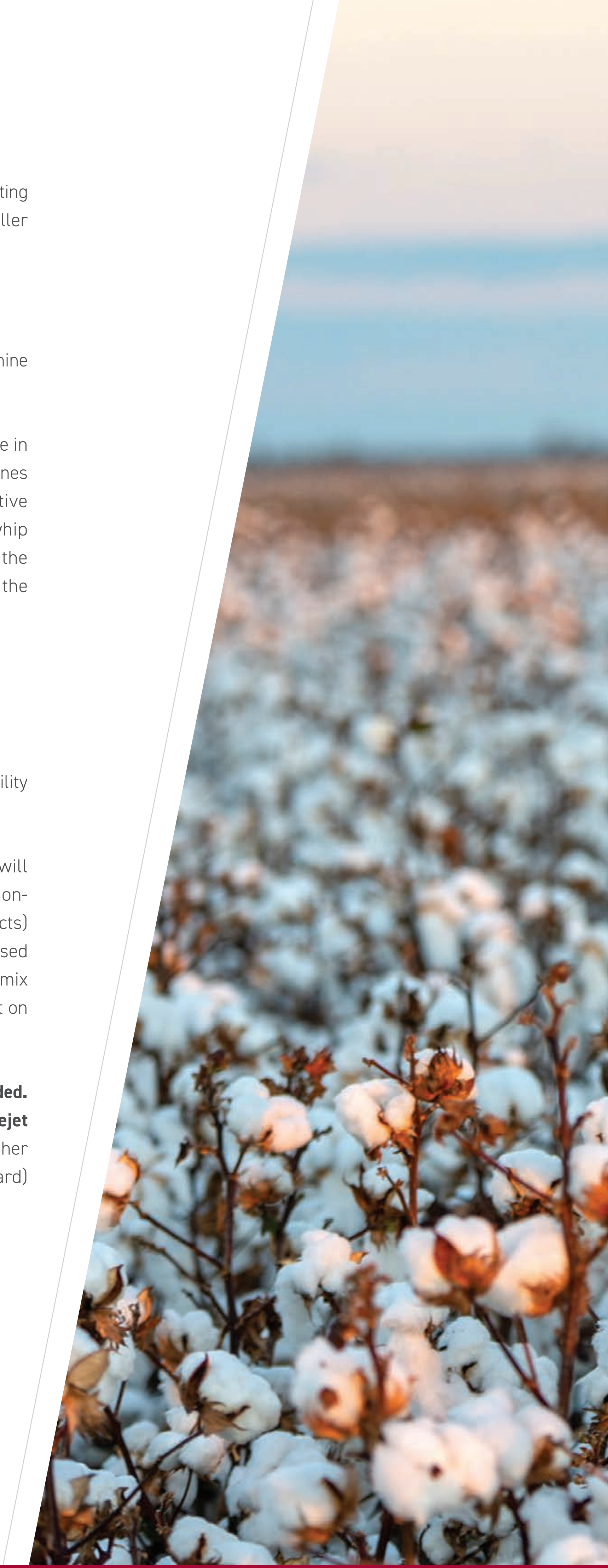
Note by limiting the duty cycle to a minimum of 35%, a speed ratio of 2.85:1 has been achieved (maximum speed in km/h ÷ minimum speed in km/h i.e. 26.99 ÷ 9.44). To achieve speed ratios of 8:1 which is sometimes claimed by these systems, the duty cycle would be too low for effective spray application.

Table 7: PWM operating parameters where the duty cycles are based on 0.4 nozzle at 3 bar, 1.6 L/min output per nozzle, 70 L/ha spray volume and 0.508 m nozzle spacing.

Duty cycle	Min 35%	50%	70%	75%	80%	85%	90%	95%	Max 100%
Litres per min per nozzle	0.56 L/min	0.8 L/min	1.12 L/min	1.2 L/min	1.28 L/min	1.36 L/min	1.44 L/min	1.52 L/min	1.6 L/min
Litres per min all nozzles (72 nozzles)	40.32 L/min	57.6 L/min	80.64 L/min	86.4 L/min	92.16 L/min	97.92 L/min	103.68 L/min	109.44 L/min	115.2 L/min
Speed km/h	9.44 km/h	13.49 km/h	18.89 km/h	20.24 km/h	21.59 km/h	22.94 km/h	24.29 km/h	25.64 km/h	26.99 km/h
Performance	Least favourable range		Satisfactory range		Optimum range				

Considerations for PWM sprayers

- **1. Calibrate flow meter:** In manual with nozzles operating at full capacity. Measure output against rate controller flow rate (L/min)
- **2. Ensure density setting is on 1**
- **3. Avoid duty cycles below 35%:** This will help determine your minimum speed
- **4. Avoid sharp turns when spraying:** As an increase in boom speed will over-run a duty cycle. Newer machines have turn compensation which will only be effective if the boom's duty cycle is below 100%. Boom whip can potentially cause spray misses in corners if the boom speed exceeds the operating parameters of the selected nozzle.
- **5. Reverse (or back-up) into corners**
- **6. Square up headlands**
- **7. Drive on opposite AB lines:** to reduce the repeatability of spray misses
- **8. Consider spray adjuvants:** Spray adjuvants will either lead to an increase in driftable fines (i.e. non-ionic surfactant and fully loaded glyphosate products) or a reduction in fan angle when oil or lecithin-based surfactants are used. Operate the sprayer with a mix of water and the surfactant rate to check the effect on spray quality and fan angle.
- **9. Air induction nozzles aren't generally recommended. The exceptions are TeeJet's air inducted Turbo Teejet AI TTJ 60, TTI 60 and TTI:** Nozzle systems are either standard flat fan pre-orifice nozzles (i.e. Drift Guard) or Turbo TeeJet.



