Application and Drift Management

GRDC
Grains Research & Development Corporation
Your GRDC working with you

Developed by Bill Gordon
Bill Gordon Consulting.
Lawrence, New South Wales, Australia

Advanced Spray Workshops

GRDC
Grains Research & Development Corporation
Your GRDC working with you

Bill Gordon and Andrew Storrie

Main Topics Discussed

- Nozzles and how they work, affect on spray quality
- Conditions for spraying – Surface Inversions
- Targets, Products, Volume, Spray Quality Issues
- Issues with Water Quality & Adjuvants
- Nozzle Selection and things to think about

Main Topics Covered

- Labels & Application (what's new?)
- Nozzles and how they work, affect on spray quality
- Conditions for spraying – Surface Inversions
- Targets, Products, Volume, Spray Quality Issues
- Issues with Water Quality & Adjuvants
- Nozzle Selection and things to think about

Changes To Labeling

New mandatory statements on labels may affect your application technique and timing.

changes include;

- Required Spray Qualities (changes to definition of coarse)
- Defined Wind Speed Ranges
- **No-spray zones / down wind buffer distances**
- **Additional Record Keeping (Federal Requirement)**

SPRAY DRIFT RESTRAINTS

DO NOT apply with spray droplets smaller than a **COARSE** spray droplet size category according to the "*APVMA compliance Instructions for Mandatory COARSE or larger Droplet Size Categories*" located under this title in the GENERAL INSTRUCTIONS section of this label.

For ground application this will accept the ASAE S572 or the BCPC standard. For aircraft it will recognise appropriate droplet size models and will accept the Dv 0.1 value for coarse.

SPRAY DRIFT RESTRAINTS

Wind speed may change on some labels for ground application, and extra warnings about inversions.

- **DO NOT** apply when the wind speed is less than 3 or more than 20 kilometres per hour as measured at the application site.

- **DO NOT** apply during surface temperature inversion conditions at the application site

No Spray Zones

NO Spray Zones are **Downwind** Distances to:

- areas occupied by humans
- aquatic areas
- terrestrial vegetation
- livestock or pastures

MANDATORY NO-SPRAY ZONES

DO NOT apply if there are people, structures that people occupy or parks and recreation areas within **xxx metres** downwind from the application area.

DO NOT apply if there are aquatic and wetland areas including aquacultural ponds, surface streams and rivers within **yyy metres** downwind from the application area.

DO NOT apply if there are sensitive crops, gardens, landscaping vegetation, protected native vegetation or protected animal habitat within **zzz metres** downwind from the application area.

DO NOT apply if there are livestock, pasture or any land that is producing feed for livestock within **uuu metres** downwind from the application area.

Record Keeping Requirements

- Some labels will include instructions on record keeping.
- These will be in addition to the State requirements

MANDATORY LABEL INSTRUCTION
TO KEEP A SPRAY RECORD

Users of this product **MUST make an accurate written record** of the details of each spray application within 24 hours following application and **KEEP** this record for a minimum of 2 years. The spray application details that must be recorded are:

1. date with start and finish times of application;
2. locations address and paddock/s sprayed;
3. full name of this product;
4. amount of product used per hectare and number of hectares applied to;
5. crop/situation and weed/pest;

6. wind speed and direction during application;
7. air temperature and relative humidity during application;
8. nozzle brand, type, spray angle, nozzle capacity and spray system pressure measured during application;
9. name and address of person applying this product.

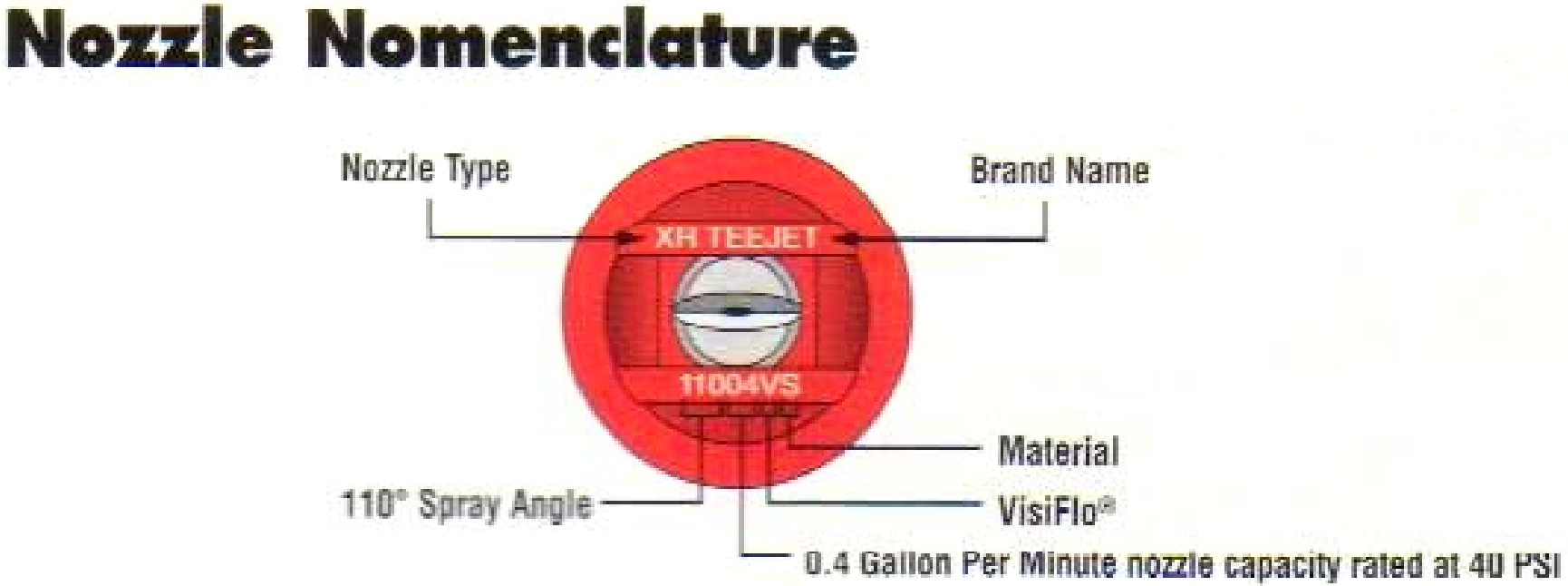
*Additional record details may be required by the state or territory where this product is used.

Mandatory Statements

- For Growers it is worth remembering that;

  In the event that some product does move off target and there is a claim for compensation against you, your insurance may not cover you if you have performed an illegal application by contravening a label instruction.

Nozzle Naming Systems



ISO Colour codes and Nozzle Materials

Characteristics of Common Spray Tip Materials				
				
Ceramic Superior wear life; highly resistant to abrasive and corrosive chemicals	**Hardened Stainless Steel** Very good wear life; good durability and chemical resistance	**Stainless Steel** Good wear life; excellent chemical resistance; durable orifice	**Polymer** Good wear life; good chemical resistance; orifice susceptible to damage when cleaned improperly	**Brass** Poor wear life; susceptible to corrosion, especially with fertilizers

Spray Quality Charts

From the spraying systems nozzle selection guide, 2011

Turbo Teejet	bar										
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
TT11001-VP	C	M	M	M	F	F	F	F	F	F	F
TT110015-VP	C	C	M	M	M	M	M	F	F	F	F
TT11002-VP	C	C	C	M	M	M	M	M	M	M	F
TT110025-VP	VC	C	C	M	M	M	M	M	M	M	M
TT11003-VP	VC	C	C	C	C	M	M	M	M	M	M
TT11004-VP	XC	VC	C	C	C	C	C	C	M	M	M

Nozzle nomenclature (ISO):

Type: TT (*for TurboTeejet*)

Fan angle: 110 degrees

Orifice Size: e.g. 04

SPRAY QUALITY (e.g. M for MEDIUM)

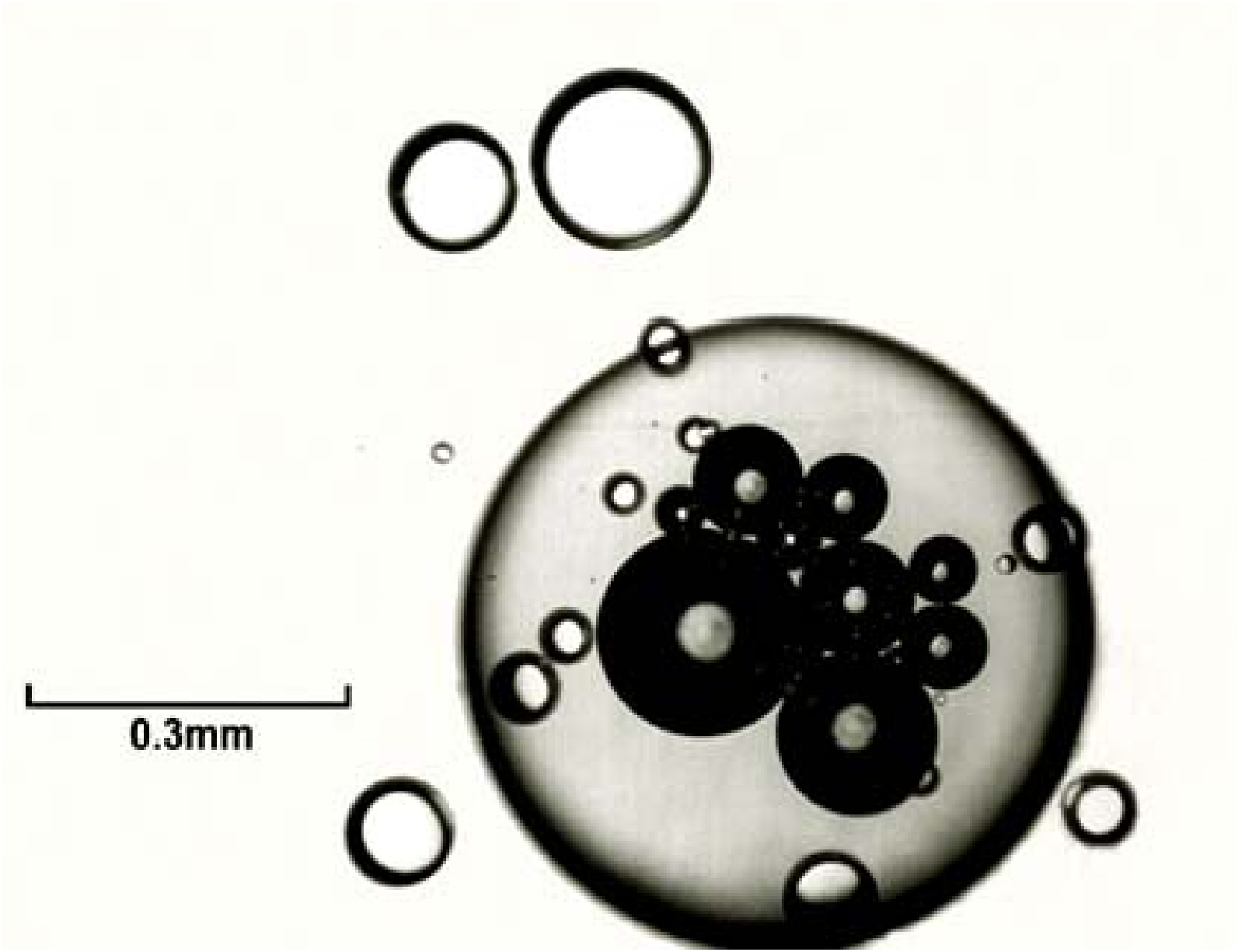
Colours assigned to spray qualities (e.g. medium or coarse) ARE NOT related to the ISO colours assigned to indicate orifice size (e.g. 02 or 025).

Tapered Fan and Even Fan

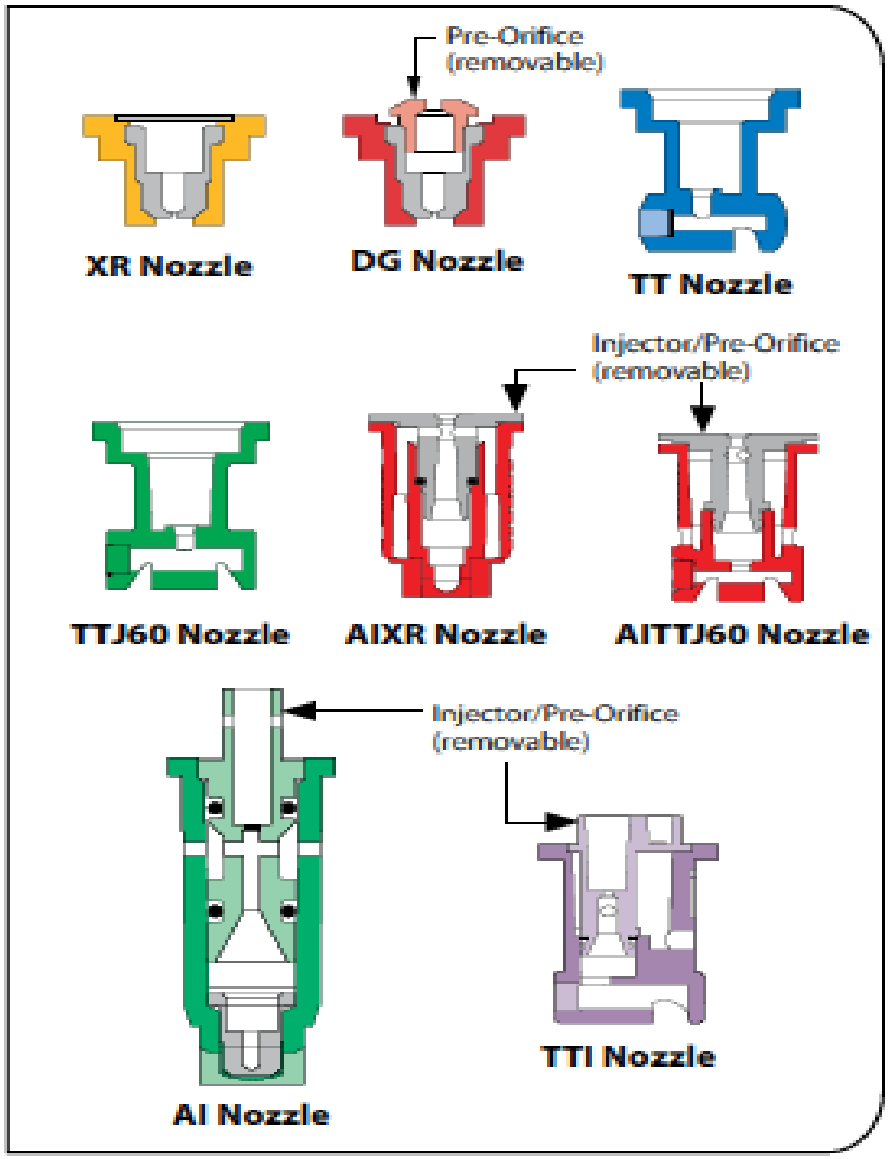
Tapered Fan

Even Fan

Mechanism of Droplet Formation (hydraulic pressure – fan type)


0.3mm

Examples of types of Nozzles that are available.



- The simplest way to change spray quality is to change nozzle type.
- If you need to produce coarse or very coarse spray qualities then standard flat fans and low drift nozzles may not be suitable at reasonable volumes.
- You will probably need to look at anvil types or air induction nozzles

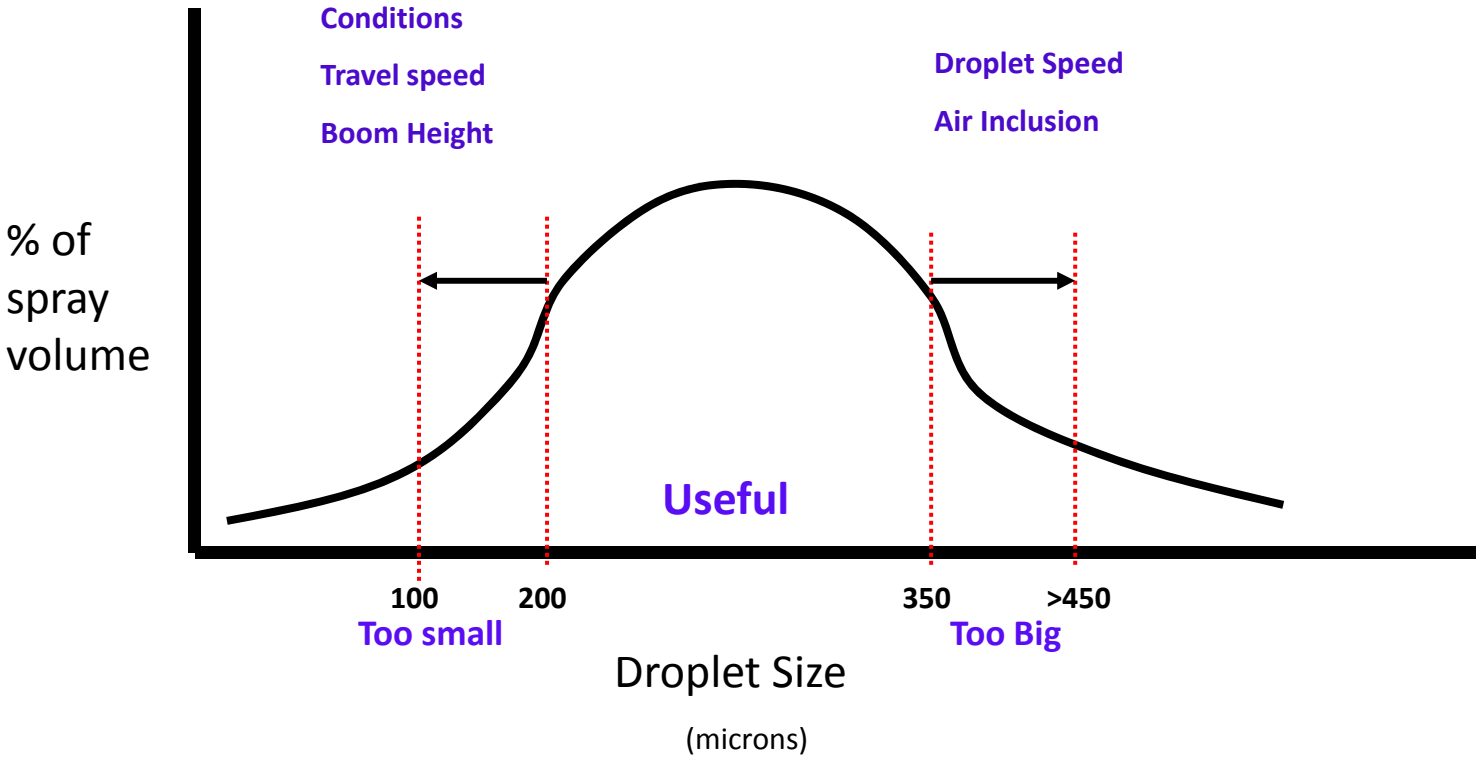
Source: Teejet Catalogue 51M

What do fine, medium, coarse, very coarse and extremely coarse spray qualities actually look like ?

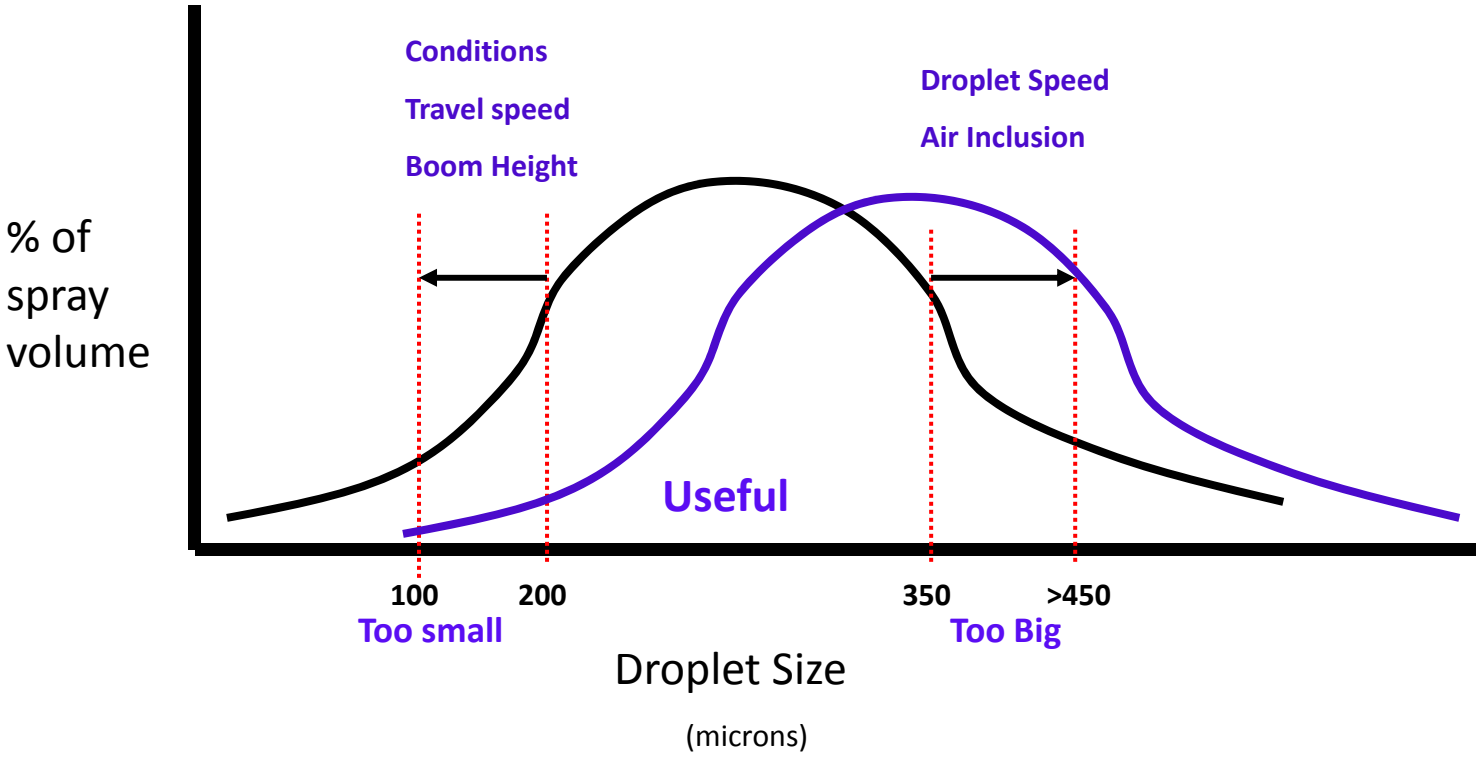
Outside Demonstration

(best done with some breeze)

Hydraulic nozzle outputs

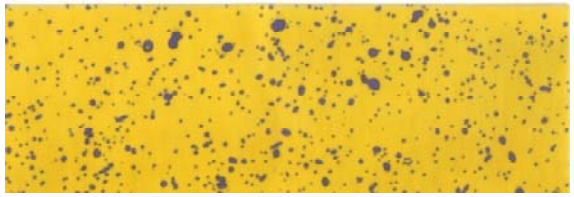


Changing nozzle type shifts the curve, less small droplets, but more big droplets



Bigger droplets = fewer droplets
(but when is that important?)

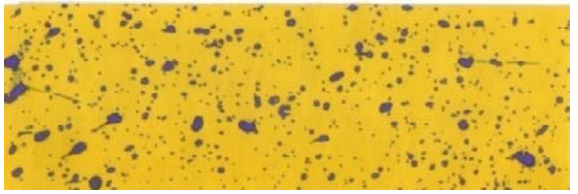
Medium Droplets



- More even deposition
- More sites for uptake
- Faster rate of evaporation
- Less time for absorption

- Good for surface active products, poorly translocated products

Coarse Droplets



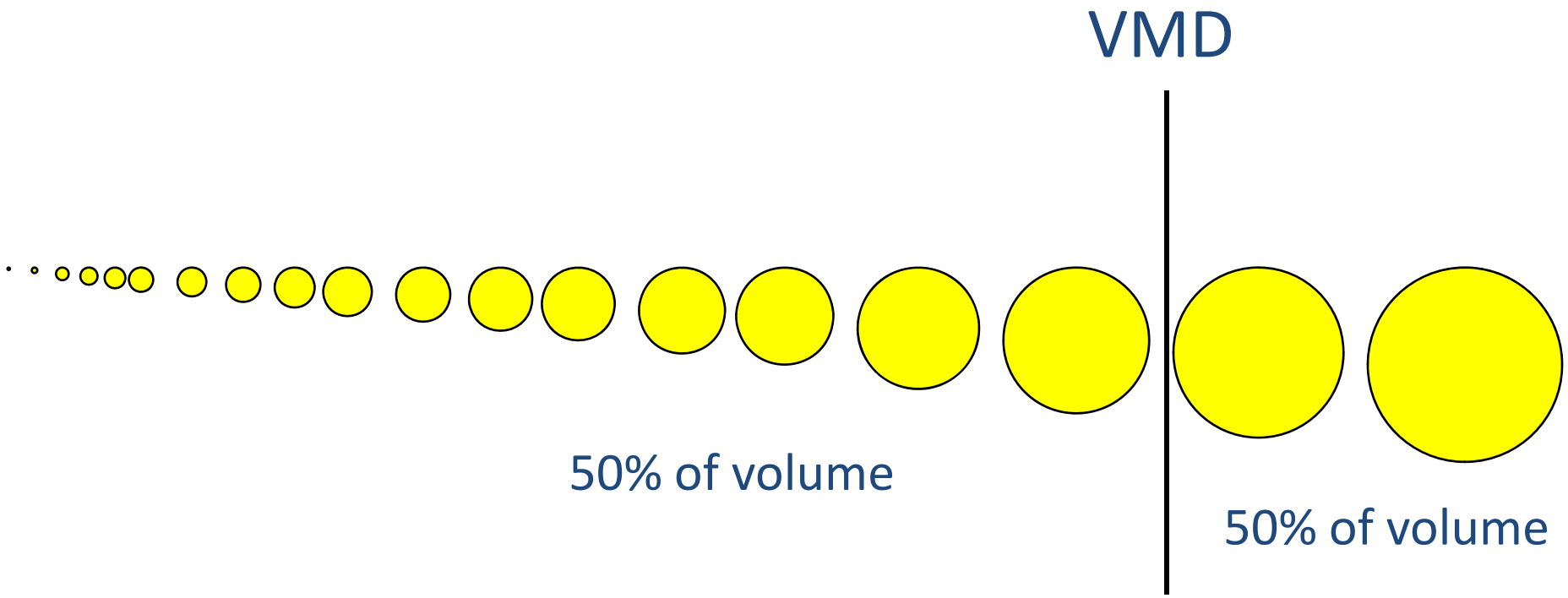
- Less even deposition
- Less sites for uptake
- Slower evaporation
- More time for absorption

- Good for fully translocated products

Droplet behaviour

Approximate Droplet Size (microns)	Expected behaviour under suitable spraying conditions.
Less than 50 microns	Will evaporate quickly and will typically be lost before reaching the target.
Droplets 50 to 150 microns.	Will move with the wind, hence present some risk as they may move off target. But are also very useful under good spraying conditions.
Droplets less than 200 microns	Considered 'driftable' because they may reduce in size due to evaporation, hence move with the wind.
Droplets > 250 microns	Will typically fall due to gravity
Droplets over 350 microns	Many may bounce or runoff without the addition of adjuvants, hence may not be useful for spraying foliage (but do provide good absorbtion for translocated products)
Droplets between 100 and 350 um	Considered the MOST USEABLE fraction when spraying foliage.

Older terminology - VMD



VMD = volume median diameter

New asabe s572.1

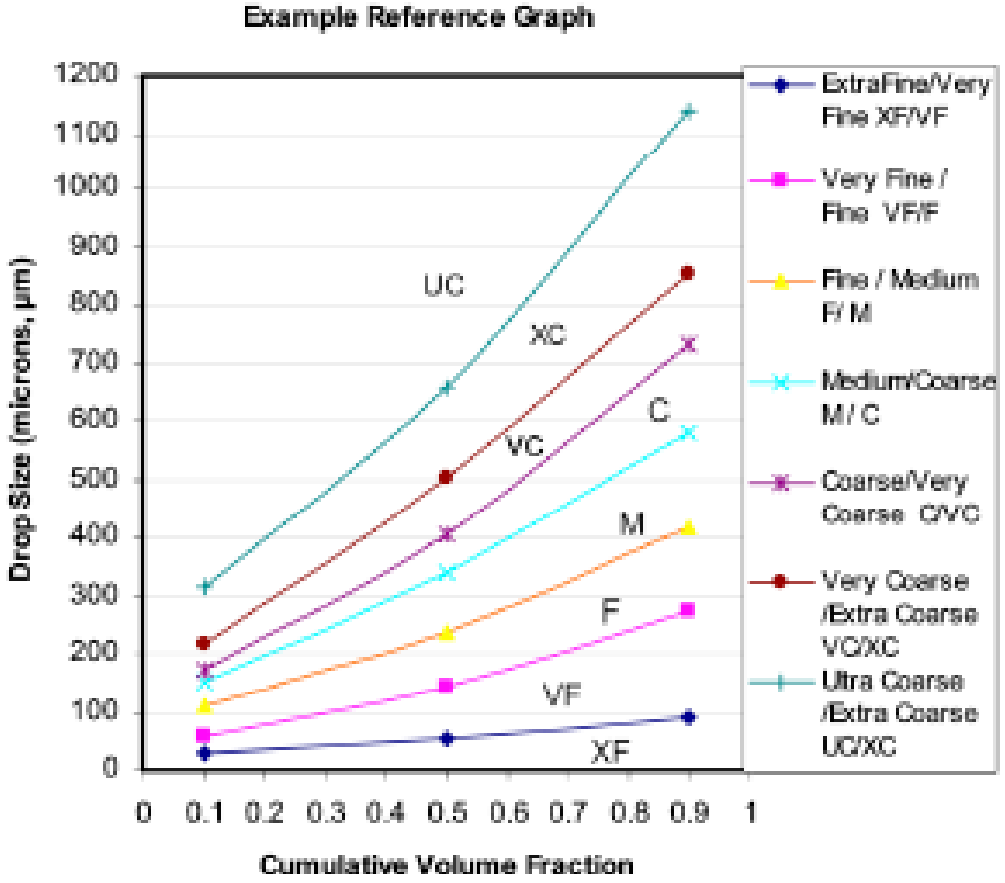


Figure 1 – Sample reference graph developed from measurements averaged from three types of laser instruments. NOTE: To view figure in color please go to http://www.asabe.org/standards/images/s572images.html

Summary

- Fine spray quality approximately 40-50% susceptible
- Medium spray quality approximately 20% susceptible
- Coarse spray quality approximately 10% susceptible
- Very Coarse quality approximately 5 % susceptible
- Extremely Coarse spray quality approx. 3 % susceptible

How many sets of nozzles do you need? (Broad-acre example).

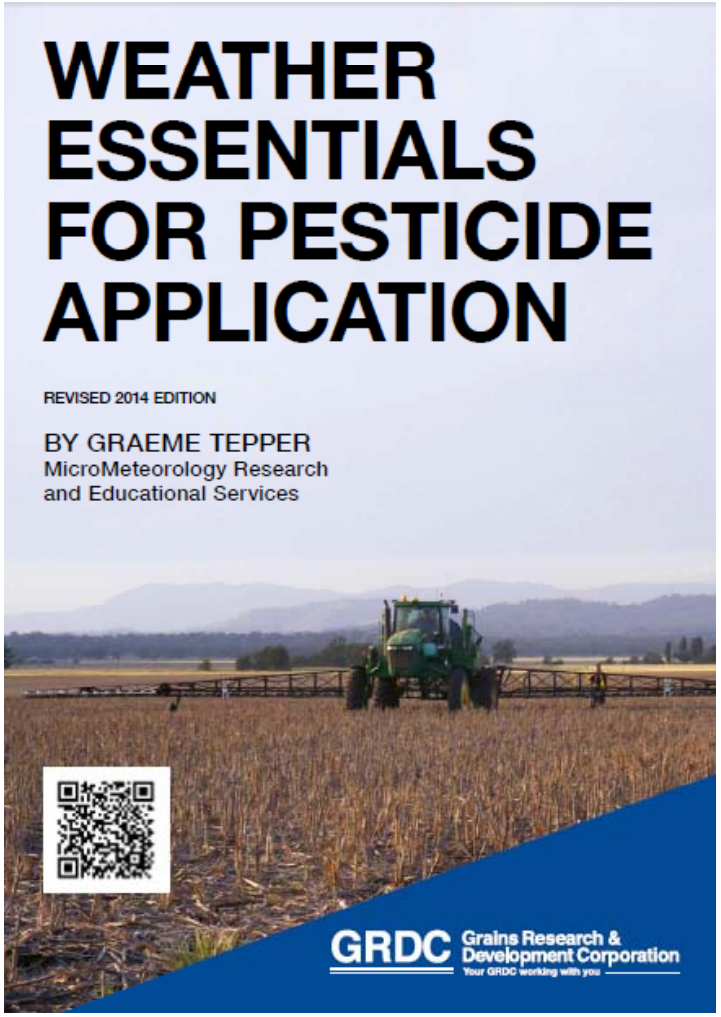
Typical Application Volume	Medium Spray Quality (lower drift risk areas)	Coarse Spray Quality	Extremely Coarse Spray Quality (higher drift risk areas)
Lower range **50 -60 L/ha** **(Low stubble load)** **to** **70-80 L/ha** **(High stubble load)**	*Only where permitted on label: Fully translocated herbicides Small to medium sized targets.	Fallow Spraying Fully translocated herbicides such as Glyphosate, MCPA. Mandatory for 2,4-D,	Fully translocated herbicides, medium targets, Very sensitive areas or NIGHT SPRAYING
Higher range **70-80 L/ha** **(Low stubble load)** **to** **100 + L/ha** **(High stubble load/ dense crop canopy)**	*Only where permitted on label: Contact type products. Small targets. In crop spraying. Penetration and coverage in large & broadleaf crops.	Good stubble penetration. Pre-emergent's. Fully Translocated herbicides, Some contact herbicides at the higher application volumes.	Pre-emergent's. Medium sized targets with fully translocated summer fallow herbicides. Very sensitive areas or NIGHT SPRAYING

What are suitable conditions for Spraying ?

(it really depends product, target & droplet size)

Critical Factors

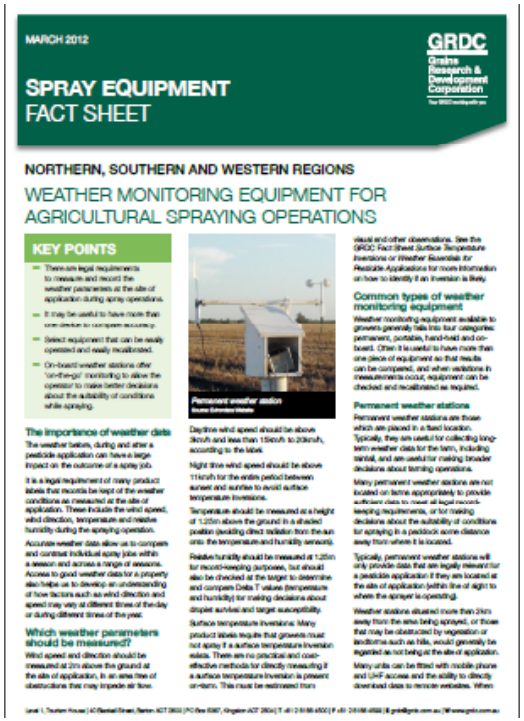
- What the product label says is MANDATORY
- Wind Speed (depends on label) and Wind direction
- Delta T (Temperature & Relative Humidity)
- Release Height & Speed (depending on spray quality)
- Local weather effects (especially night spraying)



If you can't measure the conditions at the site of application, you can't make an informed decision about when to change setup or when to stop

- Monitor and record conditions at least every load.

- **More often at night ..if the wind drops, STOP spraying**


MARCH 2012

GRDC Grains Research & Development Corporation

SPRAY EQUIPMENT
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

WEATHER MONITORING EQUIPMENT FOR AGRICULTURAL SPRAYING OPERATIONS

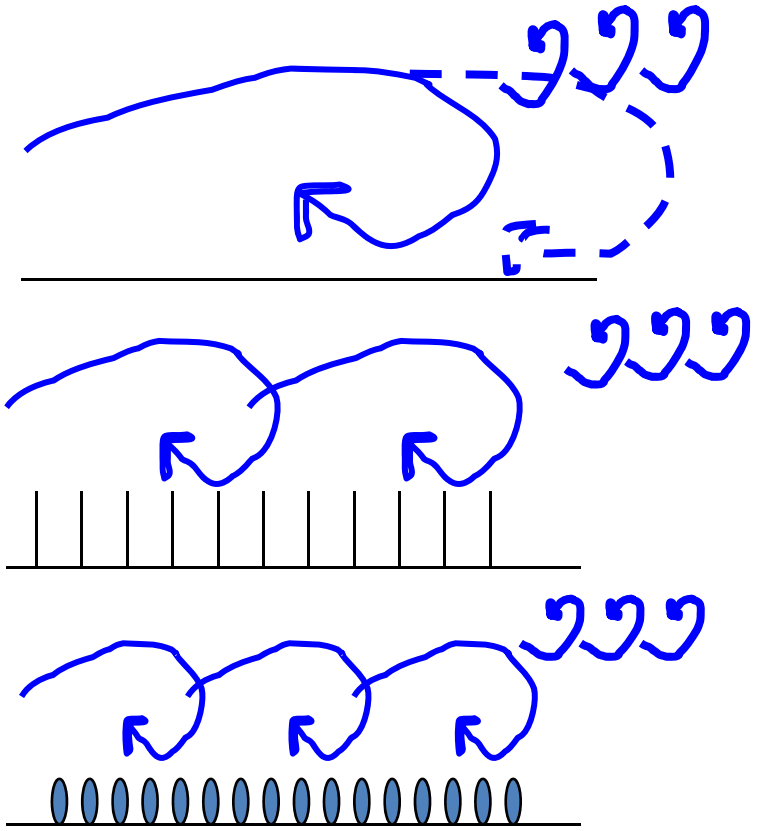
KEY POINTS

Photograph by Graham Betts

What are suitable wind speeds?

- The maximum wind speed should not be above 20 km/h and preferably around 15 km/h….
- Higher wind speed can be managed when we have a canopy to catch the droplets, and with droplet size and buffers (no spray zones) provided gusts are not too strong.
- …..during the day a minimum of about 3-4 km/h is essential to ensure the air moves and mixes, at night this should be above 12 km/h for the whole time between sunset and sunrise.

Wind Movement Over Different Surfaces



FALLOW GROUND

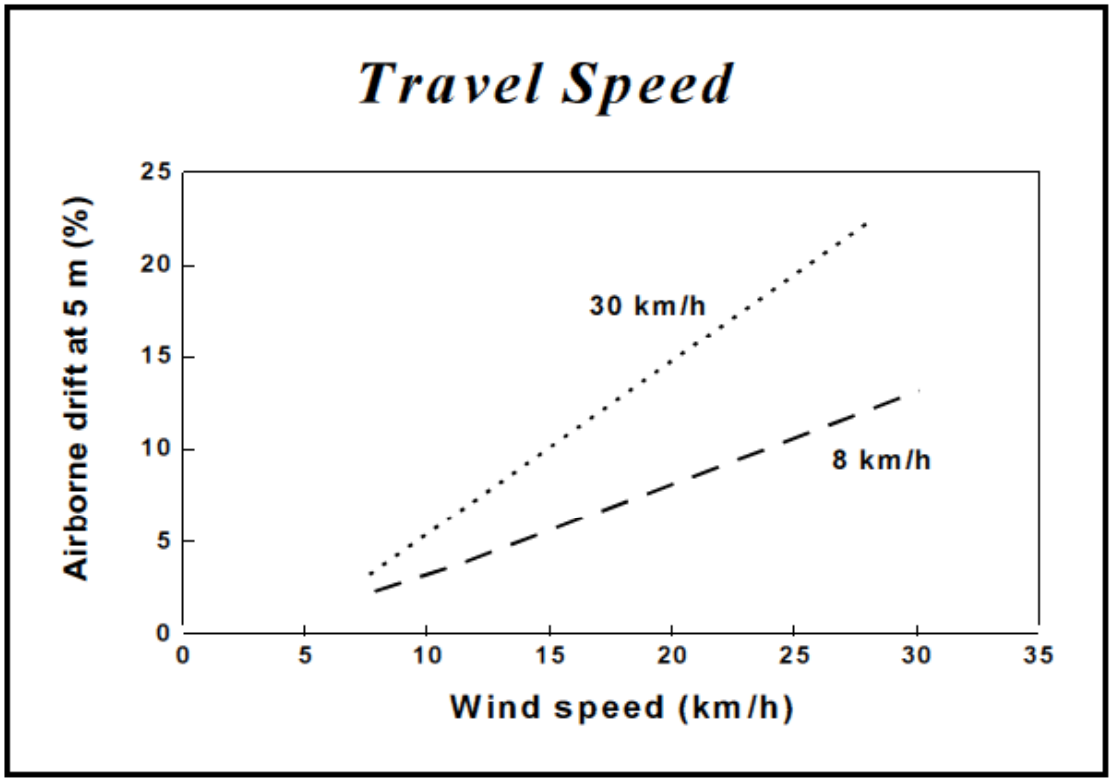
HEAVY STUBBLE

IN CROP SITUATIONS

Comments about angled nozzles and travel speed by Professor Paul Miller NIAB-TAG (UK):

Speed?

Going slowly certainly helps boom stability, but timeliness will suffer. **Going beyond 15kph risks running into a new set of problems. The faster the sprayer travels, the more turbulence or "wake" it creates behind it. Small droplets tend to be pulled into areas of high turbulence, creating drift, and these areas also produce greater levels of deposition on to plant targets.**



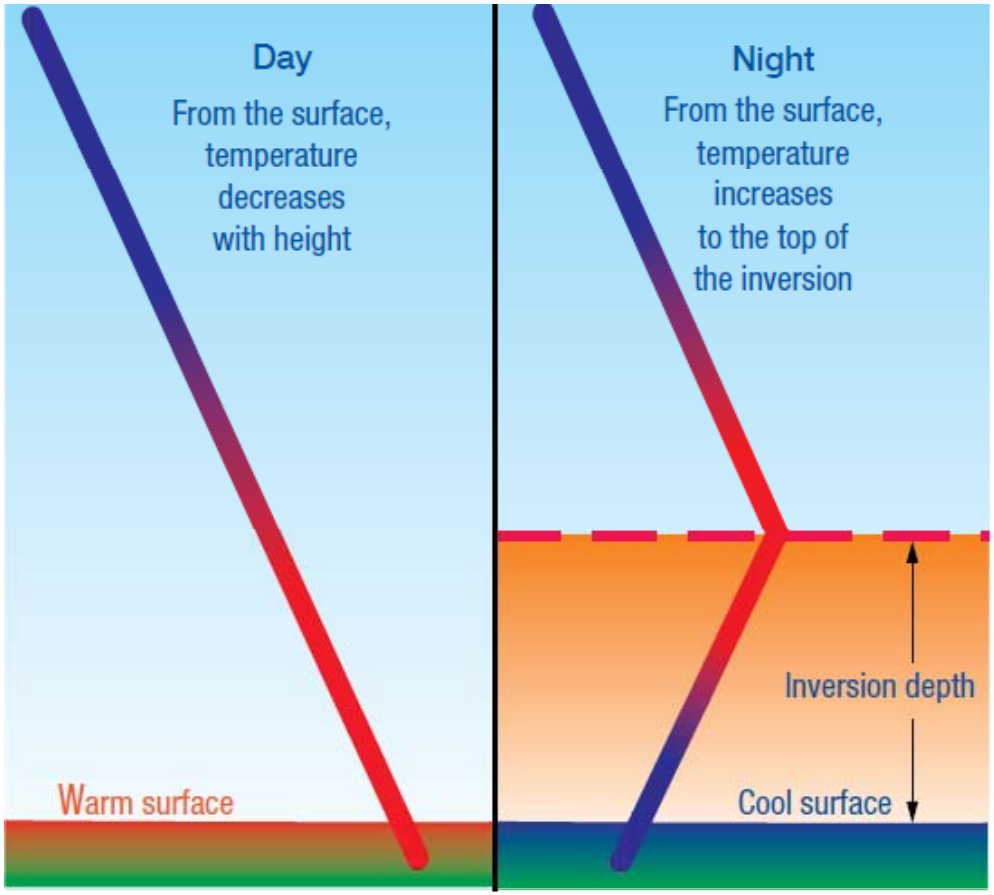
Effect of travel speed on spray drift. 30 km/h travel speed conducted using XR11002 tips applying 30 L/ha. 8 km/h travel speed done using XR8001 tips applying 50 L/ha.

Fast travel speeds have three main effects on how spray behaves after it leaves the nozzle. Faster speeds:

- increase sheet break-up and cause a finer, more drift-prone spray to be produced;
- cause the spray to stay aloft longer because it gets swept back due to air resistance;
- often require higher boom heights on uneven ground;

Thomas M. Wolf, Agriculture and Agri-Food Canada, Saskatoon Research Centre, 107 Science Place, Saskatoon, SK, S7N 0X2, WolfT@agr.gc.ca +01 306 956 7635

Temperature at the surface drives the formation of inversions



SOURCE: GRAEME TEPPER

REPRINTED AUGUST 2013

SURFACE TEMPERATURE INVERSIONS AND SPRAYING FACT SHEET

GRDC Grains Research & Development Corporation

NORTHERN, SOUTHERN AND WESTERN REGIONS

THE INFLUENCE OF SURFACE TEMPERATURE INVERSIONS ON SPRAY OPERATIONS

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.

KEY POINTS

- Where surface temperature inversion conditions exist it is unsafe for spraying due to the potential for spray drift.
- Spray applied at dawn, dusk and during the night is likely to be affected by a surface temperature inversion.
- During surface temperature inversions, air near the ground lacks turbulence. This can lead to airborne pesticides remaining at high concentrations in the air at or near the surface.
- The direction and distance that pesticides can move in the air close to the ground is very hard to predict when surface inversions exist.

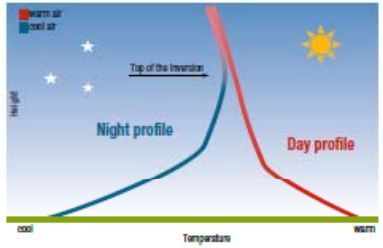


FIGURE 1 **Typical vertical temperature profiles for a point in time during the night and day. At low levels, the day profile typically cools with height and the night profile typically warms with height. Little change occurs at elevated altitudes.**

SOURCE GRAEME TEPPER

During daylight hours the temperature of the soil surface gradually increases. Air in contact with the ground also warms (Figure 1). 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 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 1). 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.

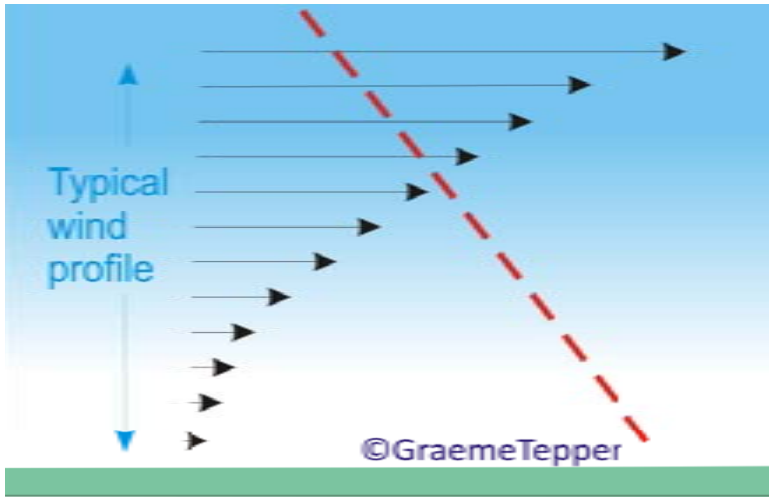
In a surface temperature inversion the point where the temperature stops increasing and begins to decrease is the top of the inversion layer.

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 2).

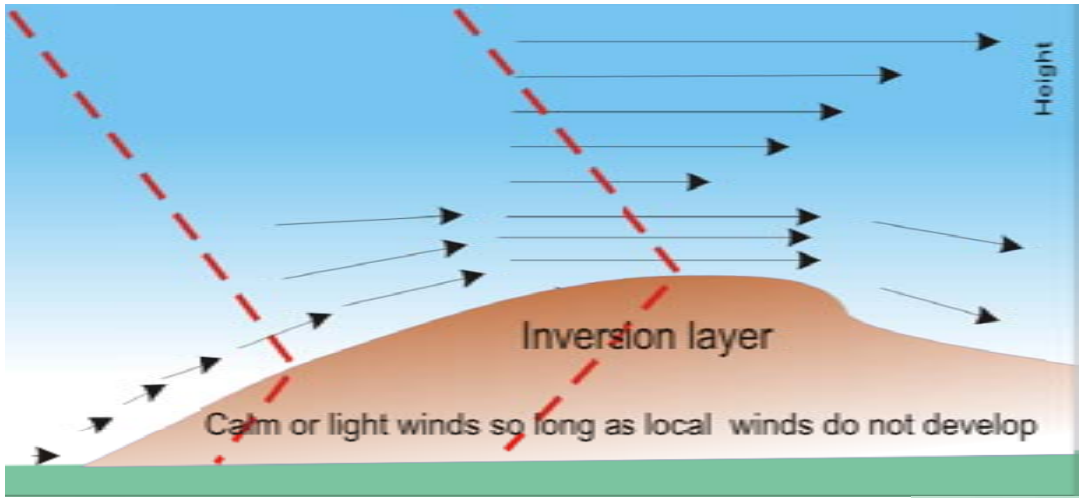
Surface temperature inversion conditions are unsafe for spraying as the potential for spray drift is high.