SPRAY APPLICATION BEST PRACTICE

Building on the spray theory in the first section, this section specifically focuses on spray application best practice. This aims to ensure optimal results not only for the individual user but for the broader cotton and agricultural industry.

Application requirements when spraying Bayer's dicamba products in XtendFlex cotton.

XtendiMax 2 Herbicide can only be used in XtendFlex cotton systems by applicators that have successfully completed the XtendFlex Cotton Spray Applicator Training.

Growers must check the label prior to spraying for the most up-to-date guidelines.

- **1. Wind speed:** Apply only when wind speed, measured at boom height, is between 3 and 20 km/h*.
- **2. Boom height:** Do not exceed a boom height of 50 cm above the target weed or crop canopy - if your boom height is unable to achieve 50 cm above the target weed or crop canopy (e.g. some self-propelled sprayers) then applicators may operate at a height up to 100 cm, this requires larger down wind buffer distances.
- **3. Droplet size:** Apply XtendiMax 2 Herbicide with nozzles and sprayer settings to deliver droplets no finer than a Very Coarse spray quality.
- **4. Water rate:** Apply in a minimum of 100 L/ha.
- **5. DO NOT mix XtendiMax 2 Herbicide with ammonium salts:** Don't tank-mix with Roundup Ready Herbicide with PLANTSHIELD (granular formulation, contains ammonium), glufosinate-ammonium, fertilisers, buffers, drift modifiers etc. that contain ammonium salts, ammonium sulphate (AMS), urea ammonium nitrate (UAN) and any other glyphosate with an ammonium salt as small quantities of ammonium can greatly increase the volatility of dicamba.
- **6. Do not spray during a surface temperature inversion.**
- **7. Check the label for downwind and omni-directional buffer zones.**
- **8. Keep records as required by your State authorities and as requested by Bayer:** Refer to the 'Record Keeping Requirements' chapter for more information.
- **9. Clean boom sprayer:** Ensure entire sprayer is properly cleaned before and after spraying.
- **10. Tank-mix partners:** Use only approved tank-mix partners. Do not apply unless the pH of the spray solution is 5.2 or above.
- **11. VapourGrip Xtra Agent:** Add VapourGrip Xtra Agent to the tank at 1.0% v/v when XtendiMax 2 Herbicide is being sprayed.
- **12. Rainfastness:** Do not apply if rain is likely within four hours
- **13. Maximum number of applications:** Pre-emergence to 7 days before harvest, do not apply more than 1 application per season.
- **14. Application timing:** Do not apply in December, January and February.
- **15. Neighbouring crops:** Do not apply within 20 metres of neighbouring crops on all sides of the treated field.
- **16. Run-off:** Do not apply if heavy rains or storms are forecast within 3 day. Do not irrigate to the point of field runoff from the treatment area for at least 3 days after application, unless all run-off can be captured on-farm.

APPLICATOR TRAINING

Go to our website to register for an Applicator training session.

RECORD KEEPING

Follow record keeping requirements published as per the relevant state or territory legislation and according to the registration requirements as requested by Bayer.

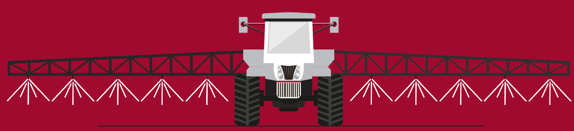
BUFFER ZONES

Always refer to the product label for omnidirectional and downwind buffer zones.

APPLICATION RATE

Always refer to the product label for the appropriate application rate.

APPLICATION REQUIREMENTS



THIS SUMMARY IS NOT A SUBSTITUTE FOR READING AND FOLLOWING ALL PRODUCT LABELING

APPLICATION TIMING

Do NOT Spray During a surface temperature INVERSION. Always refer to the product label for date restrictions.

WIND SPEED

Always refer to the product label for the required wind speed during application. (do NOT spray during a surface temperature INVERSION).

SPRAY VOLUME

Always refer to the product label for the correct water rate.

SPRAY DROPLET SIZE

Always refer to the product label for the required droplet size.

TANK-MIX PARTNER

Use only approved tank-mix partners. Please refer to all product labels to determine mix order or perform mix compatibility test.

SPRAY SYSTEM EQUIPMENT CLEANOUT

Ensure that entire sprayer system is properly cleaned before AND after using any product. Always refer to the product label for the recommended decontamination procedure.

DO NOT MIX WITH AMMONIUM SALTS.

SPRAY BOOM HEIGHT

Always refer to the product label for the correct boom height above the target pest or crop canopy.

Optimal weather conditions for spraying

The APVMA has produced a document, 'APVMA operating principles in relation to spray drift risk' which outlines its approach to spray drift risk assessment and risk management. As a result of this, pesticide products will begin to contain a lot more information about the weather conditions which must be observed.

XtendiMax 2 Herbicide label weather related restraints:

- DO NOT apply when the temperature is 35°C or above or forecast to be 35°C or above within 3 days of application.
- DO NOT apply in December, January and February.
- DO NOT apply if heavy rains or storms are forecast within 3 days.