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | T +61 2 6166 4500 | F +61 2 6166 4599 | E grdc@grdc.com.au | W www.grdc.com.au

Typical daytime situation



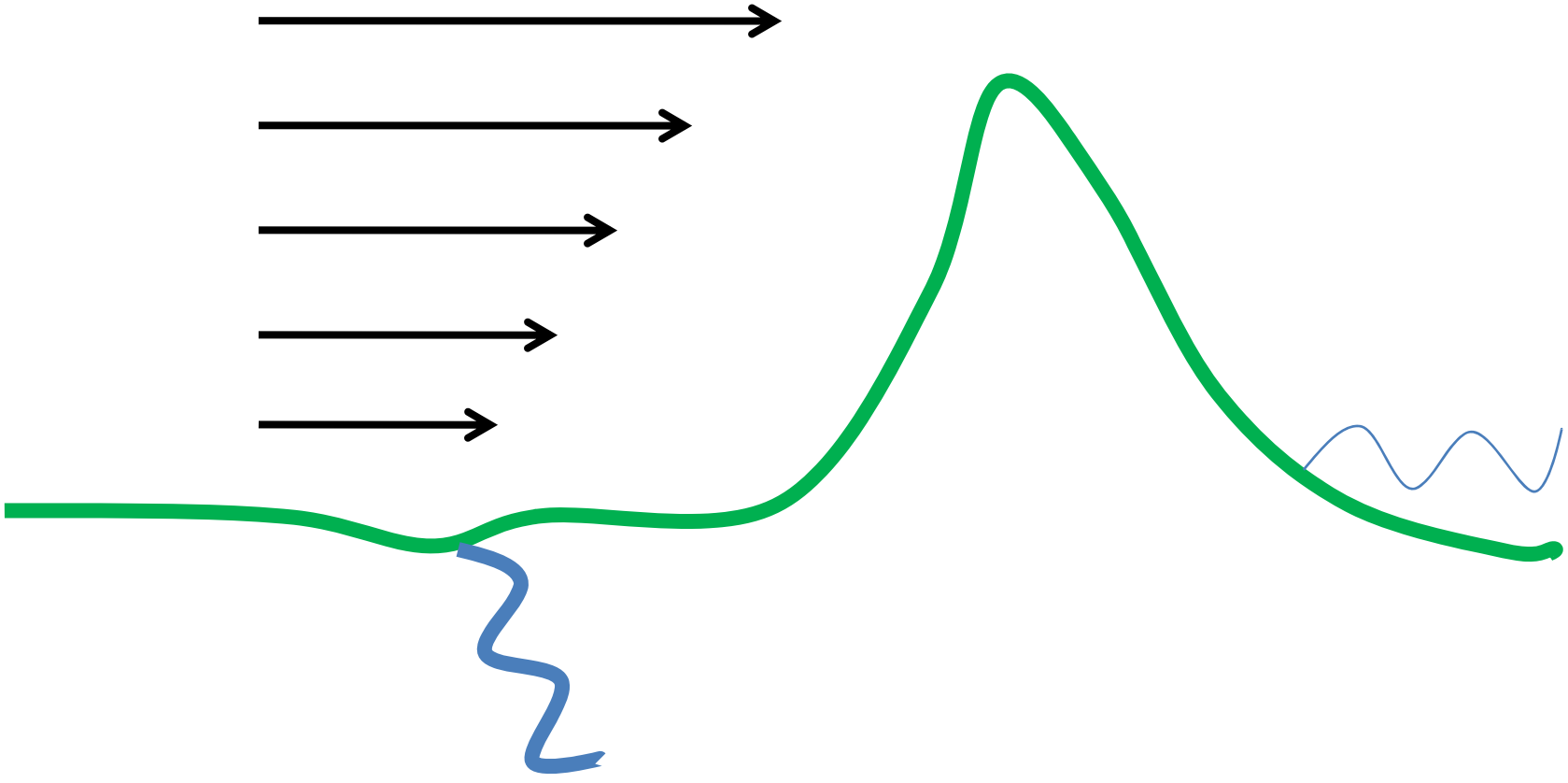
Typical Night time situation



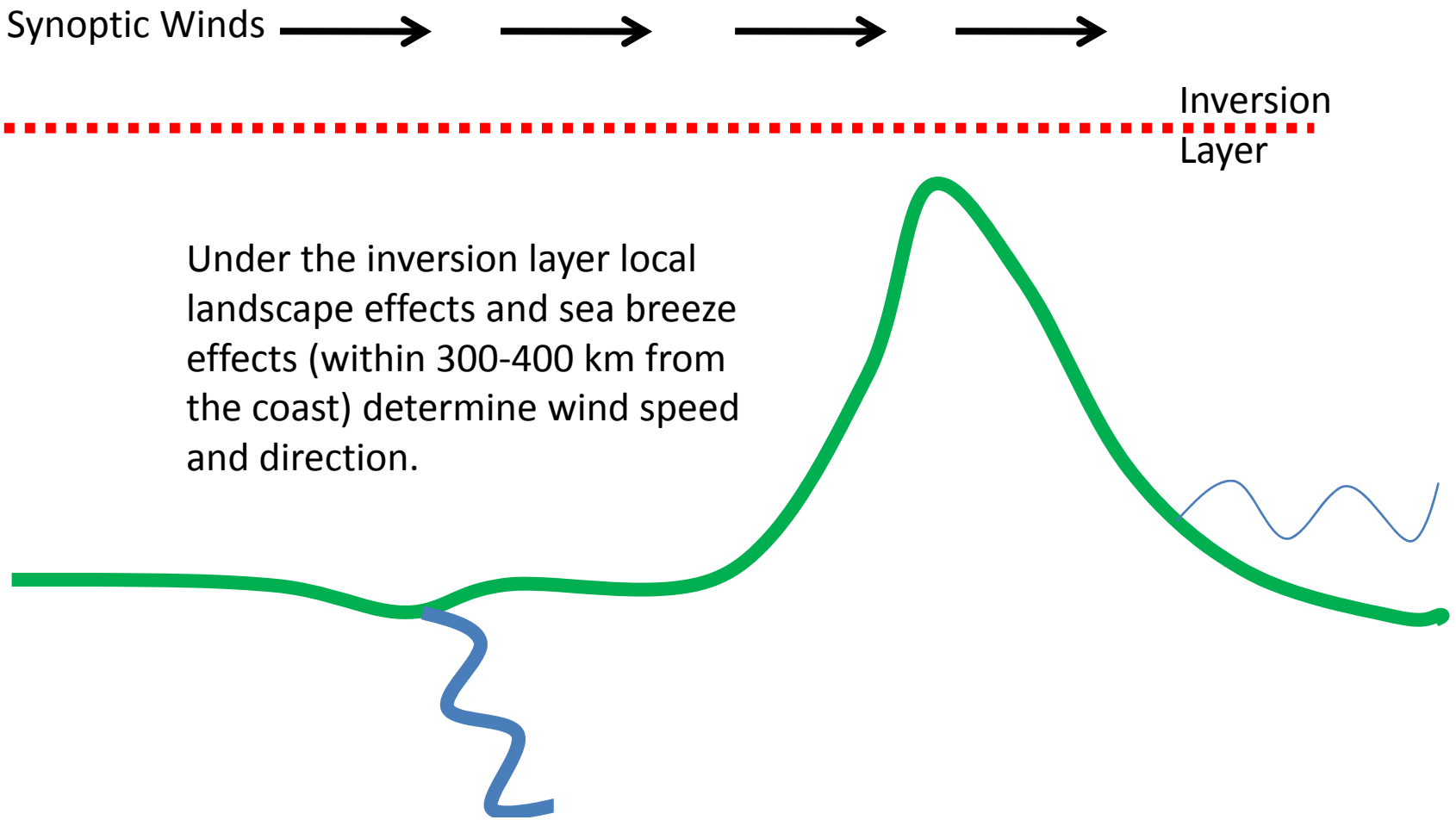
Effect of inversions over a landscape

- Through out a 24 hour cycle wind direction and strength can vary greatly, depending on where you are….

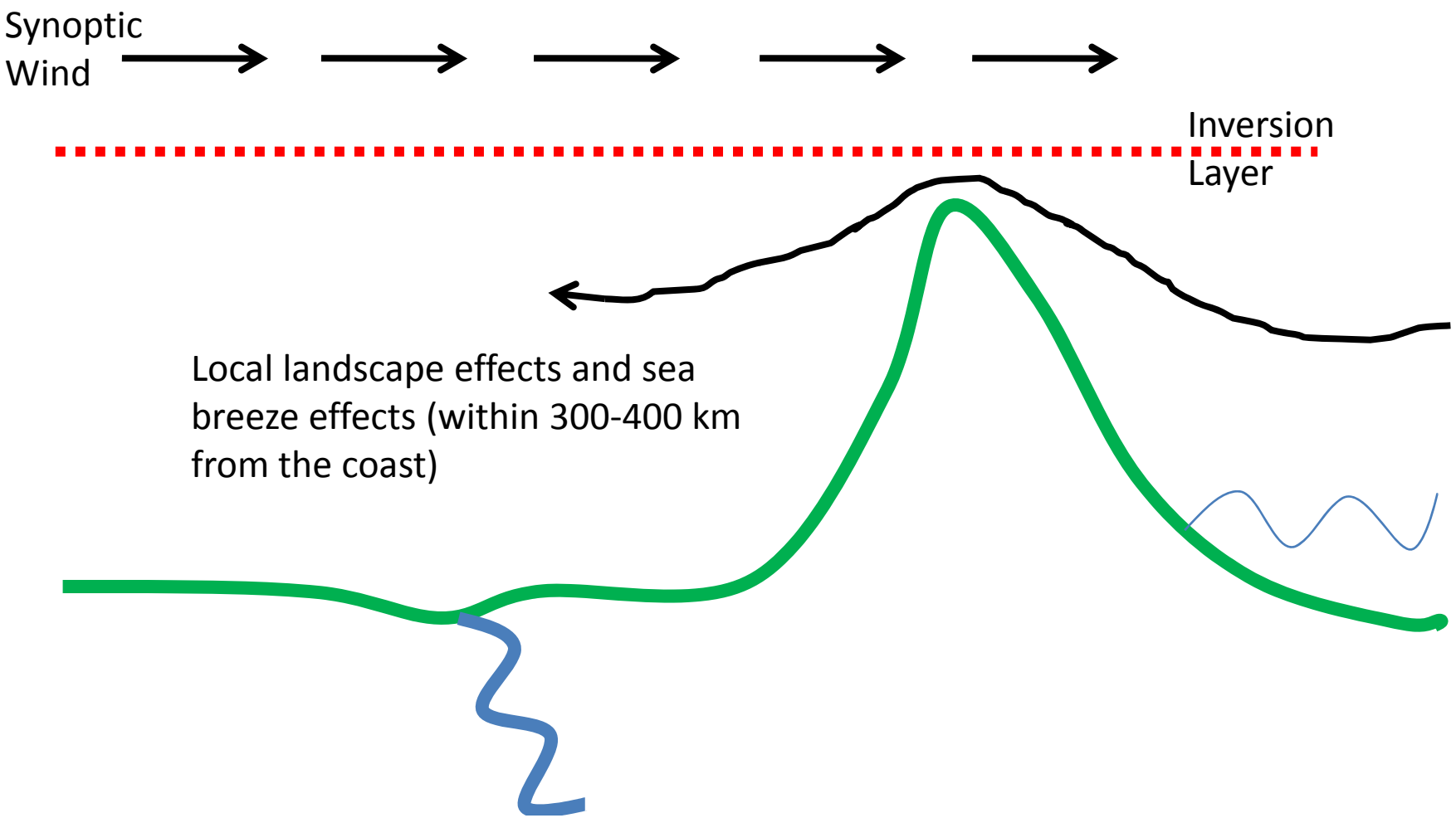
Synoptic winds, dominating during the daylight hours – following the weather pattern

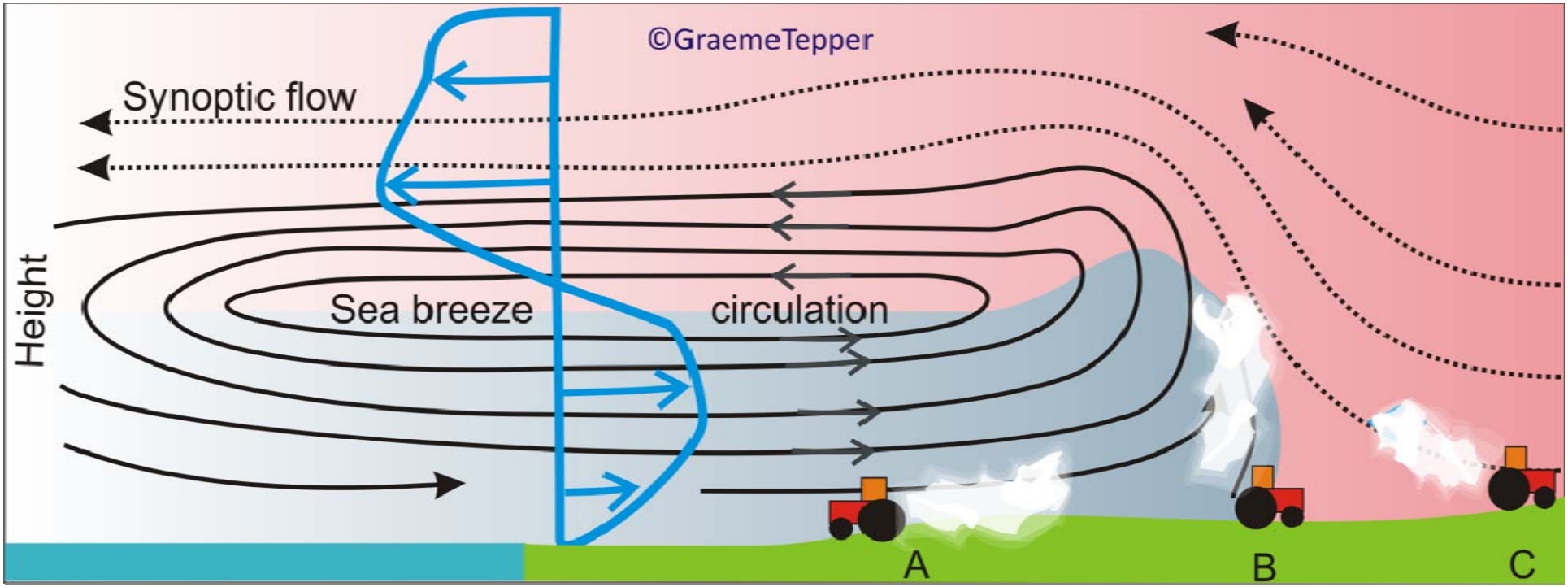


Late in the afternoon the landscape can be cut off from the Synoptic Wind when the inversion forms

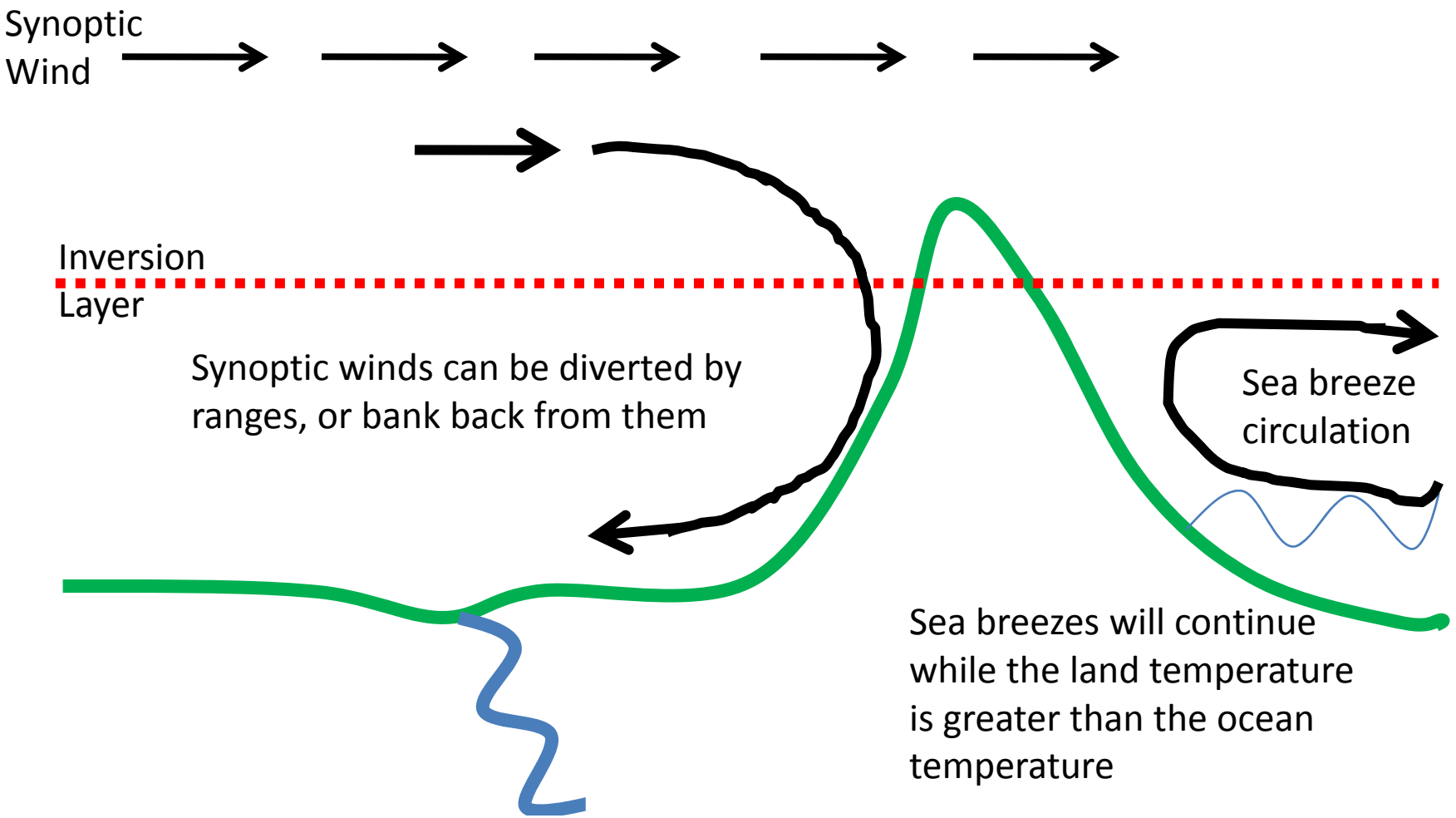


Effects of an inversion on a whole of landscape scale

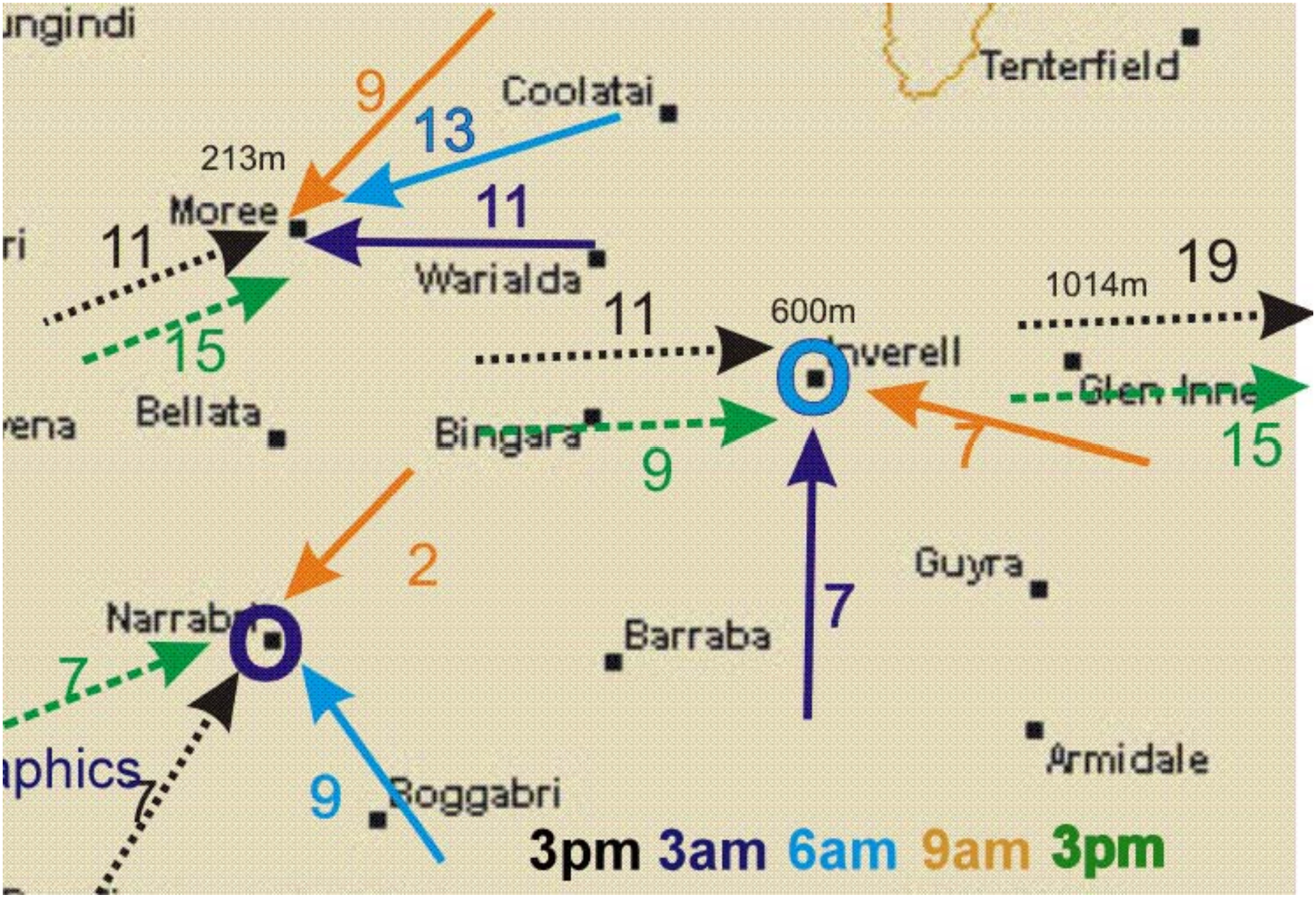



©GraemeTepper
Synoptic flow
Height
Sea breeze
circulation
A
B
C

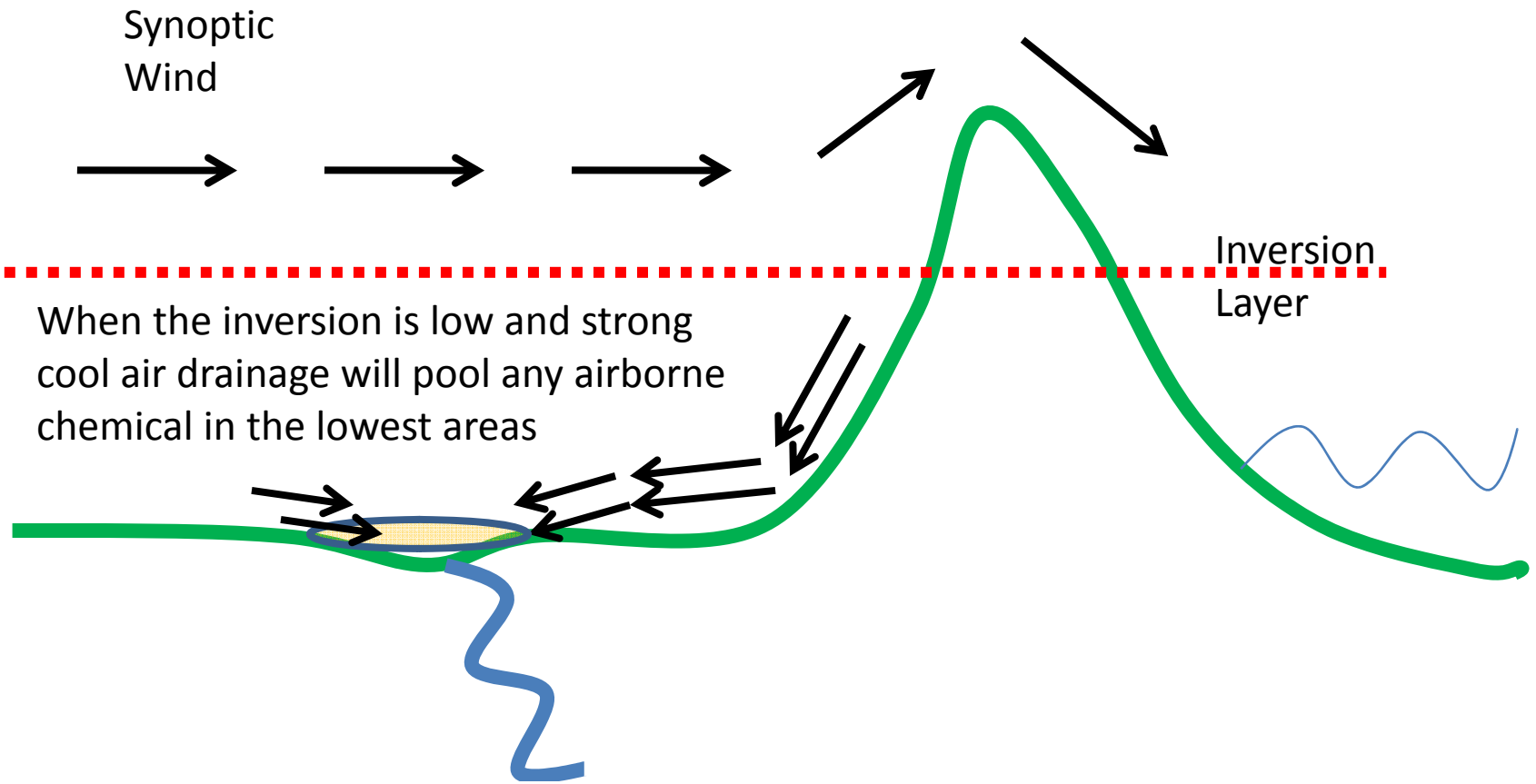
Effects of an inversion on a whole of landscape scale



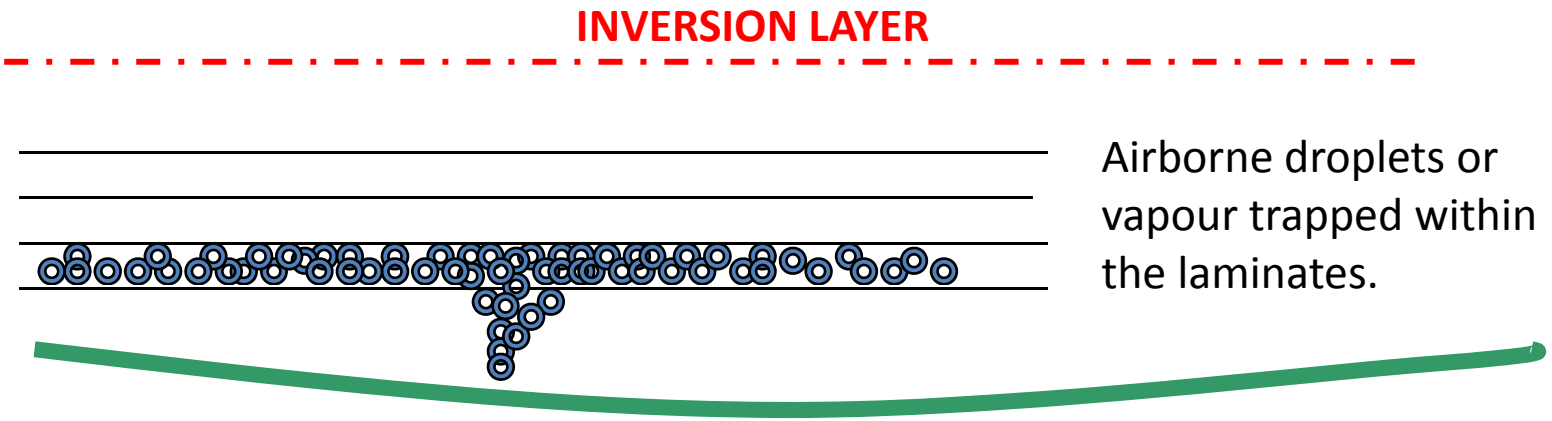

© Graeme Tepper Graphics


ungindi
Tenterfield
9
Coolatai
13
213m
Moree
11
11
Warialda
11
600m
Inverell
1014m
19
15
Bellata
Bingara
9
Glen Inne
15
7
2
Narrabri
7
Barraba
7
Guyra
aphics
9
Boggabri
Armidale
3pm 3am 6am 9am 3pm

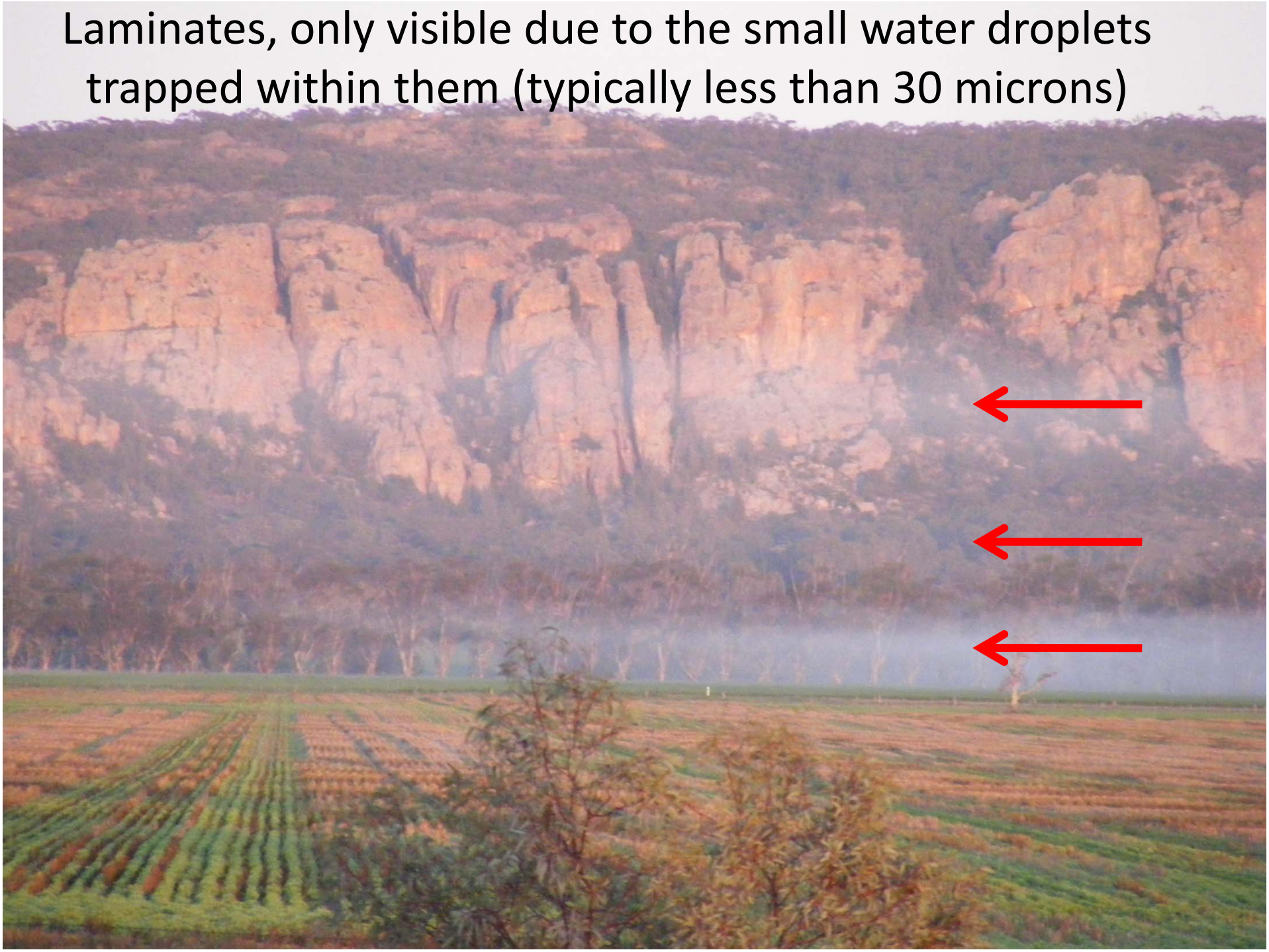
Drainage winds under the inversion layer will typically be laminar (not turbulent).

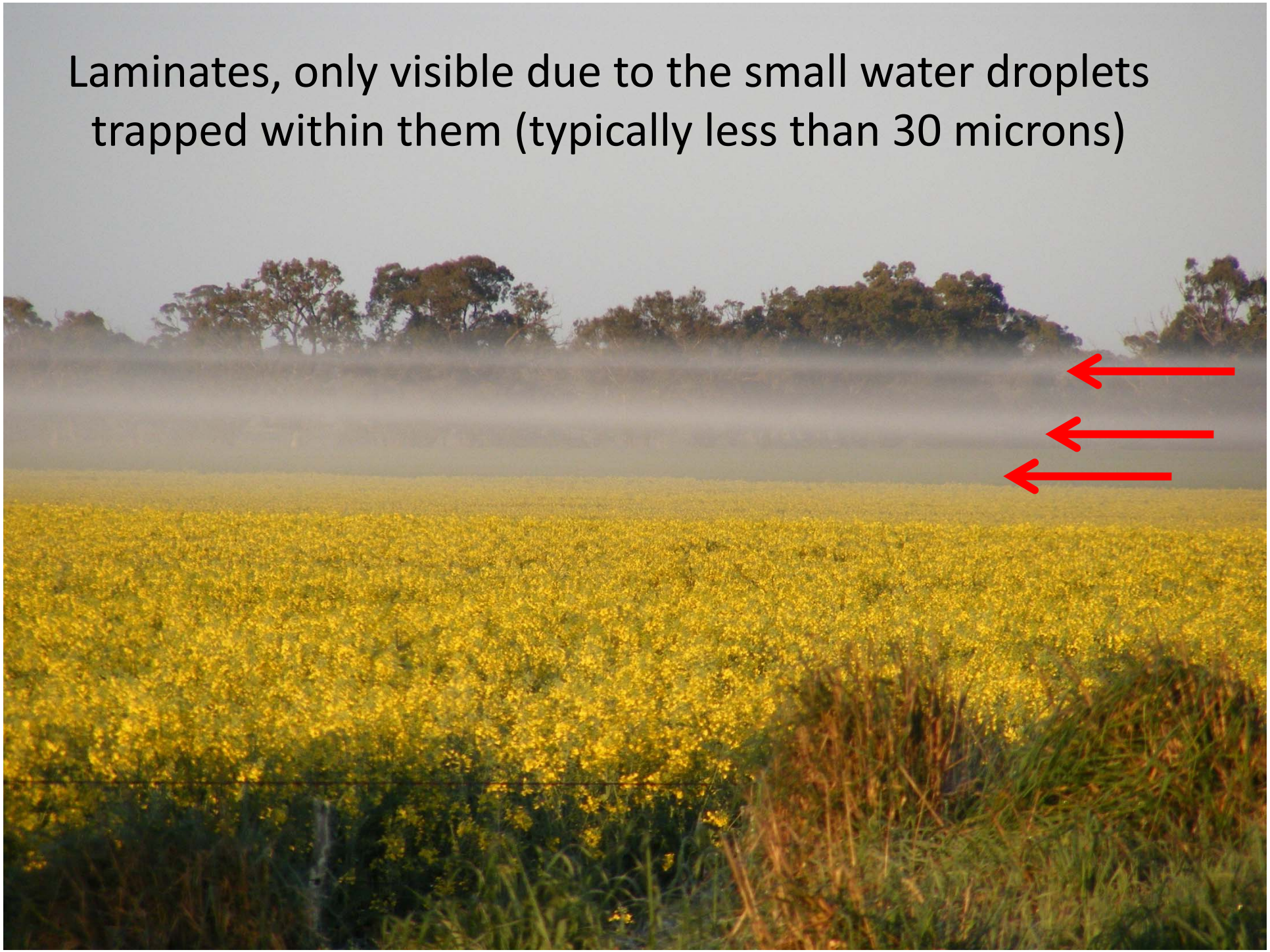


Small droplets can become trapped within the laminates and move towards the lowest point in the catchment.



Laminates, only visible due to the small water droplets trapped within them (typically less than 30 microns)

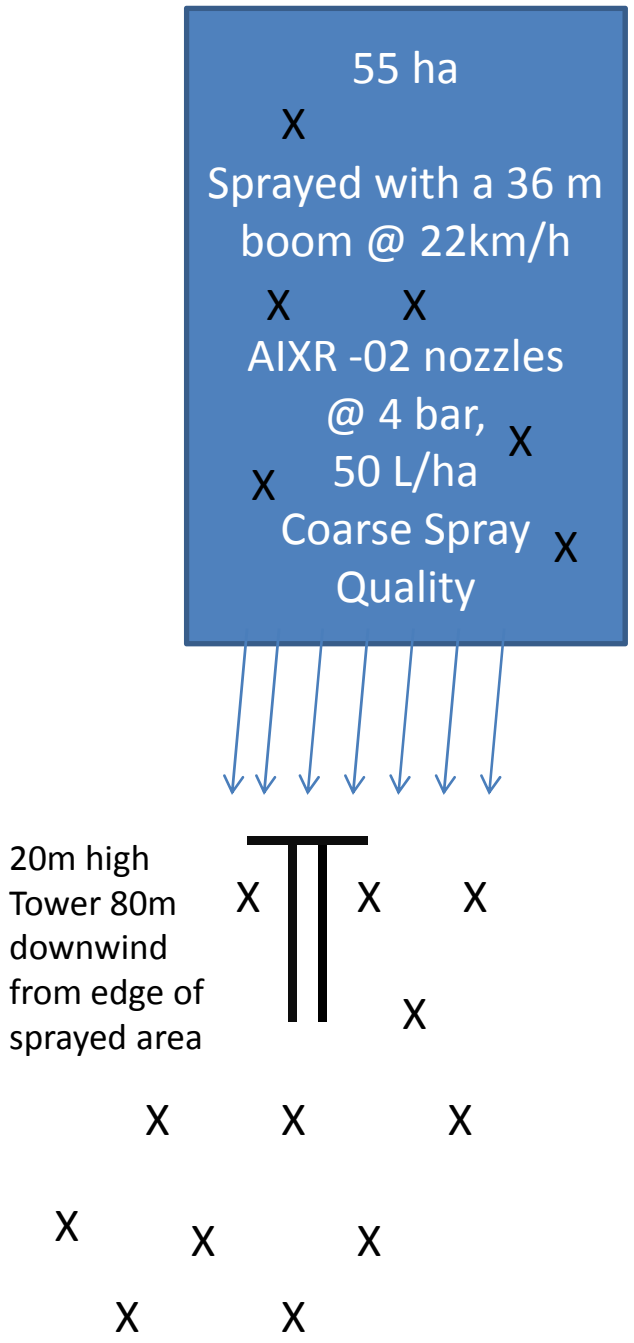



Laminates, only visible due to the small water droplets trapped within them (typically less than 30 microns)

Millee Drift Study
Night vs Day Spraying
Feb, 2011

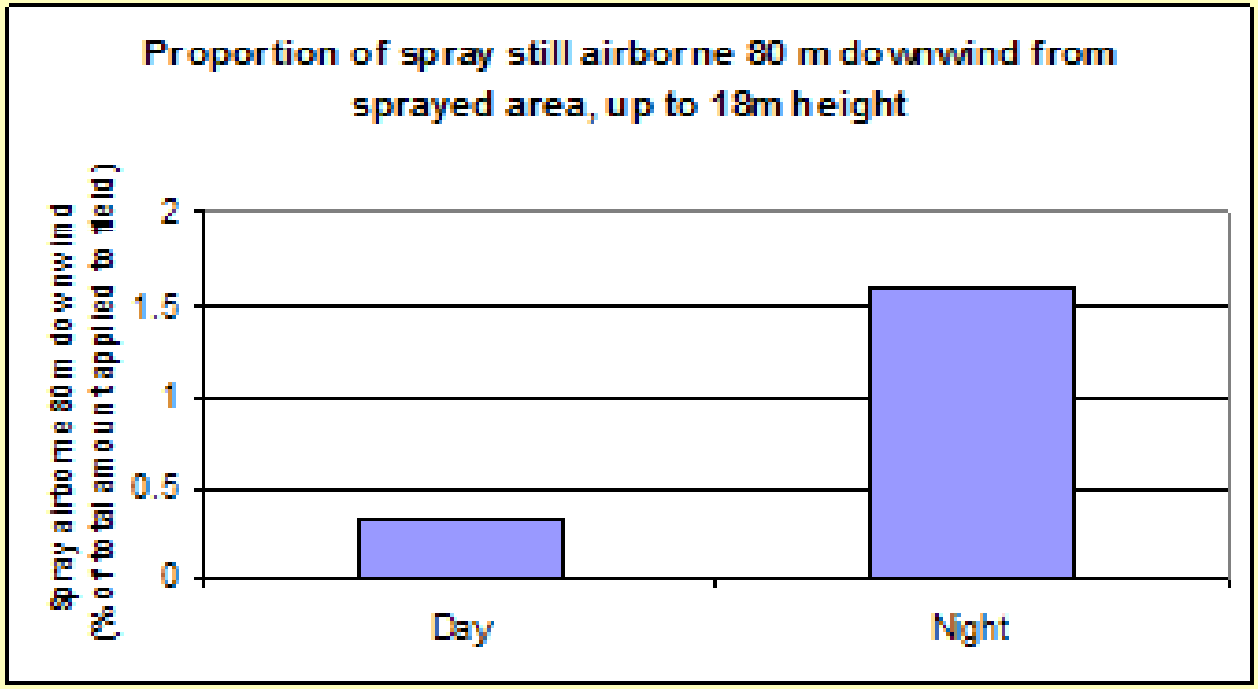
- Night Time Spraying conducted around 2.30am

- Daytime spraying conducted around 7.30am

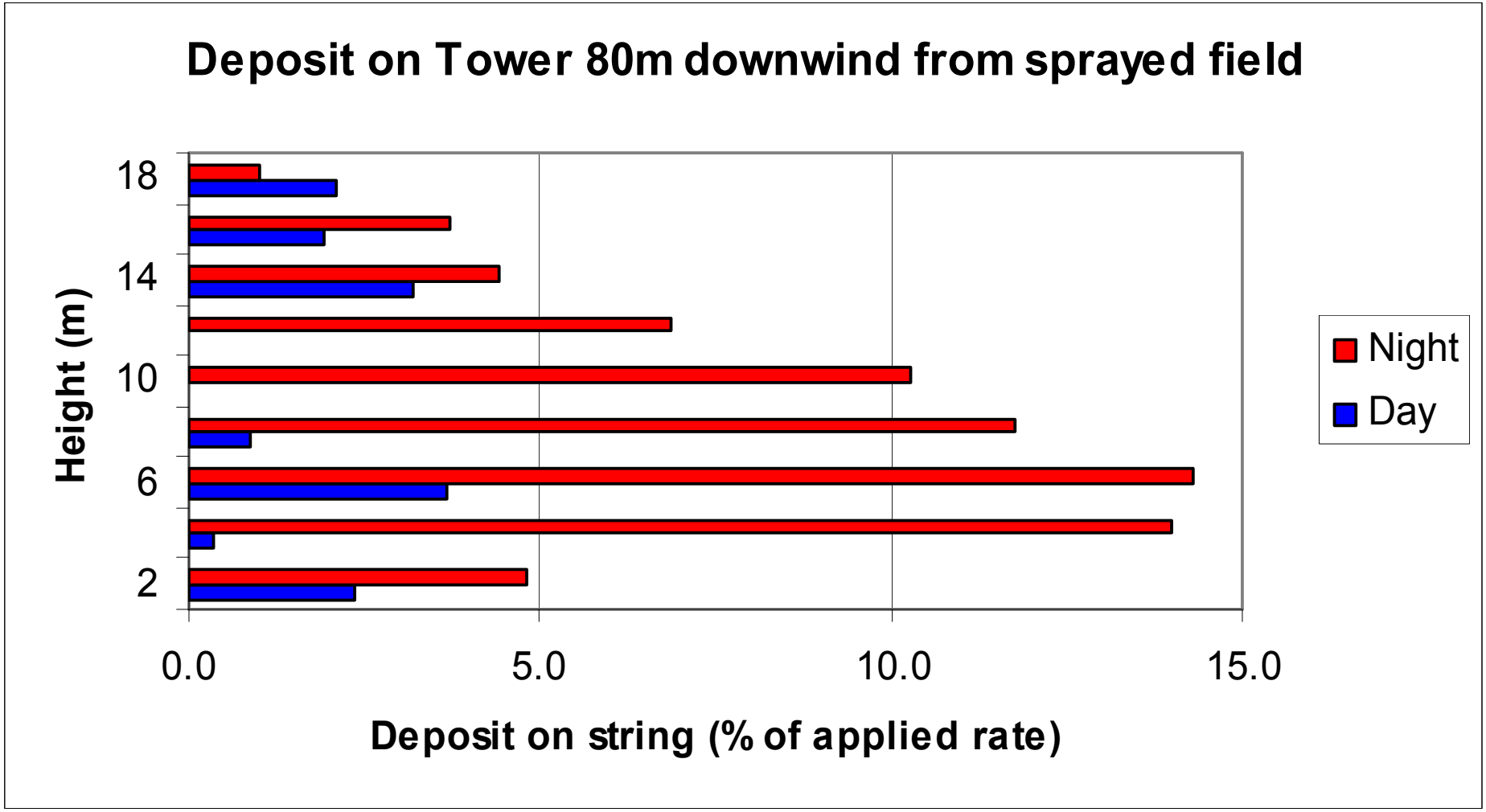


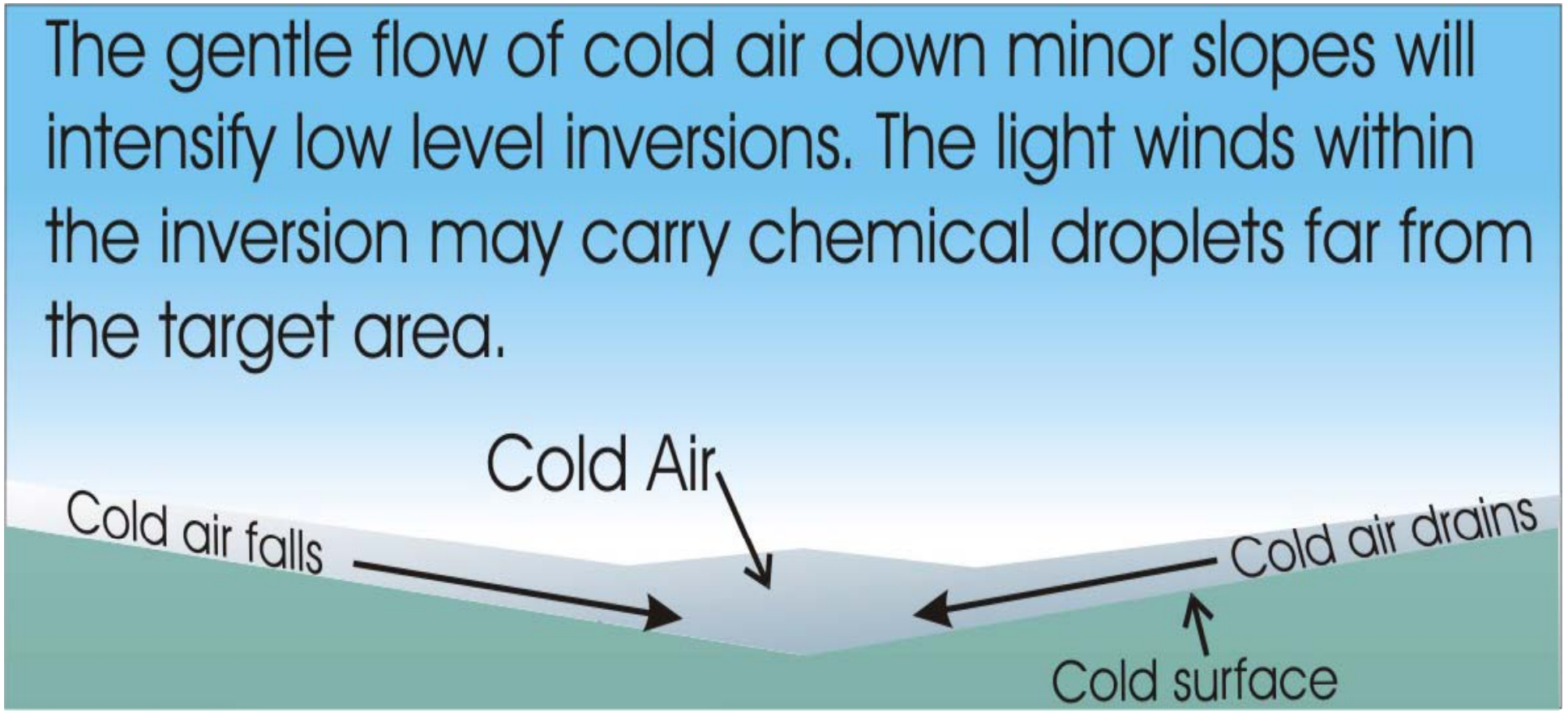
Night vs Day (Feb 2011, Millee)

	Wind Speed (km/hr)	Wind Direction (°)	Temperature (°C)	Relative Humidity (%)	Stability Ratio
Night	11.6	19	25.5	64	0.26
Day	18.3	4	28.7	61	-0.29



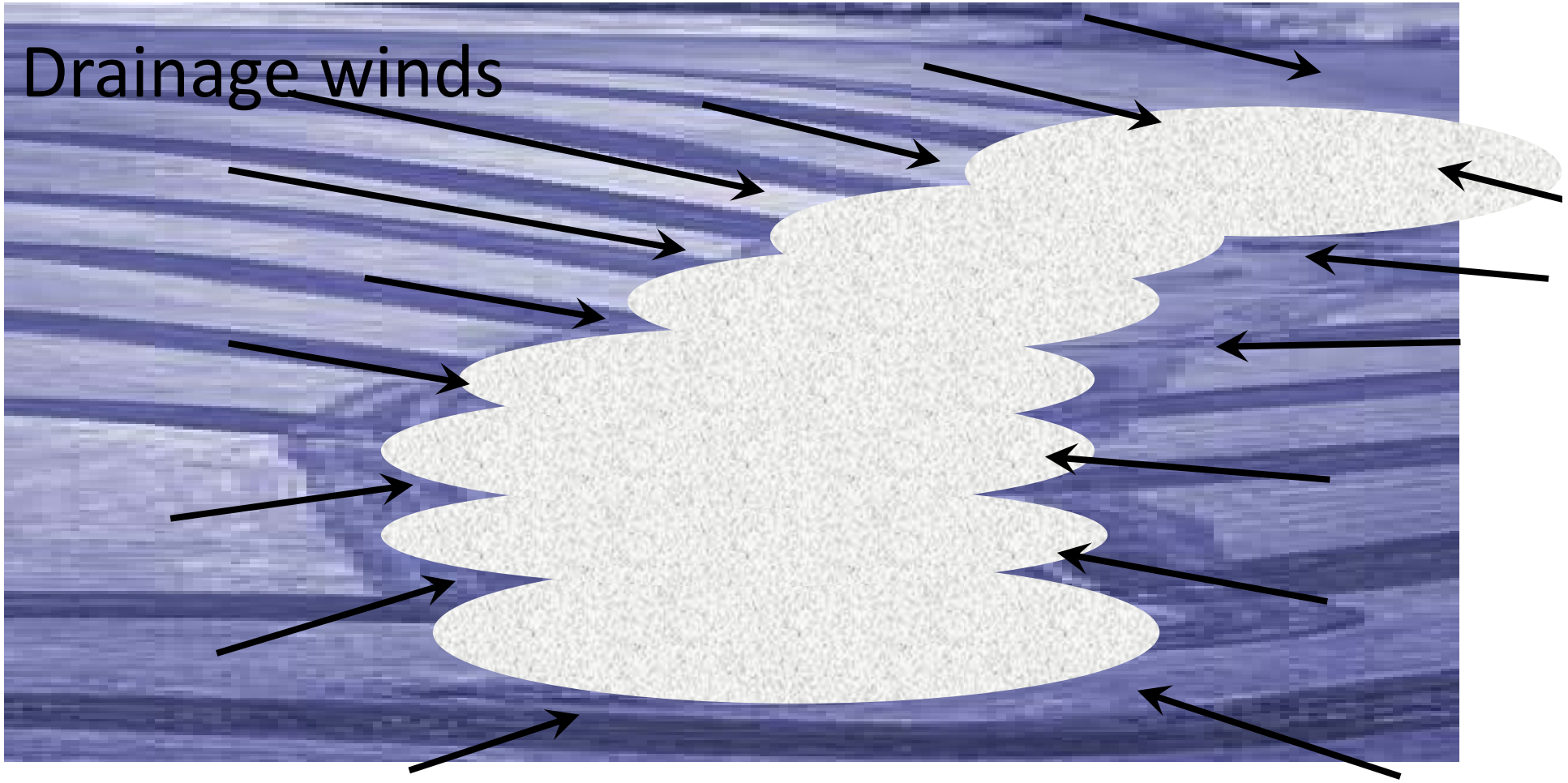
	Wind Speed (km/hr)	Wind Direction (°)	Temperature (°C)	Relative Humidity (%)	Stability Ratio
Night	11.6	19	25.5	64	0.26
Day	18.3	4	28.7	61	-0.29





Source: BOM, Australia.