However, it is also advised that growers follow the following weather guidelines, in addition to those on the label[9]

- Spray when Delta T is between 2–8. (ΔT relates temperature and relative humidity)
- Spray when the temperature is below 28°C
- Spray in a steady wind of 3-20 km/h, blowing away from sensitive areas.

Buffer requirements for the protection of sensitive crops

To minimise the potential for unintentional damage to other crops or vegetation, there is a maximum boom height for XtendiMax 2 Herbicide alone and XtendiMax 2 Herbicide plus Roundup Ready PL Herbicide to be applied above the target canopy, associated downwind buffer zones for vegetation areas and an omnidirectional buffer, see Tables 8 & 9.

Table 8: Buffer zones for XtendiMax 2 Herbicide with VapourGrip Technology (including also VapourGrip Xtra Agent applied at 1 % v/v)

Application rate	Boom height above the target canopy	Mandatory downwind buffer zones	
		Vegetation areas	Livestock areas
1.17 L/ha or lower	0.5 m or lower	375 m	0 m
335 mL/ha or lower	0.5 m or lower	70 m	0 m
	1.0 m or lower	250 m	0 m

Table 9: Buffer zones for XtendiMax 2 Herbicide with VapourGrip Technology (including also VapourGrip Xtra Agent applied at 1 % v/v) plus Roundup Ready PL Herbicide with PLANTSHIELD Technology

Application rate	Boom height above the target canopy	Mandatory downwind buffer zones Vegetation areas
Up to 1.17 L/ha XtendiMax 2 with VapourGrip Technology plus 1.9 L/ha Roundup Ready PL Herbicide with PLANTSHIELD Technology	0.5 m or lower	130 m
335 mL/ha XtendiMax 2 with VapourGrip Technology with 1.9 L/ha Roundup Ready PL Herbicide with PLANTSHIELD Technology	0.5 m or lower	85 m
	1.0 m or lower	350 m

In addition, for the protection of sensitive areas the following conditions should be considered;

- DO NOT apply under weather conditions, or from spraying equipment, that may cause spray to drift onto nearby susceptible plants/crops, cropping lands or pastures.
- Avoid spray drift and vapour movement onto susceptible crops such as cotton that does not have the XtendFlex technology, flowers, fruit trees, lupins, ornamentals, tomatoes, vegetables, vines or any other field crop.

- Spray equipment must be calibrated accurately prior to use in crops.
- Minimise spray drift by using low pressure and nozzles which achieve the target spray quality required on label.
- DO NOT apply this product on or near desirable trees or plants or in locations where the chemical may be washed or moved into contact with their roots.
- DO NOT use in high wind.
- All spray equipment must be thoroughly washed out after use and must not be used for spraying horticultural crops.
- DO NOT use at a higher rate than recommended.
- DO NOT use empty containers for any other purpose.
- DO NOT contaminate dams, rivers or streams with the product or used container.

Mixing other products with Xtendimax 2 Herbicide

The following products must NOT be mixed with XtendiMax 2 Herbicide.

- Fertilisers containing ammonium salts, including ammonium sulphate (AMS), adjuvants, buffers, drift reduction agents containing ammonium
- Sprayable liquid fertilisers (often ammonium based) and fungicides (yet to be compatibility tested)
- Any water conditioners or buffering agents that acidify the spray solution
- Roundup Ready Herbicide with PLANTSHIELD (granular formulation, contains ammonium) and any other glyphosate based on an ammonium salt
- Products containing glufosinate-ammonium.

It is critical that ammonium sulfate (AMS) or ammonium-based products are not mixed with XtendiMax 2 Herbicide. This is because they have the ability to increase the volatility of dicamba in low pH spray mixes.[10] Ammonium ions dissociate into a volatile ammonia and a hydrogen ion (H^+) and the resulting protons in solution overwhelm the buffering capacity of the volatility reduction technology included in and with XtendiMax 2 herbicide, leading to significant increase in the volatility of dicamba.[11] Therefore, before spraying it is also important to ensure equipment is thoroughly clean and free of ammonium ions prior to use.

As the volatility of dicamba formulations, even formulations containing volatility reduction technology, can increase in low pH spray solutions, growers need be mindful of using water conditioning, acidifying and buffering agents and make appropriate adjustments to avoid low pH spray mixtures.

XtendiMax 2 Herbicide may be tank-mixed with other herbicides registered for selective use in cotton to provide longer residual weed control, a broader weed control spectrum or an alternate mode of action, depending on the registered claims for the tank-mix partner.

Before tank-mixing, refer to the tank-mix product labels to confirm that the respective tank-mix products are registered for the specific crop use. Check all individual product labels, supplemental labelling and fact sheets for all products in the tank mixture and observe all precautions and limitations on the label. This includes application timing restrictions, soil restrictions, minimum re-cropping intervals and rotational guidelines.

In addition to making sure the tank-mix partners are registered for the specific crop use, it is possible that some tank-mix products have the potential to cause crop injury under certain conditions, at certain growth stages and/or under other circumstances. Read the label for all products to be used in the tank mixture prior to use to determine the potential for crop injury.

Bayer has not tested all tank-mix product formulations for compatibility, antagonism or reduction in product performance. Always predetermine the compatibility of all tank-mix partners by mixing small proportional quantities in advance.

The herbicides, insecticides and adjuvants that are proposed to be able to be mixed with XtendiMax 2 Herbicide are noted below (Tables 10, 11, 12).

9. Department of Primary Industries Victoria, 2010. 10. Mueller and Steckel, 2019. 11. Abraham, 2018

Table 10: Registered herbicides may be applied with XtendiMax 2 Herbicide according to the specific tank mixing instructions on the respective product labels.

Trade name	Active ingredient
Select®	240 g/L clethodim
Verdict®	520 g/L haloxyfop
Dual® Gold	960 g/L s-metolachlor
Rifle®	440 g/L pendimethalin
Shogun®	100 g/L propaquizafop
Factor®	250 g/kg butroxydim
Roundup Ready PL Herbicide with PLANTSHIELD Technology	540 g/L glyphosate (potassium salt)

Table 11: Registered insecticides may be applied with XtendiMax 2 Herbicide according to the specific tank mixing instructions on the respective product labels. Limited trial work to date has shown the following products to be physically and biologically compatible.

Trade name	Active ingredient
Regent®	200 g/L fipronil
Zeal®	110 g/L etoxazole
Talstar®	250 g/L bifenthrin
Pegasus®	500 g/L diafenthiuron
Admiral®	100 g/L pyriproxyfen
Shield®	200 g/L clothianidin
Skope®	218 g/L acetamiprid 32.5 g/L emamectin
Wizard® 18	18 g/L abamectin
Altacor®	350 g/kg chlorantraniliprole
Transform®	240 g/L sulfoxaflor
Aphidex® 800	800 g/kg pirimicarb
MainMan®	500 g/kg flonicamid
Movento®	240 g/L spirotetramat
Exirel®	100 g/L cyantraniliprole
Sero-X®	400 g/L clitoria ternatea extract
Starkle®	200 g/kg dinotefuran

Table 12: Registered adjuvants that may be applied with XtendiMax 2 Herbicide according to the specific tank mixing instructions on the respective product labels.

Trade name	Active ingredient
Kwickin®	704 g/L methyl and ethyl esters of vegetable oil with 196 g/L non-ionic surfactants
Banjo®	725 g/L methyl esters of canola oil fatty acids
Canopy® oil	792 g/L paraffinic oil
Supercharge® elite	471 g/L paraffin oil

Spray records required

Australian state regulations, and the conditions of registration for XtendiMax 2 Herbicide, require pesticide users to record the details of their pesticide use. Adequate records are important to:[13,14,15]

- **1.** Identify chemical use pattern in the event a traceback is required to explain an unusual outcome
- **2.** Monitor the effectiveness of the pesticide
- **3.** Assist in designing and implementing pest management strategies
- **4.** Understand financial costs of application
- **5.** Meet legal obligations
- **6.** Reduce health, environmental and trade implications if an incident occurs
- **7.** Defend the pesticide user by demonstrating they used the pesticide(s) responsibly.

Records must be kept that meet the requirements of the State or Territory in which the spraying will take place and and additional requirements set as conditions of registration for XtendiMax 2 Herbicide. As a minimum, the following application details are required;

- **1. What pesticide(s) were applied:** including the full product name. Recording the active ingredient, the APVMA's registration number and the manufacturer is good practice and a requirement in some situations. Record also the product batch number and date of manufacture.
- **2. What other additives were applied:** including the full registered name of any wetter, spreader, mixing partner, emulsifier or other material added to the tank.
- **3. Where the pesticides were applied:** Include GPS coordinates, property and paddock name and location.
- **4. Why the pesticides were applied:** Include the target pests/weeds/diseases/purpose and the crop type they are in e.g. fleabane in XtendFlex cotton.
- **5. When the pesticide was applied:** Include the date and time operation started and finished.
- **6. How much pesticide was applied:** Include the total spray mix volume, the rate per hectare and the total area covered.
- **7. Who applied the pesticide:** Include full name, address and contact numbers of operators and supervisors.
- **8. Detailed weather conditions:** Include wind direction and speed before spraying commences and after spraying finishes. Include if any changes in conditions occurred during application. It may also be useful to include the temperature and humidity at the time of application, and details of how these details were determined.

These records are required to be kept for a minimum of two years in Queensland and three years in NSW.

XtendiMax 2 Herbicide record keeping requirements

As a condition of the XtendiMax 2 Herbicide with VapourGrip Technology registration, Bayer is required to collect the following application information from users of XtendiMax 2 Herbicide with VapourGrip Technology in XtendFlex cotton:

* Date of application.
* Farm address where spray application occurred.
* Rate of application.
* Total amount of product applied.
* Air temperature at the start and end of application

Personal protective equipment (PPE) and occupational health and safety (OH&S) requirements for using XtendiMax 2 Herbicide

XtendiMax 2 Herbicide will irritate the eyes and may irritate the skin and so care should be taken to avoid contact with eyes and skin.

Therefore, when handling and spraying XtendiMax 2 Herbicide, the following items should be worn;

- Cotton overalls buttoned to the neck and wrist
- Elbow-length chemical resistant gloves
- Face shield.

If the products come in contact with the skin, wash immediately with water. After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with water. After each day's use, wash gloves, face shield and any contaminated clothing.

If poisoning occurs, contact a doctor or the Poisons Information Centre on 13 11 26. Refer to label/SDS for full details.

13. Queensland Government, 2020. 14. EPA NSW, 2020.
15. Agriculture Victoria, 2020

Mixing order

Before mixing, ensure the mixing equipment and boom spray are thoroughly clean and free of products containing ammonium ions prior to use (extremely important for XtendiMax 2 Herbicide).