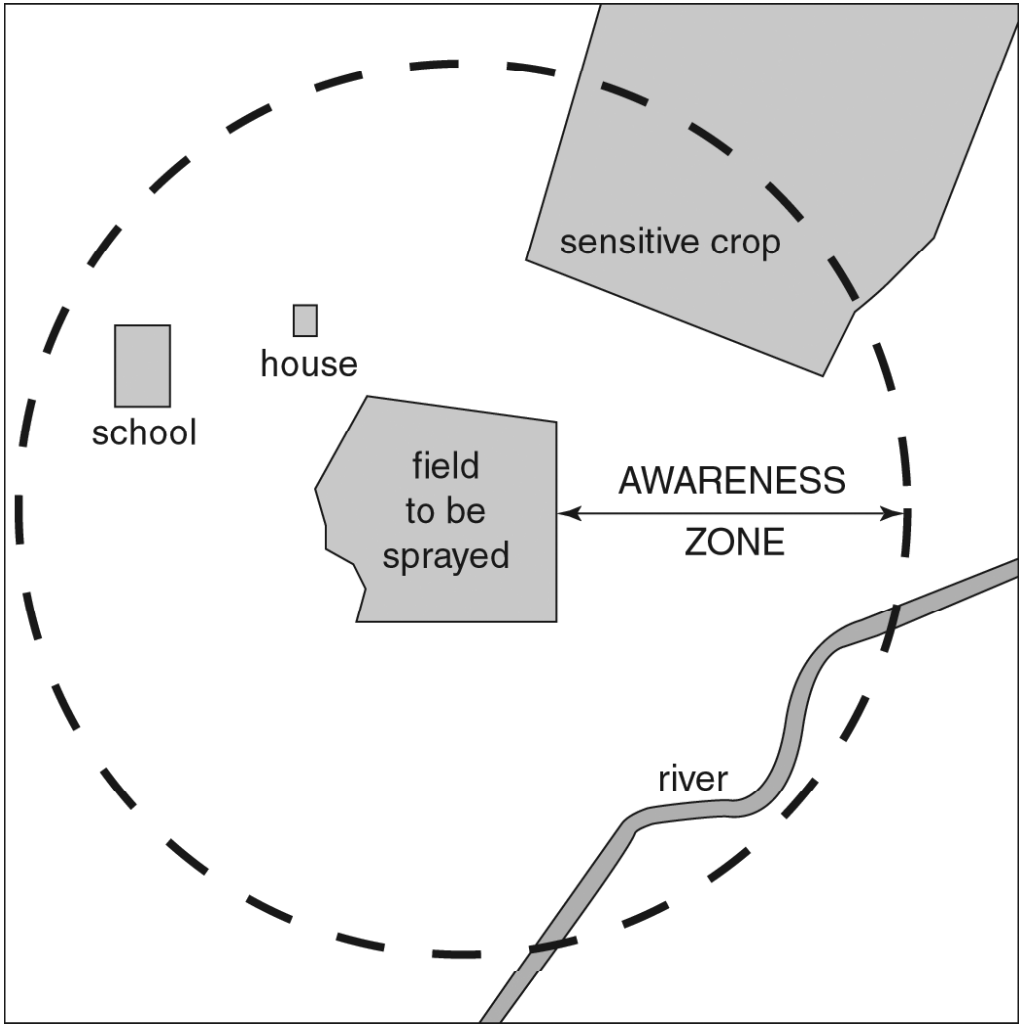
Where are the low points on your farm, in the catchment?



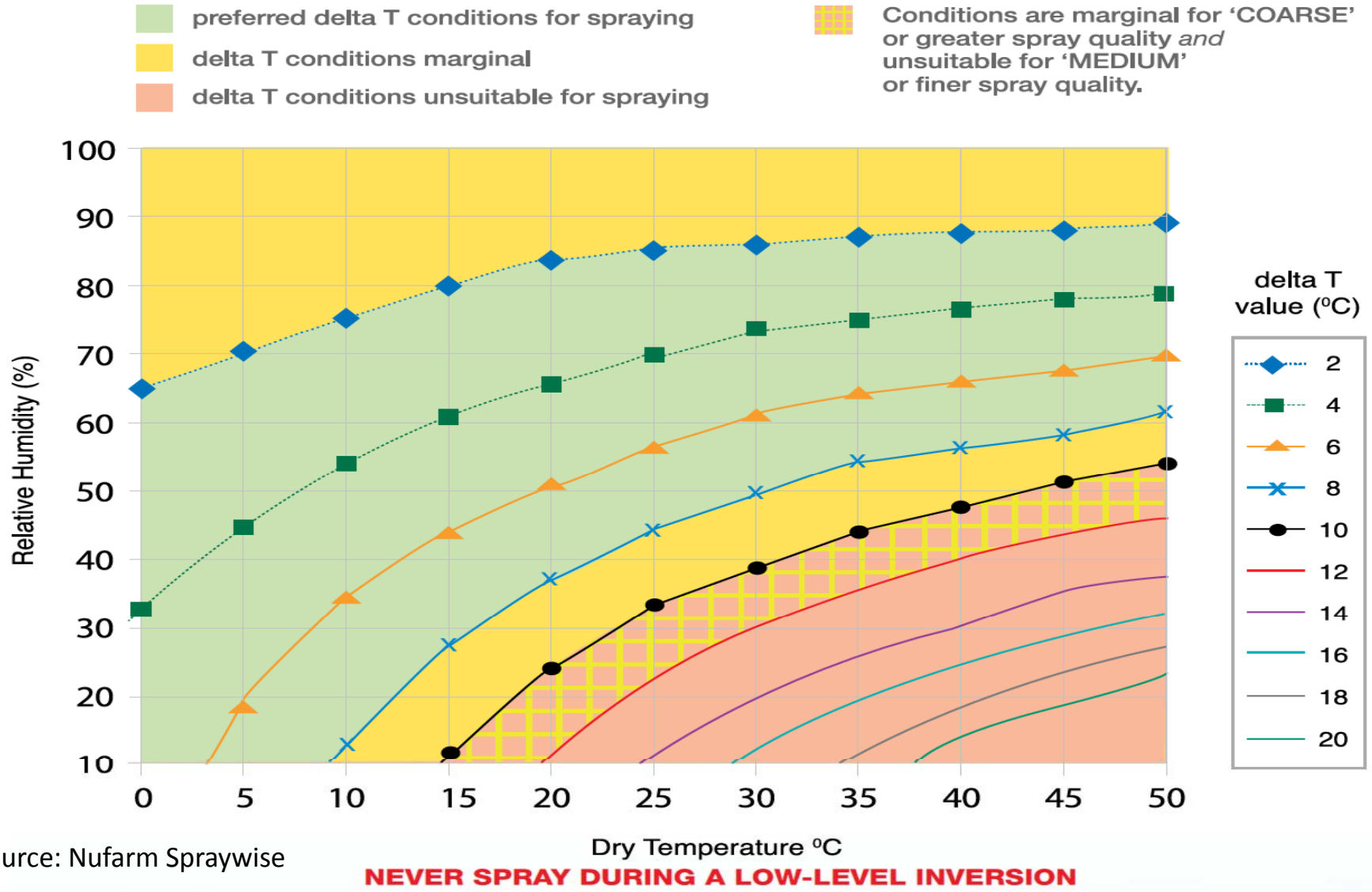
Source : Graeme Tepper

Awareness zones

If the applicator is spraying in the evening or early morning then the slope of the land towards sensitive areas should also be taken into account.



Selecting the right delta T conditions for spraying



Source: Nufarm Spraywise

Evaporation of water droplets

		Temperate: cool		Temperate summer, Dry sub-tropical		Humid tropical	
	T (°C)	**16**		**25**		**30**	
Droplet	RH (%)	58		50		89	
diameter	**Δ T =**	**4.5**		**7**		**1.5**	
µm		lifetime (s)	fall dist. (m)	lifetime (s)	fall dist. (m)	lifetime (s)	fall dist. (m)
10		0.3	0.0004	0.2	0.0003	0.8	0.0013
20		1.1	0.007	0.7	0.004	3.3	0.020
30		2.5	0.03	1.6	0.02	7.5	0.10
40		4.4	0.11	2.9	0.07	13	0.32
50		6.9	0.26	4.5	0.17	21	0.78
75		16	1.3	10	0.85	47	3.96
100		28	4.2	18	2.7	83	12.5
150		63	21	40	14	188	63
200		111	67	71	43	333	200
300		250	338	161	217	750	1013
500		694	2604	446	1674	2083	7813
1000		2778	41667	1786	26786	8333	125000

(estimates based on Amsden, 1962)

We should make better use of planning tools

Nufarm have the Spraywise decisions website with planning tools (subscription cost).

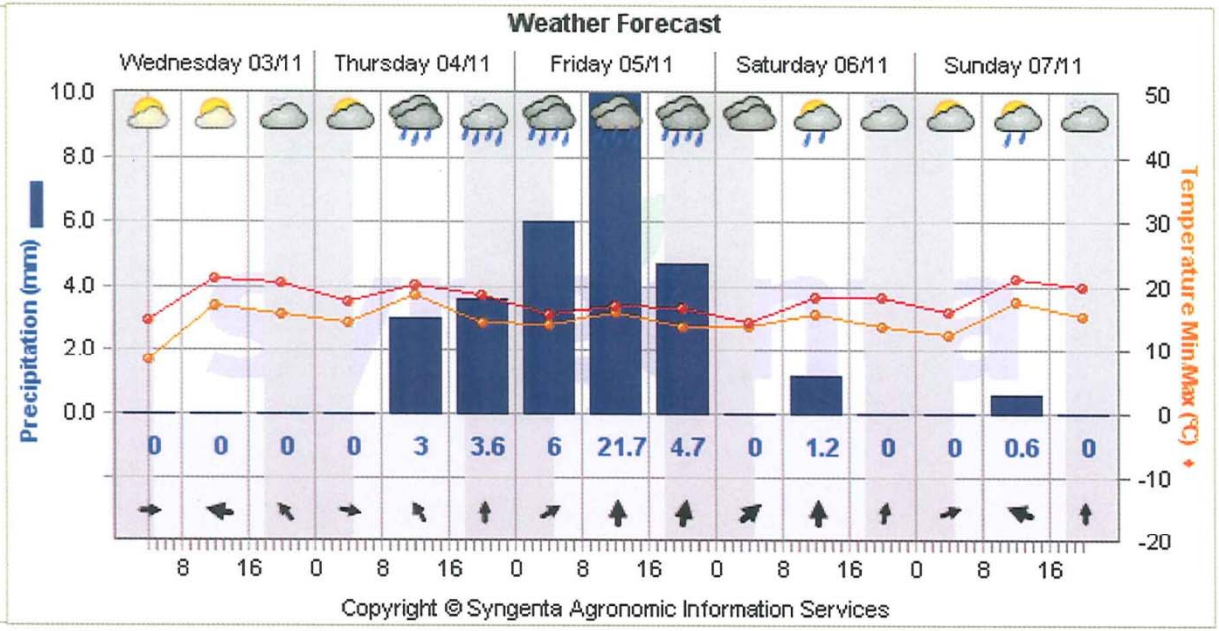
Syngenta have there Agricast service available through their website (free).

Lawrence
Sunrise: 04:52 Sunset: 18:10 +10 GMT, 0 DST.

5 Day Forecast
3 November - 7 November

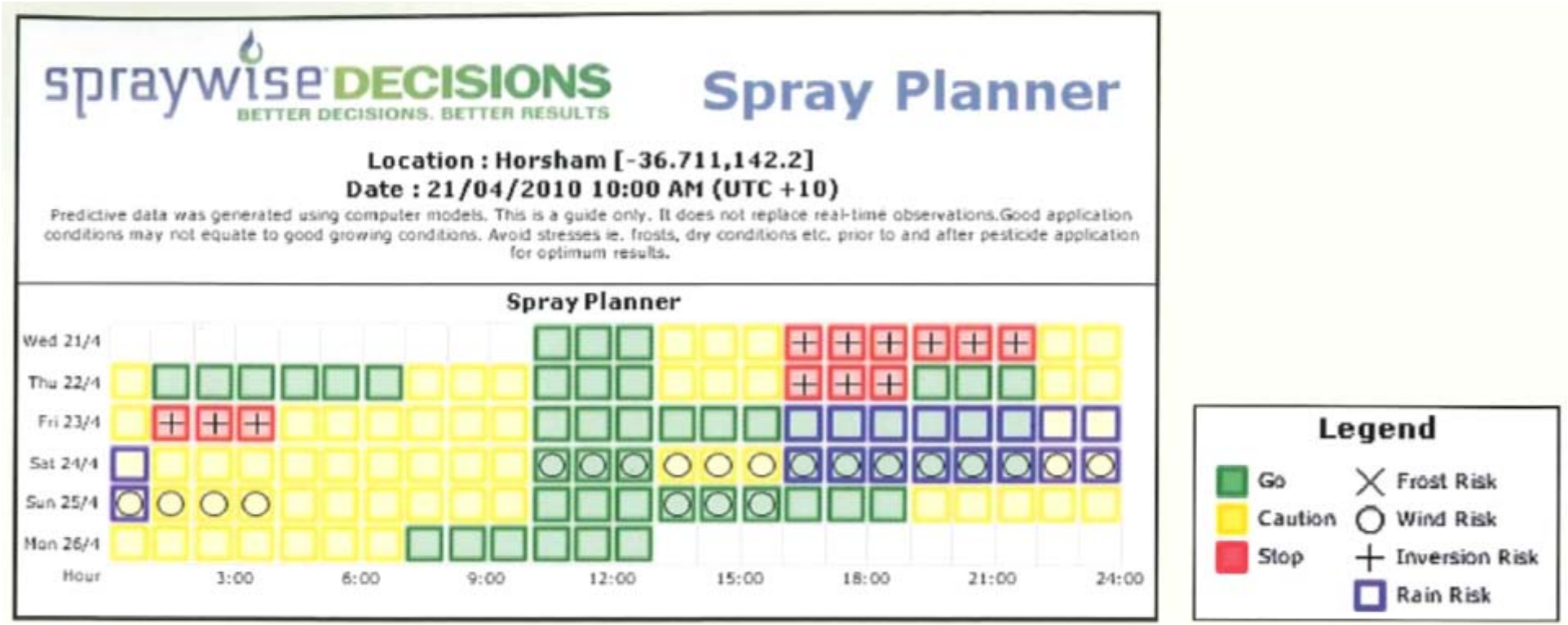
Grafton Res. Weather Station

Distance: 19km SW from **Lawrence**, elevation 26m asl



	Wednesday 03/11		Thursday 04/11		Friday 05/11		Saturday 06/11		Sunday 07/11	
Hours of the Day:	0-12	12-0	0-12	12-0	0-12	12-0	0-12	12-0	0-12	12-0
Cloud cover (%)	46	70	86	92	94	95	93	86	82	81
Precipitation (mm)	0	0	0.9	5.7	17	15.4	0.6	0.6	0	0.6
Probability of Rainfall (%)	5	20	60	75	100	100	50	50	25	50

Spraywisedecisions.com.au




cottonmap
COTTON AWARENESS MAPPING
Information
Search
Manage
Print
Send
Link
Help
Map
Satellite
Hybrid
Terrain
Moree
Internet

Guidelines for WIND SPEED, Delta T & SPRAY QUALITY

When Label Information on Application is Insufficient.

	FINE	MEDIUM	COARSE or Larger
Conditions suitable for that spray quality	Wind speeds 4-12 kph at 4 kph consistent for at least 45 min before spraying starts	Wind speeds 4-20 kph at 4 kph consistent for at least 45 min before spraying starts	Wind speeds 4-20 kph at 4 kph consistent for at least 45 min before spraying starts
Minimum distance to sensitive areas	Greater than 30 km	Greater than 1.5 km	Greater than 400 m
Delta T Values	Delta T value 2-8 ….but only when targets are not stressed	Delta T value 2-10 ….but only when targets are not stressed	Delta T value 2-12 ….but only when targets are not stressed, and all other factors are considered suitable

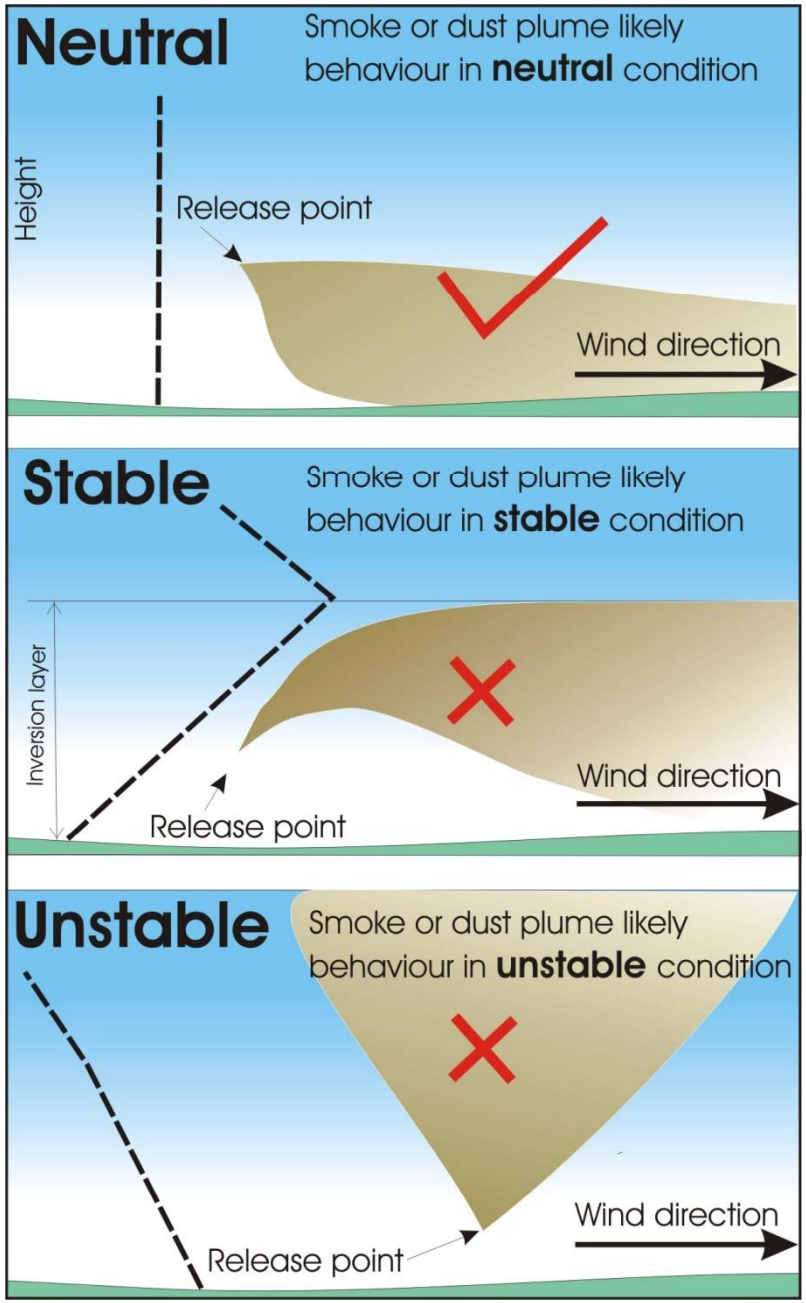
Label Guidelines Will Always Over-ride Any of the Information Provided Above.

Always avoid inversions and thermal activity.

WIND and Visual Clues

Why it's important to have air movement

- **You need wind to get the air mixing and moving**
- **No wind means that it is much easier for the air to separate into layers… that's what happens under an inversion**
- **Even when we do have some wind present we can have unstable conditions, such as late afternoons and early evenings.**



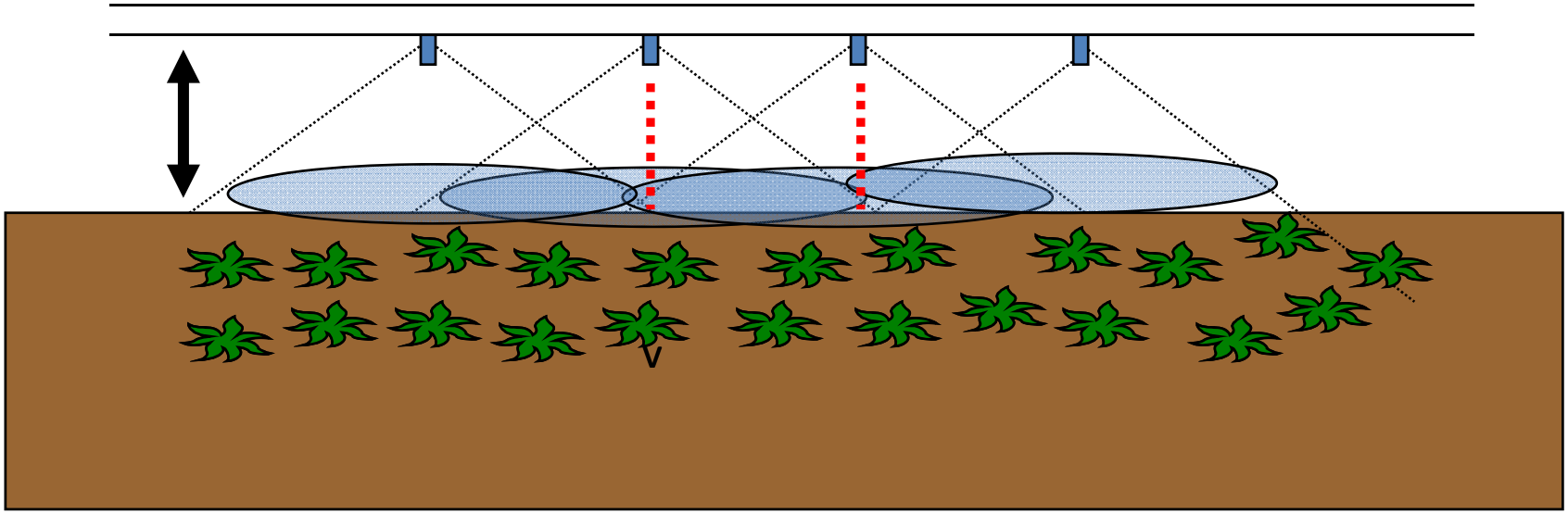
Source: BOM, Australia.