The correct mixing order for XtendiMax 2 Herbicide is:

- **1.** Ensure application and mixing equipment are thoroughly clean and free of ammonium prior to use.
- **2.** Fill the spray tank with three quarters of the required volume of clean water and start agitation.
- **3.** Add the required amount of VapourGrip Xtra Agent and agitate for 10 minutes.
- **4.** Agitation – Maintain constant agitation throughout mixing and application.
- **5.** Buffer (when applicable). Do not use acidifying buffers or buffers containing ammonium ions, unless specifically recommended.
- **6.** Drift Reduction Agents (DRA) (when applicable).
- **7.** Water-dispersible products (water dispersible granules (dry flowables), wettable powders, suspension concentrates, or suspo-emulsions).
- **8.** XtendiMax 2 Herbicide with VapourGrip Technology with any other water-soluble products (when applicable).
- **9.** Emulsifiable concentrates (such as oil concentrate when applicable).
- **10.** Roundup Ready PL Herbicide with PLANTSHIELD Technology (when applicable).
- **11.** Add remaining quantity of water.

Maintain constant agitation prior to and during application.

Tank clean-out

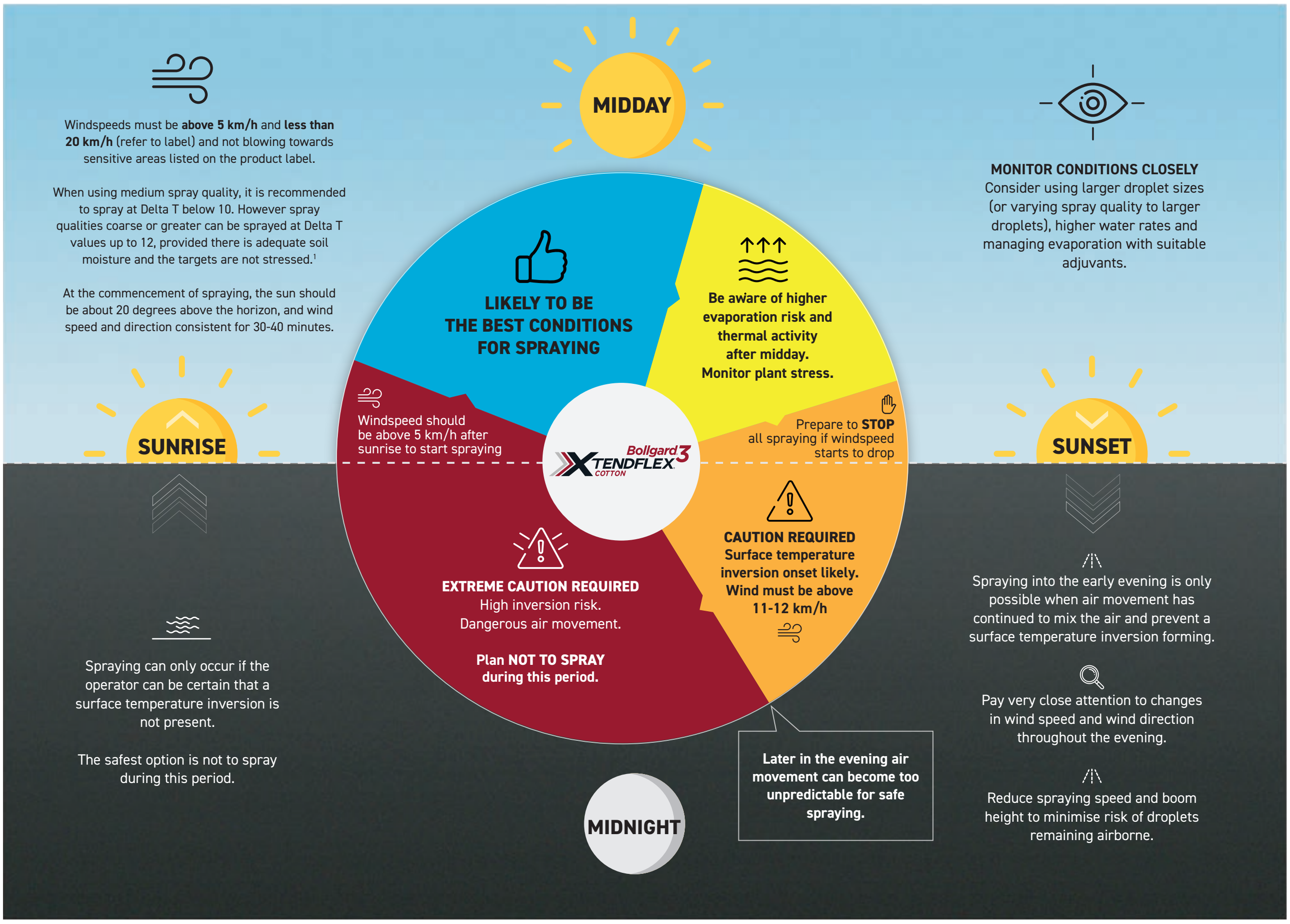
When applying herbicides it is important that boom sprayers are correctly cleaned down immediately after use to avoid unintentional damage to other crops and pastures. A triple rinse procedure should be followed to adequately remove any residual herbicides from the sprayer.