Factors affecting drift potential

- Timing and Conditions
- Nozzle Design (type, pressure & spray quality)
- Rate of Product & Adjuvant Selection
- Height above the target
- Travel Speed
- Boom Stability
- Machine Design

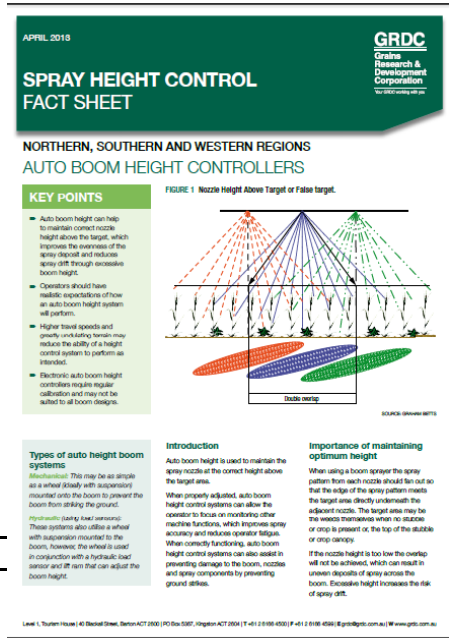
Ideal Nozzle Height – No Stubble

Double Overlap at the target area



Nozzle Height for Stubble/Crop

Double overlap at top of stubble or crop



APRIL 2013

GRDC Grains Research & Development Corporation

SPRAY HEIGHT CONTROL
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

AUTO BOOM HEIGHT CONTROLLERS

KEY POINTS

- Auto boom height can help to maintain correct nozzle height above the target, which improves the evenness of the spray deposit and reduces spray drift through excessive boom height.
- Operators should have realistic expectations of how an auto boom height system will perform.
- Higher travel speeds and greatly undulating terrain may reduce the ability of a height control system to perform as intended.
- Electronic auto boom height controllers require regular calibration and may not be suited to all boom designs.

FIGURE 1 Nozzle Height Above Target or False target.

Double overlap

SOURCE: Grower WITTS

Types of auto height boom systems

Introduction

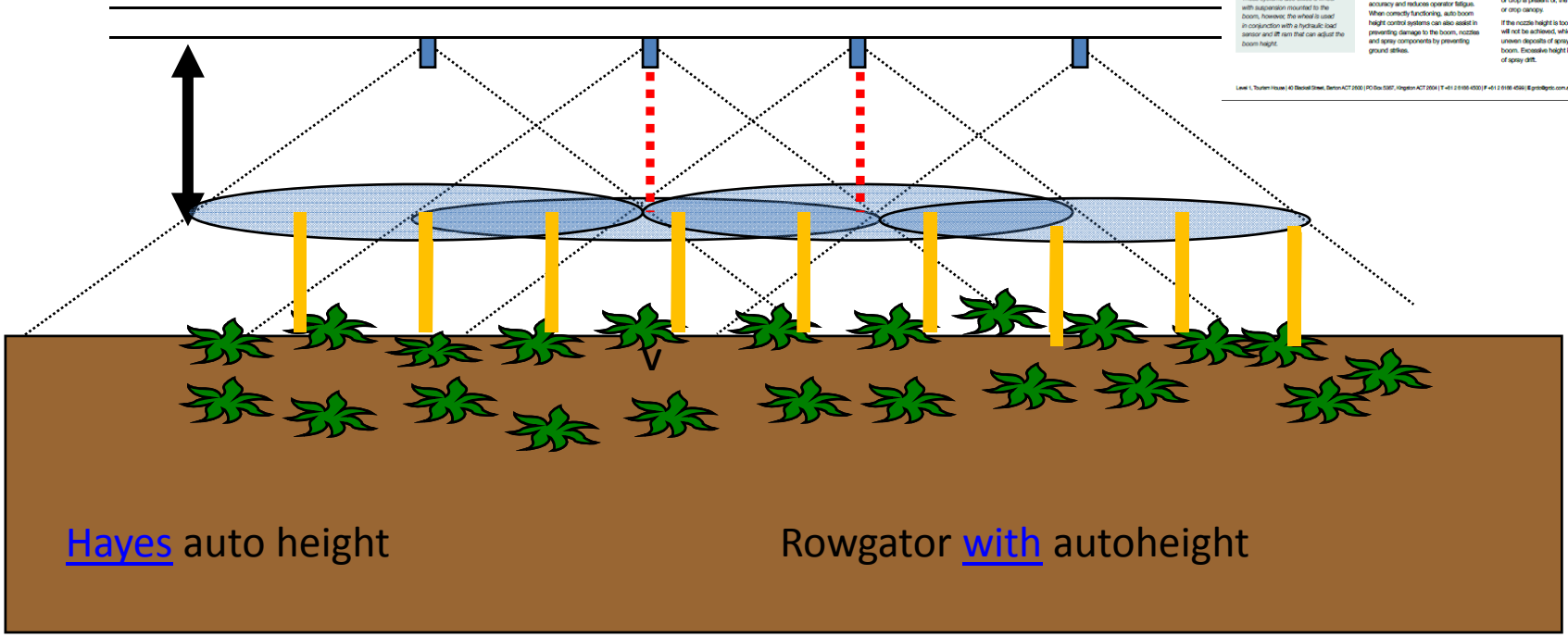
Auto boom height is used to maintain the spray nozzle at the correct height above the target area.

When properly adjusted, auto boom height control systems can allow the operator to focus on monitoring other machine functions, which improves spray accuracy and reduces operator fatigue. When correctly functioning, auto boom height control systems can also assist in preventing damage to the boom, nozzles and spray components by preventing ground strikes.

Importance of maintaining optimum height

When using a boom sprayer the spray pattern from each nozzle should fan out so that the edge of the spray pattern meets the target area directly underneath the adjacent nozzle. The target area may be the weeds themselves when no stubble or crop is present or, the top of the stubble or crop canopy.

If the nozzle height is too low the overlap will not be achieved, which can result in uneven deposits of spray across the boom. Excessive height increases the risk of spray drift.



Hayes auto height

Rowgator with autoheight

•**BOOM HEIGHT IS THE MOST COMMON MISTAKE MADE BY APPLICATORS**

Boom Height is critical for drift reduction

- Increasing boom height from 50cm to 70cm will increase the drift potential by up to **4x**.
- Doubling the boom height from 50cm to 100cm can increase drift by up to **10 X.**
- This will undo the most of the benefits of using most air induction nozzles

KEY QUESTIONS TO ASK ABOUT THE APPLICATION PROCESS

What kind of target are we aiming at ?

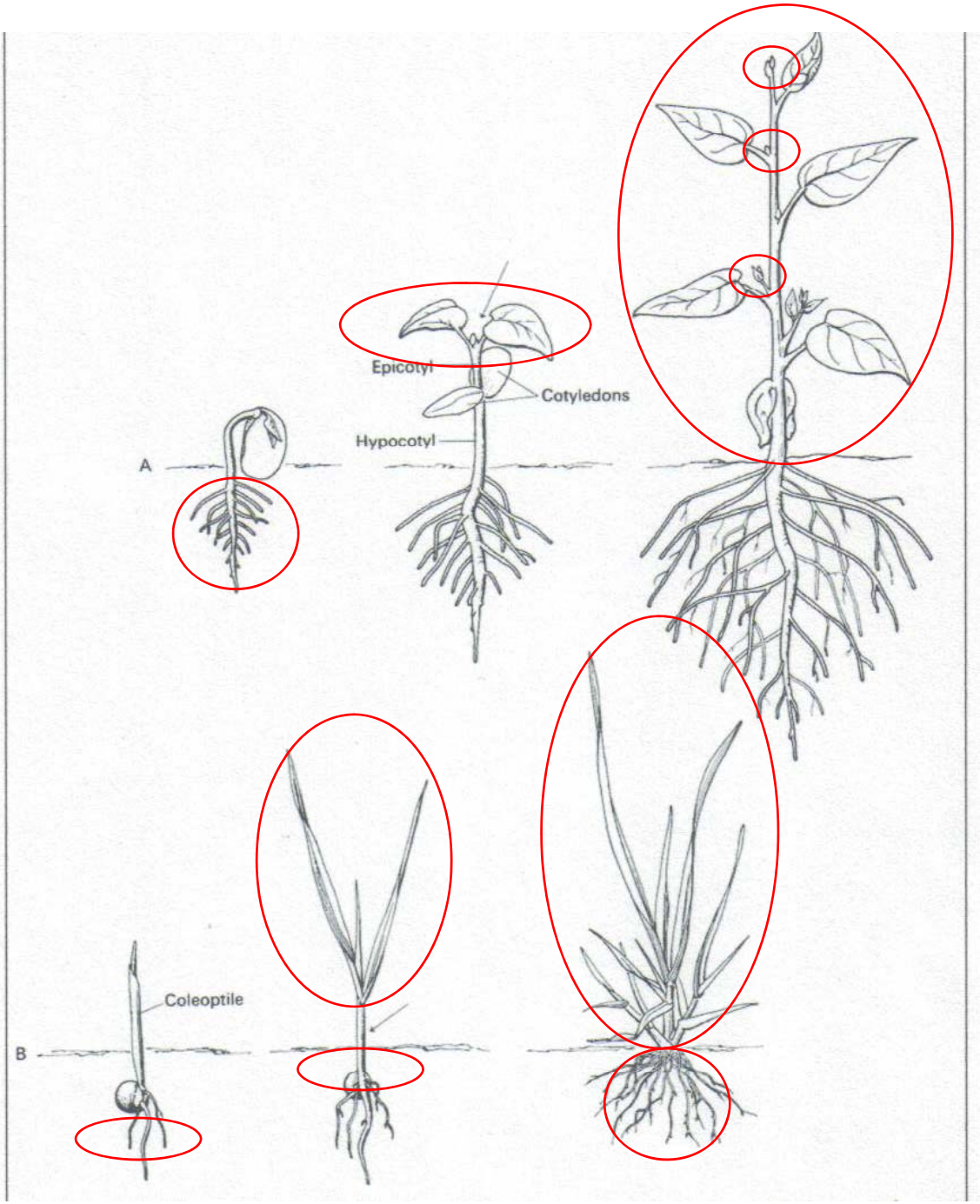
What kind of droplets are most appropriate to hit this target ?

What does the product do once it deposits on the target ?

What is the actual TARGET

What is the actual target for our application ?

That can depend on how the product works and how it moves within the plant



Guidelines for selecting Spray Quality When Label Information on Application is Insufficient.

	FINE	MEDIUM	COARSE or LARGER
Conditions suitable for that spray quality	Wind speeds 4-12 kph at 4 kph consistent for at least 45 min before spraying starts Delta T value 2-8 ….but only when targets are not stressed	Wind speeds 4-20 kph at 4 kph consistent for at least 45 min before spraying starts Delta T value 2-10 ….but only when targets are not stressed	Wind speeds 4-20 kph at 4 kph consistent for at least 45 min before spraying starts Delta T value 2-12 ….but only when targets are not stressed, and all other factors are considered suitable
Minimum distance to sensitive areas	Greater than 30 km	Greater than 1.5 km	Greater than 400 m
Targets suited to this spray quality	Mainly fine, vertical targets such as small grasses	All targets (reduced efficacy may occur with contact products on fine targets without increasing application volume)	Soils Prostrate & large Broadleaf Canopy & Stubble penetration

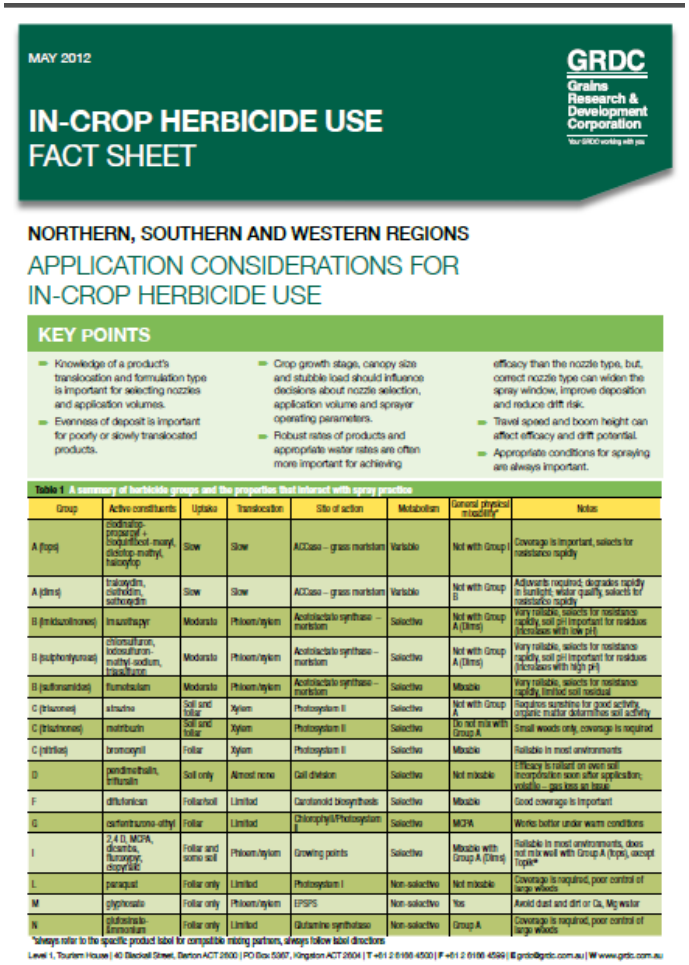
Label Guidelines Will Always Over-ride Any of the Information Provided Above.

Always avoid inversions and thermal activity.

Uptake, Mode of Action & Coverage Requirements

(what does the product do once it lands on the target ?)

- Surface Active / Contact
- Translaminar *(only into the leaf)*
- Partially Translocated *(up only)*
- Fully Translocated *(Two-way)*
- Soil Applied *(root uptake or shoot uptake ?)*



MAY 2012

GRDC Grains Research & Development Corporation

IN-CROP HERBICIDE USE
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

APPLICATION CONSIDERATIONS FOR IN-CROP HERBICIDE USE

KEY POINTS

- Knowledge of a product's translocation and formulation type is important for selecting nozzles and application volumes.
- Evenness of deposit is important for poorly or slowly translocated products.
- Crop growth stage, canopy size and stubble load should influence decisions about nozzle selection, application volume and sprayer operating parameters.
- Robust rates of products and appropriate water rates are often more important for achieving efficacy than the nozzle type, but, correct nozzle type can widen the spray window, improve deposition and reduce drift risk.
- Travel speed and boom height can affect efficacy and drift potential.
- Appropriate conditions for spraying are always important.

Table 1 A summary of herbicide groups and the properties that interact with spray practice

Group	Active constituents	Uptake	Translocation	Site of action	Metabolism	General physical incompatibility*	Notes
A (fops)	clodinafop-propargyl + cloquintocet-mexyl, clodinafop-methyl, haloxyfop	Slow	Slow	ACCase – grass meristem	Variable	Not with Group I	Coverage is important, selects for resistance rapidly
A (dims)	haloxydin, clethodim, sethoxydim	Slow	Slow	ACCase – grass meristem	Variable	Not with Group B	Adjuvants required, degrades rapidly in sunlight, water quality, selects for resistance rapidly
B (imidazolinones)	imazethapyr	Moderate	Phloem/xylem	Acetolactate synthase – meristem	Selective	Not with Group A (Dims)	Very reliable, selects for resistance rapidly, soil pH important for residues (Microclays with low pH)
B (sulphonylureas)	chlorsulfuron, iodosulfuron-methyl-sodium, triasulfuron	Moderate	Phloem/xylem	Acetolactate synthase – meristem	Selective	Not with Group A (Dims)	Very reliable, selects for resistance rapidly, soil pH important for residues (Microclays with high pH)
B (sulfonamides)	flumetsulam	Moderate	Phloem/xylem	Acetolactate synthase – meristem	Selective	Mixable	Very reliable, selects for resistance rapidly, limited soil residual
C (triazines)	simazine	Soil and foliar	Xylem	Photosystem II	Selective	Not with Group A	Requires sunshine for good activity, organic matter deactivates soil activity
C (triazinones)	metribuzin	Soil and foliar	Xylem	Photosystem II	Selective	Do not mix with Group A	Small weeds only, coverage is required
C (nitriles)	bromoxynil	Foliar	Xylem	Photosystem II	Selective	Mixable	Reliable in most environments
D	pendimethalin, trifluralin	Soil only	Almost none	Cell division	Selective	Not mixable	Efficacy is reliant on even soil incorporation soon after application; volatile – gas loss an issue
F	diflufenican	Foliar/soil	Limited	Carotenoid biosynthesis	Selective	Mixable	Good coverage is important
G	carfentrazone-ethyl	Foliar	Limited	Chlorophyll/Photosystem II	Selective	MCPA	Works better under warm conditions
I	2,4 D, MCPA, dicamba, fluroxypyr, clopyralid	Foliar and some soil	Phloem/xylem	Growing points	Selective	Mixable with Group A (Dims)	Reliable in most environments, does not mix well with Group A (fops), except Topik*
L	paraquat	Foliar only	Limited	Photosystem I	Non-selective	Not mixable	Coverage is required, poor control of large weeds
M	glyphosate	Foliar only	Phloem/xylem	EPSPS	Non-selective	Yes	Avoid dust and dirt or Ca, Mg water
N	glufosinate-ammonium	Foliar only	Limited	Glutamine synthetase	Non-selective	Group A	Coverage is required, poor control of large weeds

*always refer to the specific product label for compatible mixing partners, always follow label directions

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | T +61 2 6166 4500 | F +61 2 6166 4599 | E grdc@grdc.com.au | W www.grdc.com.au

Group		Examples	Uptake	Translocation	Site of Action	Metabolism	Mixing	*Notes*
A	(FOPS)	***clodinafop-propargyl*** ***diclofop-methyl*** ***haloxyfop-R***	Slow	Slow	***ACCase-grass meristem***	**Variable Selective with grasses**	**Not with Group I**	**Adjuvants required, Good coverage critical, Sensitive to plant stress, rapidly selects for resistance**
	(DIMS)	***tralkoxydim*** ***sethoxydim*** ***clethodim***	Slow	Slow		**Variable Selective with grasses**	**Not with Group B**	**Adjuvants required, Good coverage critical, Sensitive to plant stress, degrades rapidly in sunlight, Avoid hard water - particularly if high in bicarbonate, rapidly selects for resistance**
B	imidazolinones	***imazamox*** ***imazethapyr***	Moderate	Phloem / Xylem	***Acetolactate synthase-meristem***	**Selective**	**Not with Group A (Dims)**	**Very reliable, rapidly selects for resistance, soil pH important for residues (increase with low pH)**
	sulphonamides	***flumetsulam*** ***metosulam***	Moderate	Phloem / Xylem		**Selective**	**Mixable**	**Very reliable, rapidly selects for resistance, limited soil residual**
	sulfonylureas	***chlorsulfuron*** ***metsulfuron*** ***triasulfuron***	Moderate	Phloem / Xylem		**Selective**	**Caution with Group I**	**Very reliable, rapidly selects for resistance, soil pH important for residues (increase with high pH)**
C	triazines	***atrazine,*** ***simazine***	Soil and foliar	Xylem	***Photo-system II***	**Selective**	Not with Group A	**Small weeds only for post emergent application, Bare soil for pre-emergent application requires sunshine for good foliar activity, organic matter and moisture determines soil activity**
	triazinones	*metribuzin*	Soil and foliar	Xylem		**Selective**	Not with Group A	As above
	nitriles	*bromoxynil*	Soil and foliar	Limited		**Selective**	Mixable	Small weeds only. Good coverage and robust rate essential
D	dinitroanilines	***pendimethalin*** ***trifluralin***	Soil only	Almost none	***Formation of cell walls***	**Crop selectivity by separation of crop seed from herbicide**	**OK with Group L.**	**Level of control is reliant on even soil incorporation soon after application; volatile - lost to atmosphere if not covered especially in moist soil.**
	benzamide	***propyzamide***	Roots	Limited xylem		**Selective**	**OK with Group L.**	**Non volatile at lower temps, moderately persistent, some movement in low OM soils, breaks down by light if on soil surface, broken down by microorganisms.**

Group	Examples	Uptake	Translocation	Site of Action	Metabolism	Mixing	*Notes*
F	***diflufenican picolinafen***	Foliar / soil	Limited	***Carotenoid bio-synthesis (PDS) inhibitor***	**Selective**	**Mixable**	**Good coverage is important**
G	***oxyfluorfen carfentrazone***	Foliar	Limited	***Chlorophyll / Photosystem II***	**Selective**	**MCPA**	**Works better under warm conditions**
H	***pyrasulfotole isoxaflutole***	Foliar	Limited - phloem / xylem	***HPPD inhibitor – leads to bleaching***	**Selective**	**Mixable - not with trifluralin / propyzamide**	**Organic matter and clay content determines soil activity. Good coverage is important. Precept & Velocity best in sunny conditions.**
I	***2,4-D …. MCPA …. dicamba …. fluroxypyr …. clopyralid …. picloram***	Foliar and some soil	Phloem / Xylem	***Growing points***	**Selective**	**Mixable with Group A (Dims)**	**Reliable in most environments, do not mix well with Group A (Fops), except Topik®**
J	***2,2-DPA molinate triallate***	Soil and foliar depending on herbicide	Absorbed by coleoptile and emerging shoots	***Inhibits fat production***	**Selective by separation of herbicide from crop seed**	**Compatible**	**Triallate works better with incorporation. Lost via volatilisation under higher temperatures and moist soil.**

Group	Examples	Uptake	Translocation	Site of Action	Metabolism	Mixing	*Notes*
L	***paraquat***	Foliar only	Limited	***Photosystem I***	**Non selective**	**Good with soil applied herbicides. If tank mixed with translocated herbicides the rapid action can reduce effectiveness of partner herbicide.**	**Good coverage required, poor control of large weeds. Rapidly absorbed by leaves. Avoid water with high clay (murky) and organic matter content. Dusty leaves. Control improves when applied on cloudy days or later in afternoon.**
M	***glyphosate***	Foliar only	Phloem / Xylem	***EPSPS***	**Non selective**	**Yes**	**Avoid muddy and hard (Ca, Mg & bicarbonate) water. Dusty leaves.**
N	***glufosinate***	Foliar only	Limited	***Glutamine synthetase***	**Non selective**	**Group A**	**Good coverage required. Best under warm temperatures and high humidity. Poor control of large grasses. Residues on plastic**
O	***isoxaben***	Pre-emergent	Limited	***Inhibitor of cell wall production***	**Selective**	**Yes**	**Applied to bare soil. Absorbed through shoots and roots of germinating broadleaf seedlings**
Q	***amitrole***	Foliar	Phloem / Xylem	***Bleacher - stops caretenoid synthesis***	**Non selective**	**Yes**	**Very slow acting compared to glyphosate. Mobile in soil but rapidly degraded.**

Guidelines for selecting Spray Quality When Label Information on Application is Insufficient.

	FINE	MEDIUM	COARSE/VERY COARSE
Conditions suitable for that spray quality Minimum distance to sensitive areas	Wind speeds 4-12 kph at 4 kph consistent for at least 45 min before spraying starts Delta T value 2-8 ….but only when targets are not stressed Greater than 30 km	Wind speeds 4-20 kph at 4 kph consistent for at least 45 min before spraying starts Delta T value 2-10 ….but only when targets are not stressed Greater than 1.5 km	Wind speeds 4-20 kph at 4 kph consistent for at least 45 min before spraying starts Delta T value 2-12 ….but only when targets are not stressed, and all other factors are considered suitable Greater than 400 m
Targets suited to this spray quality	Mainly fine, vertical targets such as small grasses	All targets (reduced efficacy may occur with contact products on fine targets without increasing application volume)	Soils Prostrate & large Broadleaf Canopy & Stubble penetration Most at higher volumes
Product Modes of Action suited to this spray quality	Contacts (mainly on fine targets where canopy / stubble penetration is not required)	Contacts Translaminar Translocated Systemic	Soil Applied & Incorporated Fully Translocated Products Others at increased application volumes

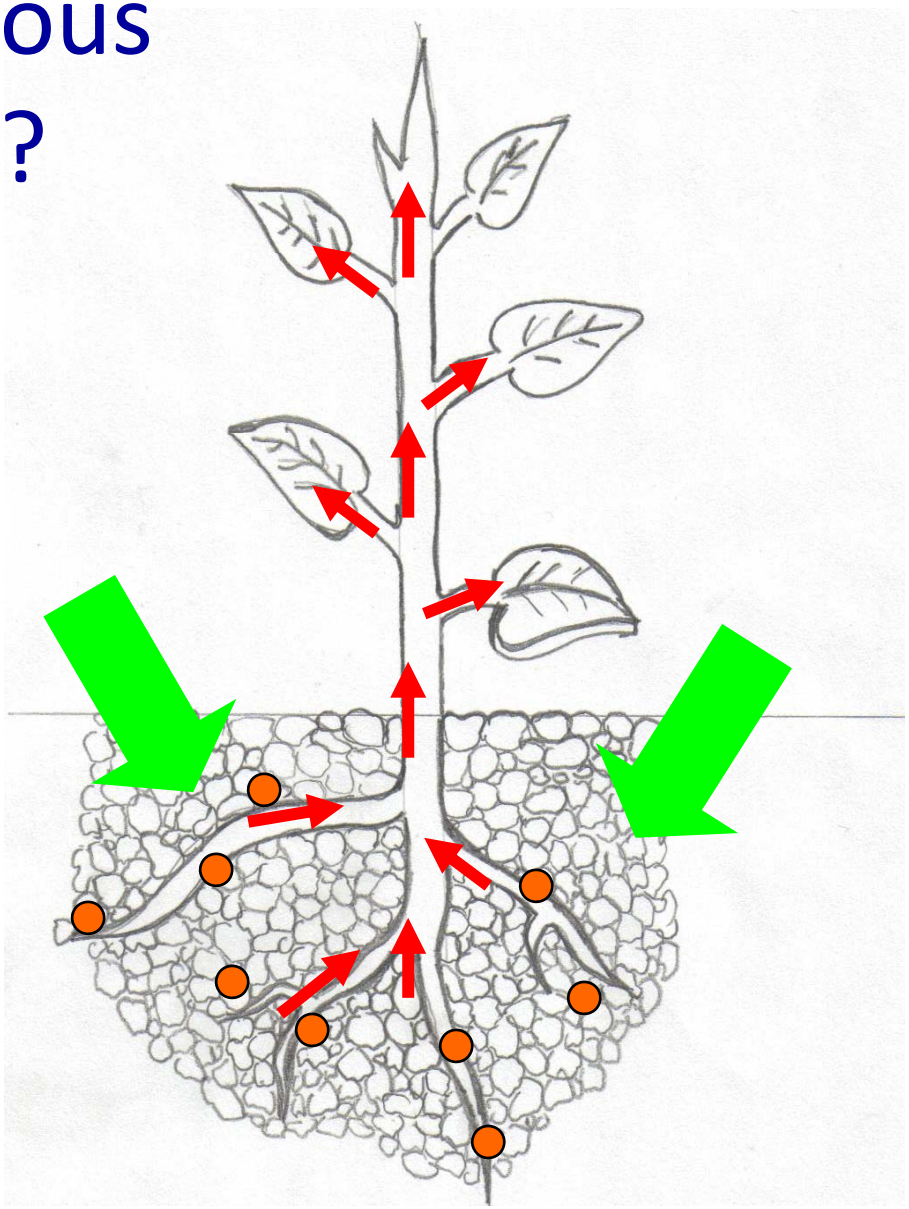
Label Guidelines Will Always Over-ride Any of the Information Provided Above.