- **1.** Immediately after spraying, drain the sprayer, including the boom and lines. Do not leave overnight before flushing.
- **2.** Flush tank, hoses, boom and nozzles with clean water and if possible, open the boom ends and flush.
- **3.** Inspect and clean all strainers, screens and filters.
- **4.** Add the preferred cleaning solution for each of the products
  - Roundup Ready PL Herbicide with PLANTSHIELD Technology: Water
  - XtendiMax 2 Herbicide: Commercial detergent, sprayer cleaner or ammonia
  - Glufosinate-ammonium: Water.

  Note: If ammonia is used, ensure all remaining ammonia is thoroughly rinsed out.
- **5.** Wash all parts of the tank, including the inside top surface. Agitate and recirculate the cleaning solution for at least 15 mins to ensure all visible deposits are removed.
- **6.** Flush hoses, spray lines and nozzles for at least one minute with the cleaning solution.
- **7.** Remove nozzles, screens and strainers and clean separately in the cleaning solution.
- **8.** Drain pump, filter and lines.
- **9.** Internally rinse the sprayer with clean water.
- **10.** Clean and wash the outside of the entire sprayer.
- **11.** Drainings, washing and rinse water must be disposed of in compliance with local, state or territory guidelines

12. Tepper, 2017

24-hour spray risk profile[16]



16. Gordon B, 2013

Spray Safe & Save Pty Ltd™

Practical & Accredited Training Solutions

Spray Safe and Save - "the name says it all"

Sprayer Set Up Record/Sprayer Operation Procedure

Operator	
Description of rig	
Location date	
Product or products	
Target pest(s)	
Droplet size recommendation per label or agronomist	
Water rate L/ha (minimum recommended)	
Determine average speed you wish to travel	km/hr
Spray zone awareness hazards of a sensitive nature/buffer zone	
Boom nozzle spacing (W) in metres	metre
Total boom width No. of nozzles on boom	metre nozzles

Make Model ....

Serial No ....

Flow Cal Original ....

Flow Cal New ....

Speed Cal Original ....

Speed Cal New ....

Boom Width .... M

GPS Width .... M

Nozzles Per Section

1........ 2........ 3........ 4........ 5........

6........ 7........ 8........ 9........ 10........

STEP 1

Litres per minute per nozzle = km/hr x W(nozzle spacing in metres) x litres/ha ÷ 600

L/min/nozzle

	Refer to nozzle chart record selections Nozzle size • • • Pressure • • •
Nozzle code selected	
Droplet size Pressure range	

Total No. of Nozzles ....

Combination of Nozzles		
Twin cap	Nozzle 1	Nozzle 2
Dual Line	Line A	Line B
Spray quality		

W = nozzle spacing (in metres) for broadcast spraying **or** W = spray width (in metres) for single nozzle band spraying or boomless spraying **or** W = row spacing (in metres) divided by the number of nozzles per row for directed spraying

	Minimum	*Constant*	*Maximum*
Spray quality as per ASAE or BCPC			
Pressure as per nozzle chart			
Litres per minute/nozzle			

STEP 2

Kilometres/hour
= Litres per minute per nozzle x 600 ÷ litres sprayed hectare ÷ width (nozzle spacing in metres)

Speed km/h			

Litres/hectare
= Litres per minute per nozzle x 600 ÷ width (nozzle spacing in metres) ÷ kilometres per hour

Final Check

Sprayer Operation Rules

Pressure 1 bar = 100 kpa = 14.5psi

Panel Settings	*Minimum/Buffer Zone*	*Constant*	*Maximum*
Total litres per minute all nozzles Litres/minute/nozzle x number of nozzles			
Speed km/h			
Pressure in bar			
Spray quality ASAE/BCPC			
Gear RPM			

Practical & Accredited Training Solutions

Spray Safe and Save - "the name says it all"

A

Spray completed by: ....

Sprayer Set Up Record/Sprayer Operation Procedure

Operator	
Description of rig	
Location date	
Product or products	
Target pest(s)	
Droplet size recommendation per label or agronomist	
Water rate L/ha (minimum recommended)	
Determine average speed you wish to travel	km/hr
Spray zone awareness hazards of a sensitive nature/buffer zone	
Boom nozzle spacing (W) in metres	metre
Total boom width No. of nozzles on boom	metre nozzles

STEP 1

Litres per minute per nozzle = km/hr x W(nozzle spacing in metres) x litres/ha ÷ 600

L/min/nozzle

	Refer to nozzle chart record selections Nozzle size • • • Pressure • • •
Nozzle code selected	
Droplet size Pressure range	

Make Model ....

Serial No ....

Flow Cal Original ....

Flow Cal New ....

Speed Cal Original ....

Speed Cal New ....

Boom Width .... M

GPS Width .... M

Nozzles Per Section

1...... 2...... 3...... 4...... 5......

6...... 7...... 8...... 9...... 10......

Total No. of Nozzles ....

Combination of Nozzles		
Twin cap	Nozzle 1	Nozzle 2
Dual Line	Line A	Line B
Spray quality		

W = nozzle spacing (in metres) for broadcast spraying **or** W = spray width (in metres) for single nozzle band spraying or boomless spraying **or** W = row spacing (in metres) divided by the number of nozzles per row for directed spraying

	Minimum	*Constant*	*Maximum*
Spray quality as per ASAE or BCPC			
Pressure as per nozzle chart			
Litres per minute/nozzle			
Duty cycle %			

STEP 2

Kilometres/hour
= Litres per minute per nozzle x 600 ÷ litres sprayed hectare ÷ width (nozzle spacing in metres)

Speed km/h			

Litres/hectare
= Litres per minute per nozzle x 600 ÷ width (nozzle spacing in metres) ÷ kilometres per hour

Final Check

Sprayer Operation Rules

Pressure 1 bar = 100 kpa = 14.5psi

Panel Settings	*Minimum/Buffer Zone*	*Constant*	*Maximum*
Total litres per minute all nozzles Litres/minute/nozzle x number of nozzles			
Speed km/h			
Pressure in bar			
Spray quality ASAE/BCPC			
Gear RPM DC/%			

Disclaimer: The author of this plan is accountable for the calculations

Spray Safe & Save Pty Ltd ™

Practical & Accredited Training Solutions

Spray Safe and Save - "the name says it all"

A

Spray completed by: ....

Sprayer Set Up Record/Sprayer Operation Procedure

Operator	
Description of rig	
Location date	
Product or products	
Target pest(s)	
Droplet size recommendation per label or agronomist	
Water rate L/ha (minimum recommended)	
Determine average speed you wish to travel	km/hr
Spray zone awareness hazards of a sensitive nature/buffer zone	
Boom nozzle spacing (W) in metres	metre
Total boom width No. of nozzles on boom	metre nozzles
Litres per minute per nozzle = km/hr x W(nozzle spacing in metres) x litres/ha ÷ 600	L/min/nozzle
	Refer to nozzle chart record selections Nozzle size • • • Pressure • • •
Nozzle code selected	
Droplet size Pressure range	

STEP 1

Make Model ....

Serial No ....

Flow Cal Original ....

Flow Cal New ....

Speed Cal Original ....

Speed Cal New ....

Boom Width .... M

GPS Width .... M

Nozzles Per Section

1...... 2...... 3...... 4...... 5......

6...... 7...... 8...... 9...... 10......

Total No. of Nozzles ....

Combination of Nozzles		
Twin cap	Nozzle 1	Nozzle 2
Dual Line	Line A	Line B
Spray quality		

W = nozzle spacing (in metres) for broadcast spraying **or** W = spray width (in metres) for single nozzle band spraying or boomless spraying **or** W = row spacing (in metres) divided by the number of nozzles per row for directed spraying

	Minimum	*Constant*	*Maximum*
Spray quality as per ASAE or BCPC			
Pressure as per nozzle chart			
Litres per minute/nozzle			
Duty cycle %			

STEP 2

Kilometres/hour
= Litres per minute per nozzle x 600 ÷ litres sprayed hectare ÷ width (nozzle spacing in metres)

Speed km/h			

Litres/hectare
= Litres per minute per nozzle x 600 ÷ width (nozzle spacing in metres) ÷ kilometres per hour

Final Check

Sprayer Operation Rules

Pressure 1 bar = 100 kpa = 14.5psi

Panel Settings	*Minimum/Buffer Zone*	*Constant*	*Maximum*
Total litres per minute all nozzles Litres/minute/nozzle x number of nozzles			
Speed km/h			
Pressure in bar			
Spray quality ASAE/BCPC			
Gear RPM DC/%			

Disclaimer: The author of this plan is accountable for the calculations

REFERENCES

1. Hartzler, B. (2017). Dicamba: Past, present, and future. *Proceedings of the Integrated Crop Management Conference.*

2. Bayer.ca. (2019). *Bayer Trait Technologies.* [online] Available at: https://traits.bayer.ca/en/soybeans/roundup-ready-xtend-crop-system/vaporgrip-technology/.

3. Heap, I. (2019). *Introduction Time of New Herbicide Sites of Action (WSSA codes).* [online] Weed Science. Available at: http://www.weedscience.org/Pages/ShowDocuments.aspx?DocumentID=7426 [Accessed 30 Jul. 2020].

4. CRDC and CottonInfo. (2019). *Cotton Pest Management 2019-20.* [online] CRDC and CottonInfo, p.93. Available at: https://www.cottoninfo.com.au/sites/default/files/documents/CPMG%202019-20.pdf [Accessed 30 Jul. 2020].

5. Andersen P. G., Jorgensen M.K. (2010). Calibration of sprayers. Julius-Kühn-Archiv 426. Third European Workshop on Standardised Procedure for the Inspection of Sprayers - SPISE 3, p. 143-152

6. Teejet Technologies. (2014). Spraying Liquids with a Density Other Than Water. In: Catalog 51A-M. Teejet Technologies, p.141.

7. Teejet Technologies (2019). Spraying Liquids with a Density Other Than Water. In: Catalog 51A-M. Teejet Technologies, p.29.

8. Department of Primary Industries Victoria (2010). *Top 10 spraying tips : to get the job done safely and effectively.* Melbourne, Vic.: Dept. Of Primary Industries.

9. Mueller, T.C. and Steckel, L.E. (2019). Spray mixture pH as affected by dicamba, glyphosate, and spray additives. *Weed Technology,* 33(4), pp.547–554.

10. Abraham, W. (2018). The other Dicamba Story: Chemistry innovations that reduce the volatility potential of an extremely effective herbicide. Available at: https://blog.americanchemistry.com/2018/06/the-other-dicamba-story-chemistry-innovations-that-reduce-the-volatility-potential-of-an-extremely-effective-herbicide/ [Accessed 30 Jul. 2020].