Always avoid inversions and thermal activity.

Typical Spray Quality and Application Volumes

Typical Application Volume	Medium Spray Quality (lower drift risk areas)	Coarse Spray Quality	Extremely Coarse Spray Quality (higher drift risk areas)
Lower range **50 -60 L/ha** **(Low stubble load)** **to** **70-80 L/ha** **(High stubble load)**	*Only where permitted on label: Fully translocated herbicides Small to medium sized targets.	Fallow Spraying Fully translocated herbicides such as Glyphosate, MCPA. Mandatory for 2,4-D,	Fully translocated herbicides, medium targets, Very sensitive areas or NIGHT SPRAYING
Higher range **70-80 L/ha** **(Low stubble load)** **to** **100 + L/ha** **(High stubble load/ dense crop canopy)**	*Only where permitted on label: Contact type products. Small targets. In crop spraying. Penetration and coverage in large & broadleaf crops.	Good stubble penetration. Pre-emergent's. Fully Translocated herbicides, Some contact herbicides at the higher application volumes.	Pre-emergent's. Medium sized targets with fully translocated summer fallow herbicides. Very sensitive areas or NIGHT SPRAYING

Translocation of various herbicides groups?



Key to this Presentation

= placement of product

= site of uptake

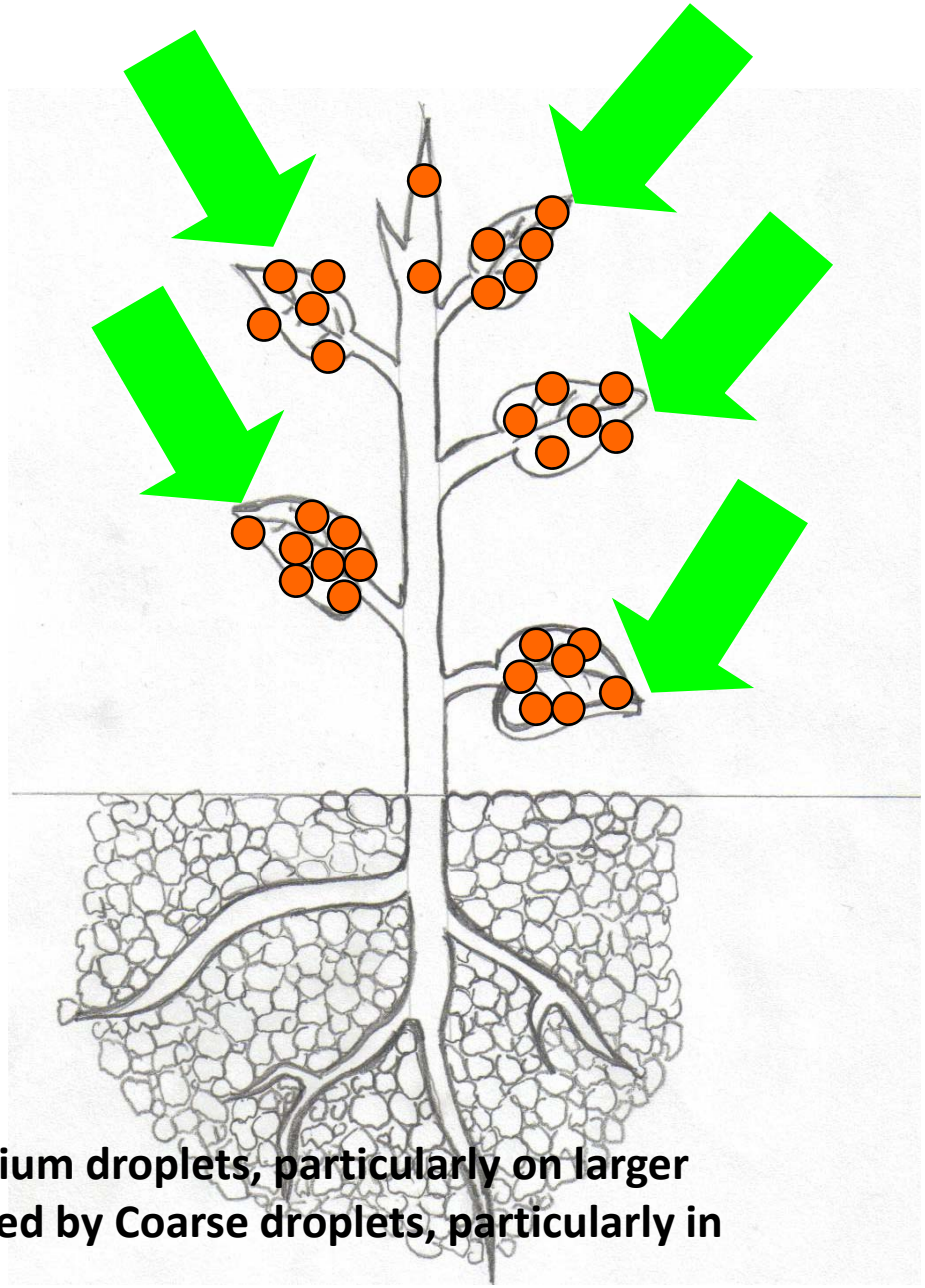
= translocation from point of uptake

Group L

inhibitors of photosynthesis
at photosystem I

Bipyridyls (paraquat, diquat)

- Contact herbicides activated by sunlight - minimal translocation if cells destroyed (there is some translaminar movement at night).
- Destroy cell membranes and disrupt photosynthesis,
- Thorough coverage required, older plants with well established roots will probably recover.

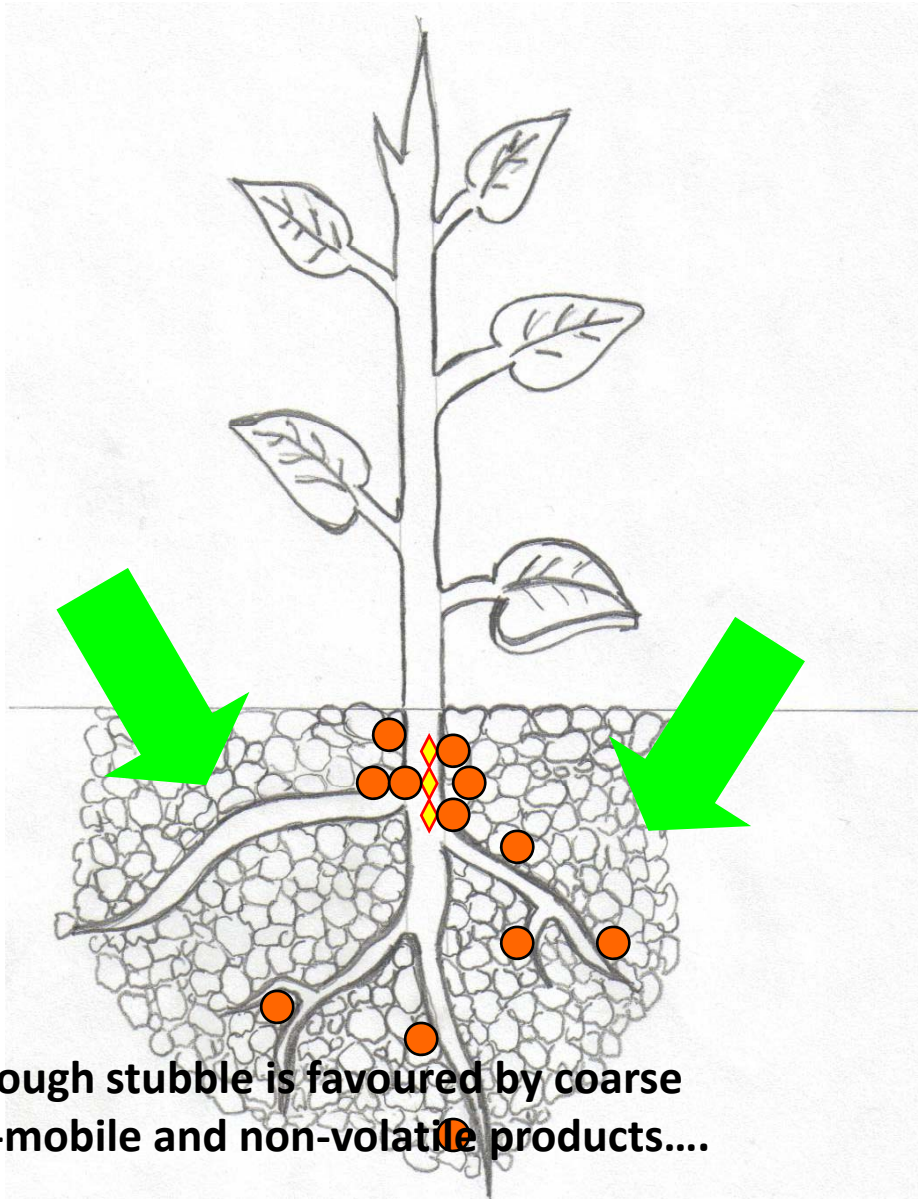


Retention and evenness is favoured by Medium droplets, particularly on larger broadleaves, however penetration is favoured by Coarse droplets, particularly in large grasses, cereals and stubble.

Group D

Inhibitors of tubulin formation

- Trifluralin, Pendimethalin (dinitroanalines)
- Soil applied- incorporated
- Very limited, if any translocation (to apical meristem)
- Shoot elongation and lateral root formation (cell division) are inhibited
- Inhibition of enzymes or uncoupling of oxidative phosphorylation
- Roots appear to be pruned, roots and coleoptiles may grow thicker
- Grass shoots may turn red or purple (phosphorus deficiency symptoms)
- Broadleaves may have swollen and cracked hypocotyls



Deposition onto soils and penetration through stubble is favoured by coarse droplets, evenness is important with non-mobile and non-volatile products…. application volume is important.

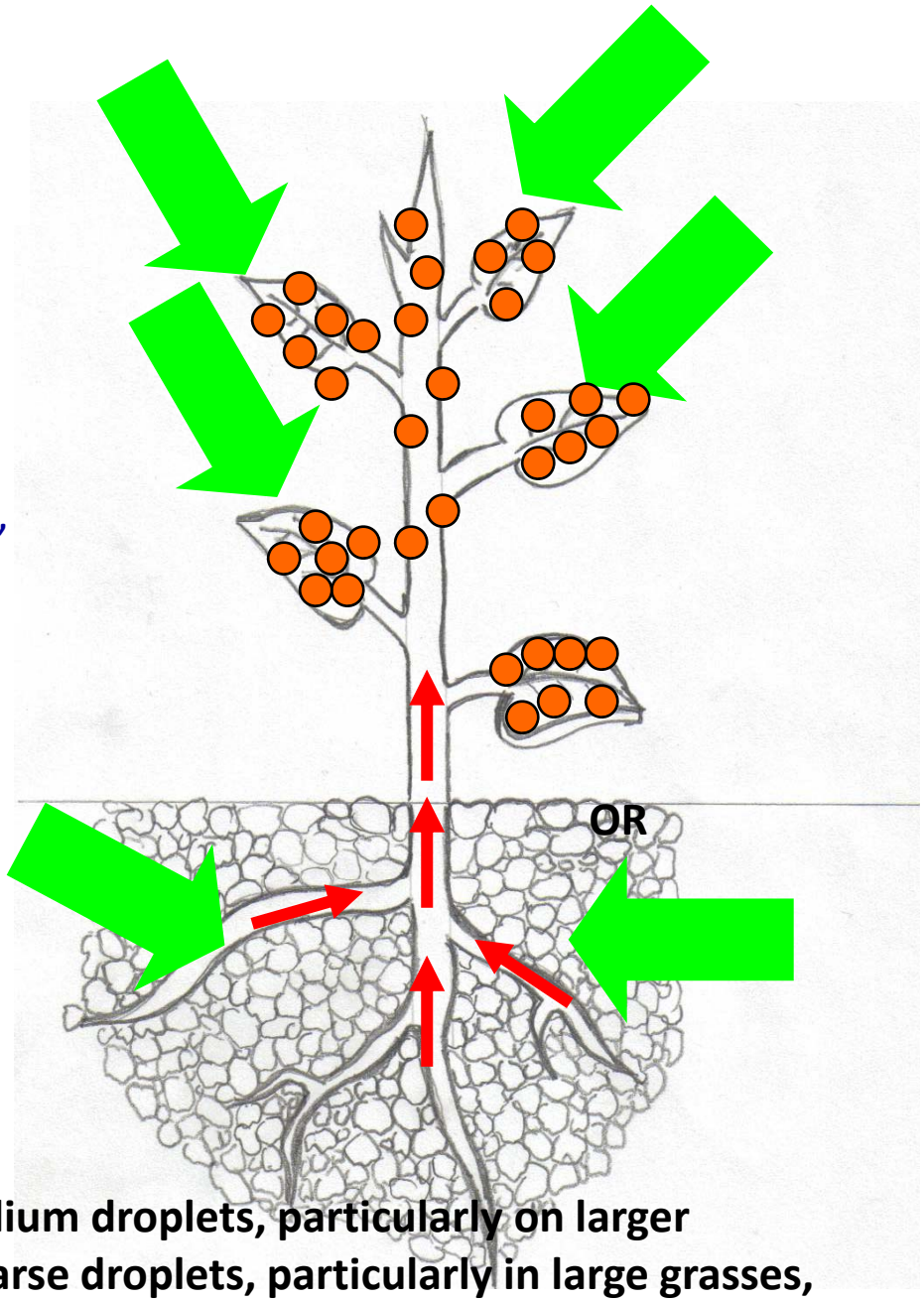
Group C

Photosynthesis Inhibitors

(inhibit photosystem II)

- Benzothidiazoles (basagran) contact only.
- Nitriles (bromoxynil), contact, little if any translocation,
- Phenyl-pyrazidines (tough) contact
- Triazines (atrazine, simazine, gesagaurd etc), soil applied, root absorbed, xylem transported to the leaves.
- Triazinones (sencor) soil acting,

  NO downward movement, chemical concentrates in leaves, stems, shoots
- Substituted Ureas (diuron) similar to triazines (xylem only),
- Selectivity varies, bromoxynil mostly due to number of growing points exposed, others by deactivation of metabolite.



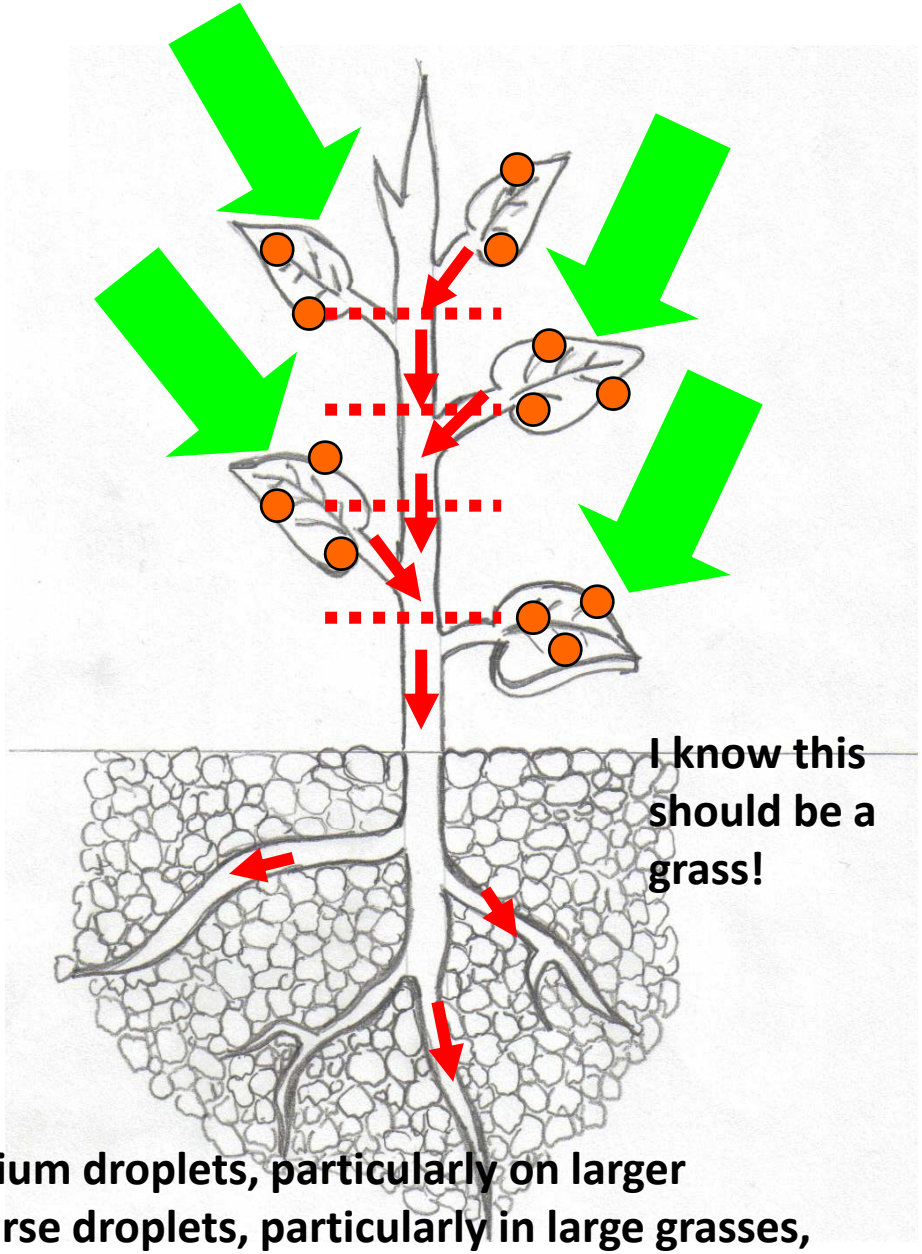
Retention and evenness is favoured by Medium droplets, particularly on larger broadleaves, penetration is favoured by Coarse droplets, particularly in large grasses, cereals and stubble.

Group A

Lipid Inhibitors

(inhibit the enzyme acetyl CoA carboxylase)

- 'Fops' & 'Dims'
- Block the formation of lipids in the shoot (meristem) and roots of GRASSES, broadleaves are tolerant to this group.
- Absorbed into foliage & move in the phloem to areas of new growth
- Symptoms slow to develop, first symptoms may be on growing points, but can differ widely
- Can cause crop injury when used with oils and adjuvants
- Possible antagonism when mixed with auxin type herbicides (2,4-D, Dicamba, less with MCPA)



Retention and evenness is favoured by Medium droplets, particularly on larger broadleaves, penetration is favoured by Coarse droplets, particularly in large grasses, cereals and stubble.

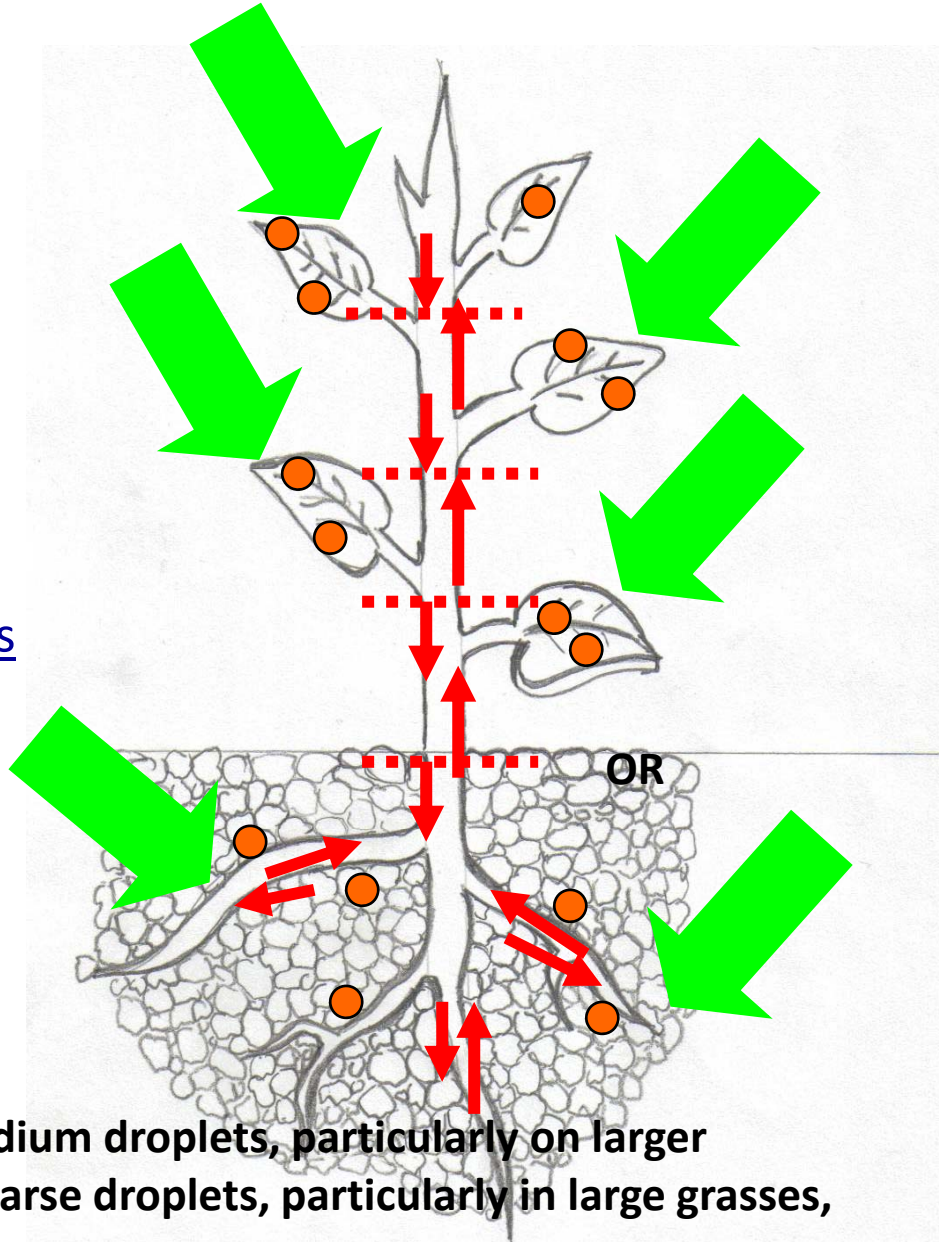
Group B

ALS Inhibitors

(inhibit the enzyme acetolactate synthase)

- Imidazolinones (spinnaker), Sulfanamides (broadstrike), Sulfonyl Ureas (Ally, glean, logran)

- All can inhibit formation of specific branched chain amino acids.
- Move in the xylem and phloem to areas of new growth, has root and shoot uptake. Can be soil or foliage applied.
- Kills a wide range of weeds
- Selectivity may be lost when crop stressed



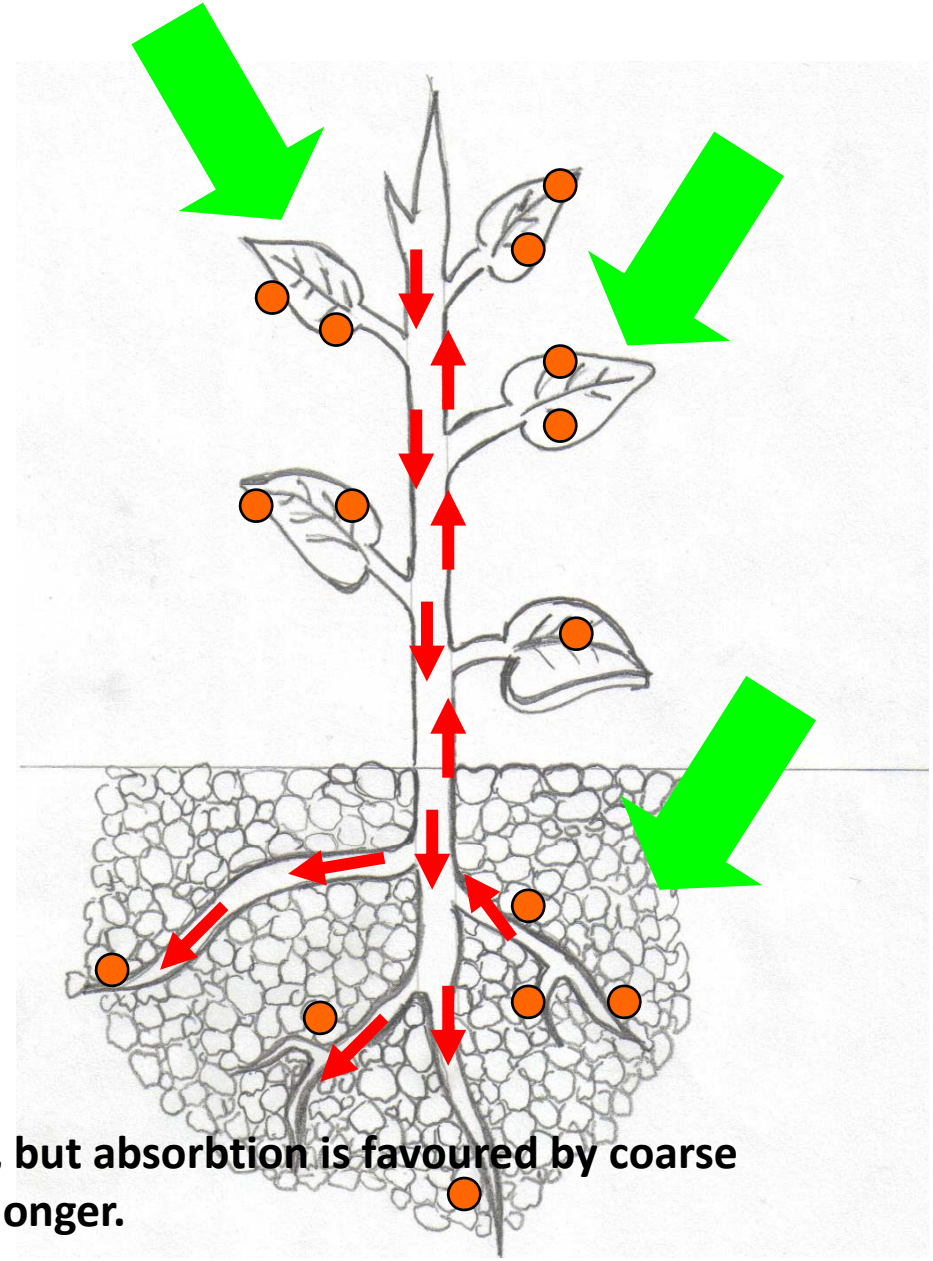
Retention and evenness is favoured by Medium droplets, particularly on larger broadleaves, penetration is favoured by Coarse droplets, particularly in large grasses, cereals and stubble.