11. Tepper, G. (2017). *Title: Weather Essentials for Pesticide Application.* [online] Available at: https://grdc.com.au/GRDC-Booklet-WeatherEssentials [Accessed 30 Jul. 2020]

12. Queensland Government. (2020). *Keeping Records Of Agricultural Chemical Applications | Business Queensland.* [online] Business.qld.gov.au. Available at: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/chemical-controls/using-chemicals/keeping-records [Accessed 30 Jul. 2020].

13. EPA NSW. (2020) *Compulsory-record-keeping.* [online] NSW Environment Protection Authority. Available at: https://www.epa.nsw.gov.au/your-environment/pesticides/compulsory-record-keeping [Accessed 30 Jul. 2020].

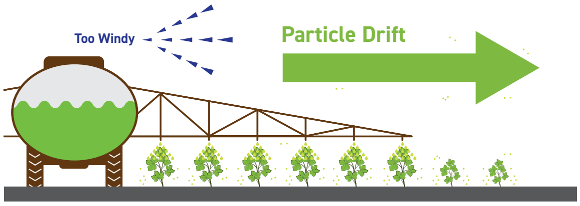
14. Agriculture Victoria. (2020). *Agricultural chemical use records - Agriculture.* [online] agriculture.vic.gov.au. Available at: https://agriculture.vic.gov.au/farm-management/chemicals/keeping-records-of-chemical-use/agricultural-chemical-use-records [Accessed 30 Jul. 2020].

15. Gordon B (2013). *Monitor weather conditions and droplet size to manage drift - GRDC GROUNDCOVER.* [online] grdc.com.au. Available at: grdc.com.au/resources-and-publications/groundcover/ground-cover-supplements/gcs105/monitor-weather-conditions-and-droplet-size-to-manage-drift [Accessed 26 May, 2021]. Adapted from Nufarm (2018), 24 Hour risk profile for Summer Spraying.

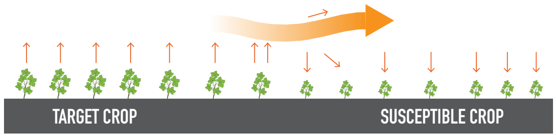
Bollgard 3 XTENDFLEX COTTON

ENSURING ON-TARGET APPLICATION

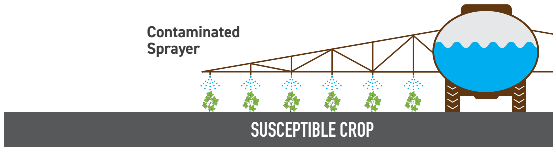
Avoiding off-target movement, through contamination, volatility and physical drift is critical in all cropping systems.
Bayer is developing a robust stewardship package to ensure growers maximise their chances of on-target applications.



Physical Drift
Physical movement of spray particles during application. Most common and significant type of off-target movement for any herbicide



Volatility
Movement of a herbicide in a volatilised form as a gas or vapour AFTER spray application. Least frequent type of off-target movement



Sprayer Contamination
Off-target movement from herbicide residue in remaining sprayer **components**

Bollgard 3 Roundup Ready Flex® Cotton sprayed with dicamba and 2, 4-D at different rates (Percentage of full label rate). Demonstrating potential spray drift damage. Summer Crop Matrix trial – Locharba, Bayer Research Center, Narrabri, AUS 2022-23 Season


XtendiMax 2 Herbicide with VapourGrip Technology – 0.1%


XtendiMax 2 Herbicide with VapourGrip Technology – 1%


XtendiMax 2 Herbicide with VapourGrip Technology – 5%


XtendiMax 2 Herbicide with VapourGrip Technology – 10%


Amicide® Advance – 0.1%


Amicide Advance – 1%


Amicide Advance – 5%


Amicide Advance – 10%

100% application rate of XtendiMax 2 = 1.17 L/ha.
100% Amicide Advance application rate = 1.5 L/ha

NOTES

FOR MORE INFORMATION CONTACT YOUR BAYER TERRITORY BUSINESS MANAGER

Mick Fing
Territory Business Manager
Darling Downs and St George/Dirranbandi
0417 305 717
michael.fing@bayer.com

Greg Pearce
Territory Business Manager
Gwydir, Macintyre and Mungindi
0427 766 605
greg.pearce@bayer.com

Emma Brotherton
Territory Business Manager
Central Queensland and Dawson/Callide
0409 742 738
emma.brotherton@bayer.com

David Higgins
Territory Business Manager
North QLD
0477 675 084
david.higgins@bayer.com

Wes Amor
Territory Business Manager
Murray (selected stores)
0438 019 355
wes.amor@bayer.com

Seamus McKinley
Territory Business Manager
Murray (selected stores)
0427 330 684
seamus.mckinley@bayer.com

Jack Sharp
Territory Business Manager
Namoi and Walgett
0436 355 226
jack.sharp@bayer.com

Mark Dawson
National Sales Manager -
Row Crop
0428 106 090
mark.dawson@bayer.com

Ben Turner
Territory Business Manager
Northern Australia
0429 809 502
ben.turner@bayer.com

Jon Bennett
Territory Business Manager
Macquarie & Bourke
0409 490 923
jon.bennett@bayer.com

Kyleigh Turner
Territory Business Manager
Griffith & Murrumbidgee Irrigation Area (MIA),
Coleambally Irrigation Area (CIA), Hay & Lachlan
0409 348 878
kyleigh.turner@bayer.com

Bayer CropScience Pty Ltd
ABN 87 000 226 022
Level 4, 109 Burwood Road
Hawthorn VIC 3122
Phone: 1800 636 001
bollgard3.com.au