Group I

disruptors of cell growth

Benzoic acids (dicamba),
Phenoxy acetic acids (2,4-D, MCPA),
Pyridines (starane, tordon)

- Most post emergent, broadleaf control
- Upset hormone balance and cell growth (multiple sites in plant).
- Move in xylem and phloem to areas of new growth. Primarily absorbed through foliage, but roots possible
- Excessive rates can cause localised damage and restrict translocation
- Pyridines have greater soil activity, act as general growth inhibitors, especially to the roots.



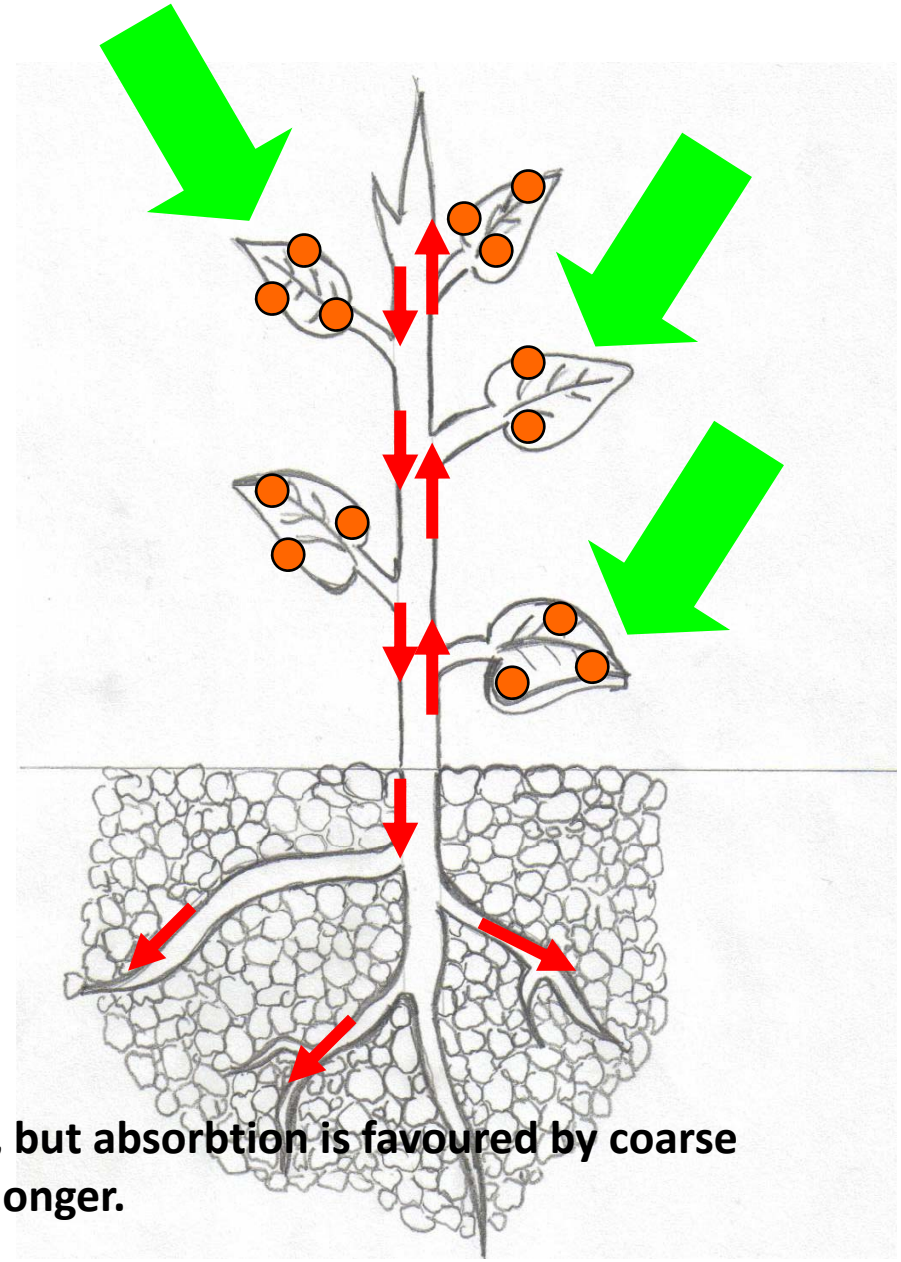
Retention is favoured by medium droplets, but absorbtion is favoured by coarse droplets, as the product stays in solutions longer.

Group M

inhibitors of EPSP synthase

- Phosphorus Compounds (Glyphosate)

- Glyphosate is an organic acid formulated as an amine salt
- Post emergent, non-selective
- Acts on an enzyme pathway to disrupt the production of 3 essential amino acids.
- Moves freely, mainly in the phloem, some say xylem as well (some up & all the way DOWN), no soil activity…..probably the most mobile of all herbicides once in the plant…if plant not stressed.



Retention is favoured by medium droplets, but absorbtion is favoured by coarse droplets, as the product stays in solutions longer.

What is good coverage ?

…that depends on the mode of action.

Fine,
45L/Ha
88drops/cm
8.5% covered

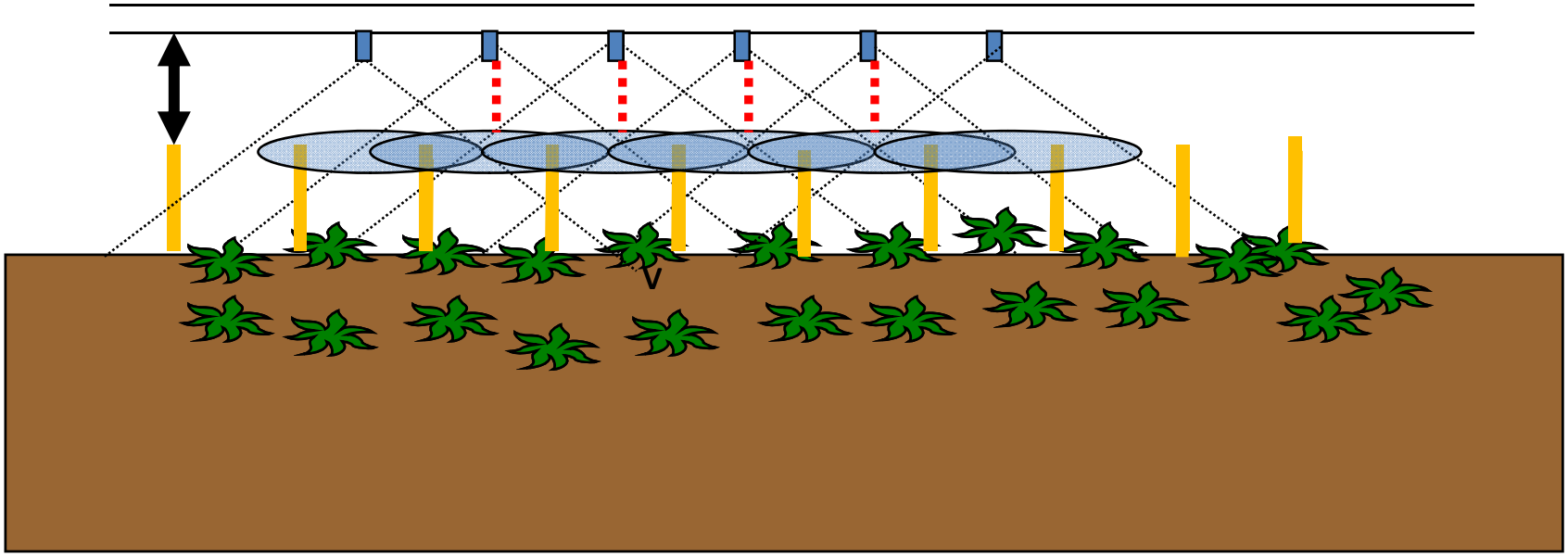
Medium,
45L/Ha
32 drops/cm
8.5% covered

Coarse, 45L/Ha
35drops/cm
9.3% covered

Nozzle Height for Stubble/Crop

Double Overlap top of stubble or crop

(narrower spacing = allows reduced boom height)



Recent Trial Results

SEPTEMBER 2012

GRDC Grains Research & Development Corporation

SUMMER FALLOW SPRAYING FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

IMPLICATIONS FOR NOZZLE SELECTION AND SPRAY QUALITY FROM RECENT TRIAL RESULTS

KEY POINTS

- Plan to control summer weeds as early as possible.
- Have the machine ready to go.
- Select an appropriate application volume for the product and situation.
- Choose the coarsest spray quality that will provide efficacy with the products selected.
- Monitor and record application details and weather parameters.

Plan to control summer weeds early and have the sprayer ready to go

If spraying to conserve soil moisture and retain nutrients over summer, early weed fallow control can increase the yield potential of future crops. Waiting for later germinations of summer weeds may not provide the same return on the dollars invested in control measures as a spray program that starts earlier.

Often the most important factor is getting the timing right in relation to weed susceptibility and using a robust rate of product. However, it is worth remembering that delayed control, which will result in reduced moisture and nitrogen in the soil, is better than no control at all.

As part of the planning process, ensure that the sprayer is ready to go as soon as it is needed. This means that the sprayer and the mixing equipment are clean and decontaminated, the correct nozzles are available and calibrated, and the machine is functioning correctly.

Select an application volume to match the target weeds, stubble situation and the herbicides' mode of action

The majority of fully translocated herbicides require the use of a coarse spray quality or larger, particularly Group M, Group I and Group B herbicides. When using a coarse spray quality to apply fully translocated products to summer weeds, it is often best to keep water volumes at or above 50 litres per hectare in low stubble environments and at more than 60L/ha as stubble loads increase. Consider using higher application rates for poorly translocated products or when mixingproducts with a high loading of active ingredient.

Self-propelled sprayer

Choose the coarsest spray quality that will provide efficacy

In situations where sensitive summer crops are grown and there is potential for off-target movement of product to cause damage or result in residues, consider a spray quality that is larger than coarse, such as extremely coarse, to further minimise risk.

Summer fallow trials over the last six years have shown that equivalent efficacy can be obtained for Group I and Group M products with extremely coarse droplets, provided that nozzles are operated appropriately (for example, sufficient pressure with the air induction types).

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | T +61 2 6166 4500 | F +61 2 6166 4599 | E grdc@grdc.com.au | W www.grdc.com.au

REVISED JUNE 2014

GRDC Grains Research & Development Corporation

IN-CROP HERBICIDE USE FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

APPLICATION CONSIDERATIONS FOR IN-CROP HERBICIDE USE

KEY POINTS

- Knowledge of a product's translocation and formulation type is important for selecting nozzles and application volumes.
- Evenness of deposit is important for poorly or slowly translocated products.
- Crop growth stage, canopy size and stubble load should influence decisions about nozzle selection, application volume and sprayer operating parameters.
- Robust rates of products and appropriate water rates are often more important for achieving efficacy than the nozzle type, but, correct nozzle type can widen the spray window, improve deposition and reduce drift risk.
- Travel speed and boom height can affect efficacy and drift potential.
- Appropriate conditions for spraying are always important.

Test controller settings and nozzle performance well before cropping starts.

Know how a herbicide works

Knowledge of how a product enters the plant and how it is translocated is important for determining the most appropriate application volume, adjuvant type and nozzle style.

Uptake, translocation and application volume

Products that have a slow uptake or slow or limited translocation (such as Group A herbicides) should be applied at higher water rates (typically 70-100L/ha in cereals and higher in many pulses).

Products that are phloem and xylem transported (such as Groups B, I and M herbicides) can often be applied at lower application volumes – 50-70L/ha in low stubble situations and small crop canopy – but normally need to be applied at 70L/ha or more where high stubble loads exist or the crop canopy is dense. Always check product labels and the manufacturer's technical information for specific advice about appropriate application volumes and timing in relation to a crop's growth stage.

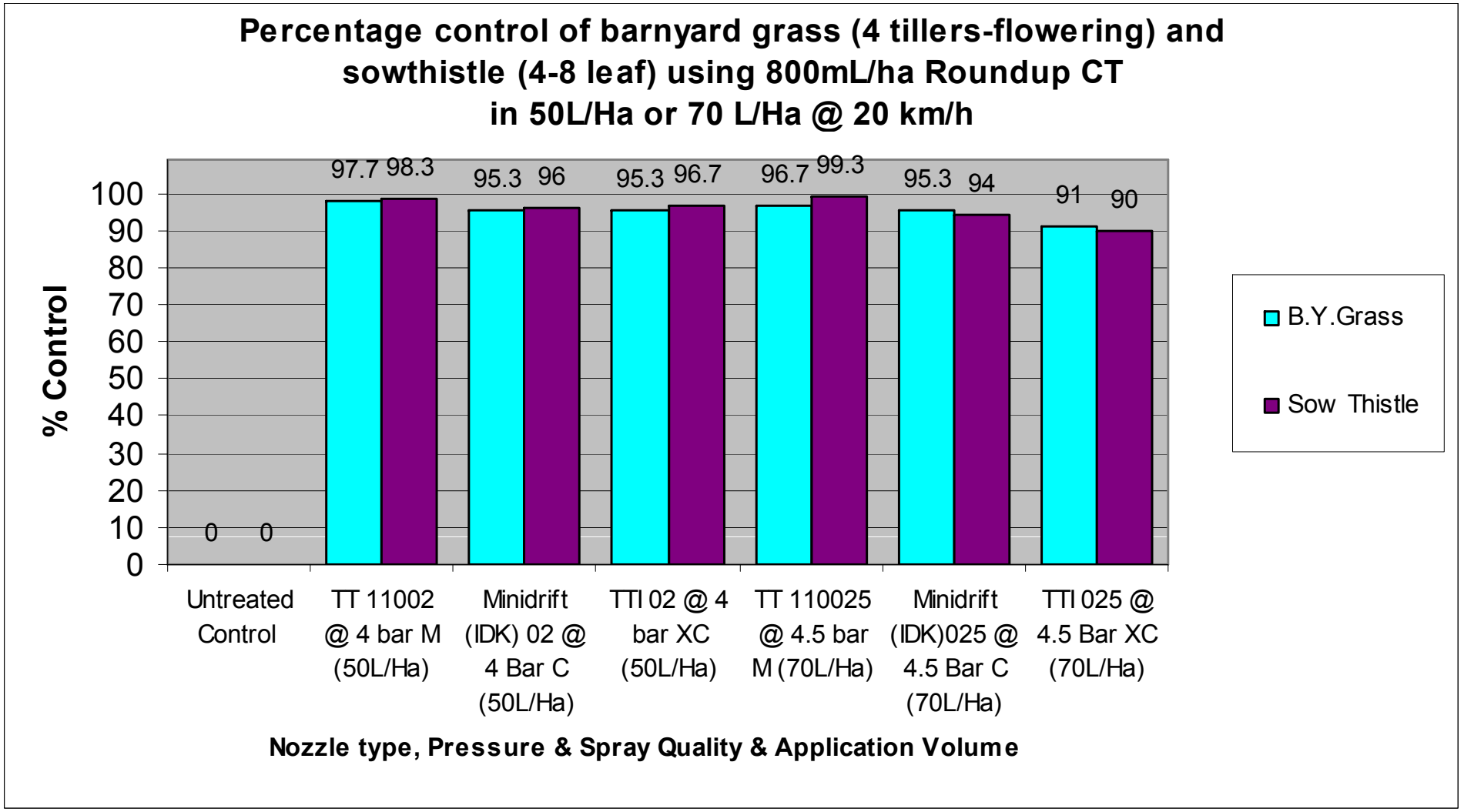
Water volume and spray quality

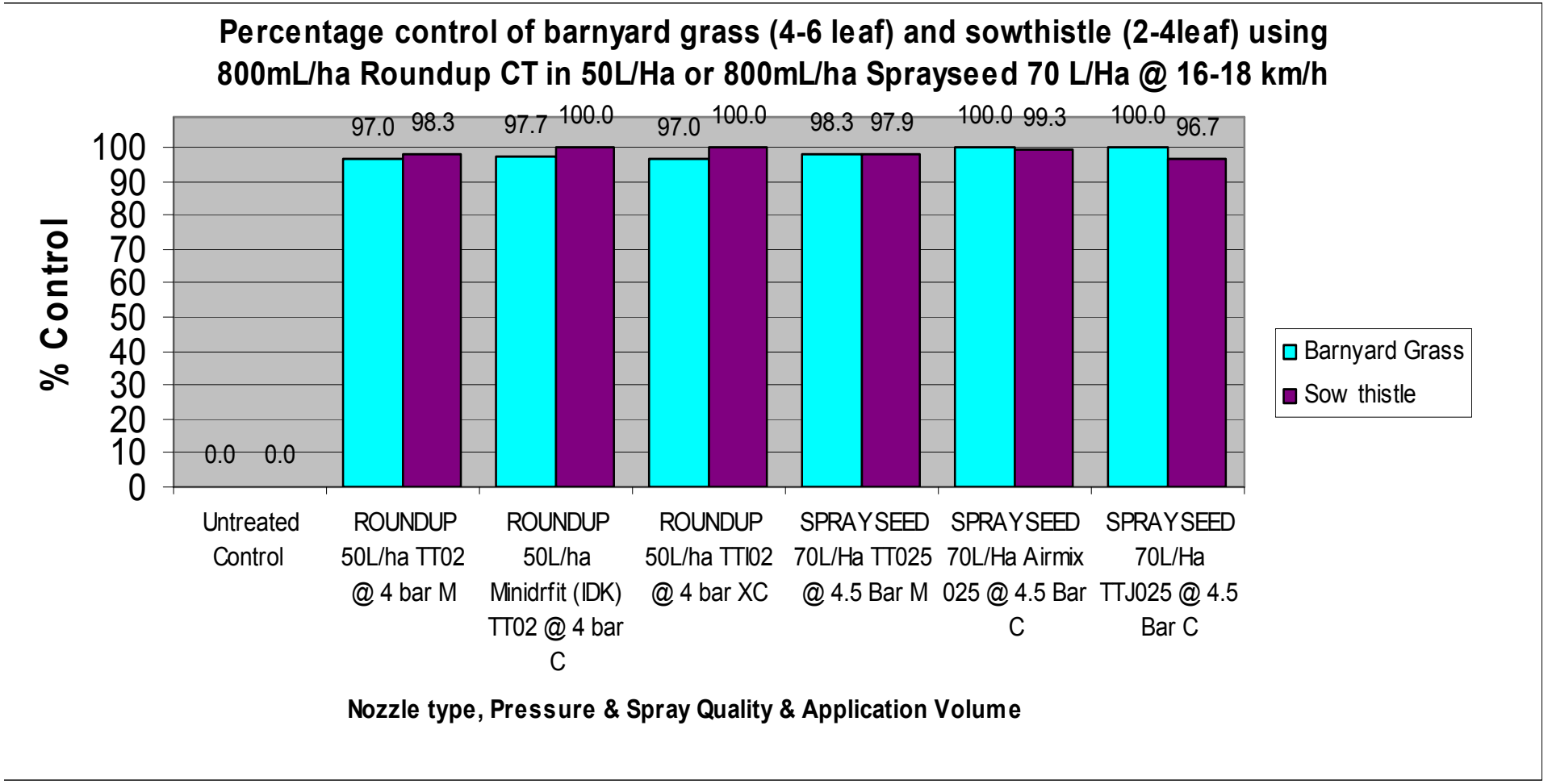
Depositing droplets onto foliar targets is a numbers game. Increasing application volumes produces more droplets, which usually increases the evenness of the application, provided droplets reach where they are required.

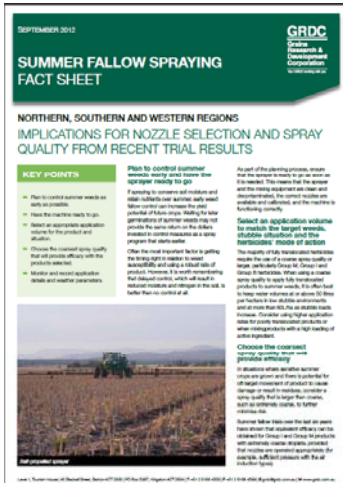
Anything that is situated between the nozzle and the desired target weed, such as stubble or a large crop canopy, has the potential to intercept spray droplets. Where crop canopies are large or stubble load is heavy, it is always advisable to use robust or higher water rates.

More droplets can be produced by decreasing the droplet size. However, fine spray qualities do not penetrate dense canopies as well as medium spray qualities from non-air induction nozzles or air-inducted coarse droplets (unless they are used with an air-assisted spray system). Finer spray qualities also increase spray drift risk and are likely to be intercepted by stubble when the load is high.

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | T +61 2 6166 4500 | F +61 2 6166 4599 | E grdc@grdc.com.au | W www.grdc.com.au


Percentage control of barnyard grass (4 tillers-flowering) and sowthistle (4-8 leaf) using 800mL/ha Roundup CT in 50L/Ha or 70 L/Ha @ 20 km/h
% Control
100
90
80
70
60
50
40
30
20
10
0
0 0
97.7 98.3
95.3 96
95.3 96.7
96.7 99.3
95.3 94
91 90
Untreated Control
TT 11002 @ 4 bar M (50L/Ha)
Minidrift (IDK) 02 @ 4 Bar C (50L/Ha)
TTI 02 @ 4 bar XC (50L/Ha)
TT 110025 @ 4.5 bar M (70L/Ha)
Minidrift (IDK)025 @ 4.5 Bar C (70L/Ha)
TTI 025 @ 4.5 Bar XC (70L/Ha)
B.Y.Grass
Sow Thistle
Nozzle type, Pressure & Spray Quality & Application Volume


Percentage control of barnyard grass (4-6 leaf) and sowthistle (2-4leaf) using 800mL/ha Roundup CT in 50L/Ha or 800mL/ha Sprayseed 70 L/Ha @ 16-18 km/h
% Control
100
90
80
70
60
50
40
30
20
10
0
0.0
0.0
97.0
98.3
97.7
100.0
97.0
100.0
98.3
97.9
100.0
99.3
100.0
96.7
Untreated Control
ROUNDUP 50L/ha TT02 @ 4 bar M
ROUNDUP 50L/ha Minidrfit (IDK) TT02 @ 4 bar C
ROUNDUP 50L/ha TTI02 @ 4 bar XC
SPRAYSEED 70L/Ha TT025 @ 4.5 Bar M
SPRAYSEED 70L/Ha Airmix 025 @ 4.5 Bar C
SPRAYSEED 70L/Ha TTJ025 @ 4.5 Bar C
Barnyard Grass
Sow thistle
Nozzle type, Pressure & Spray Quality & Application Volume



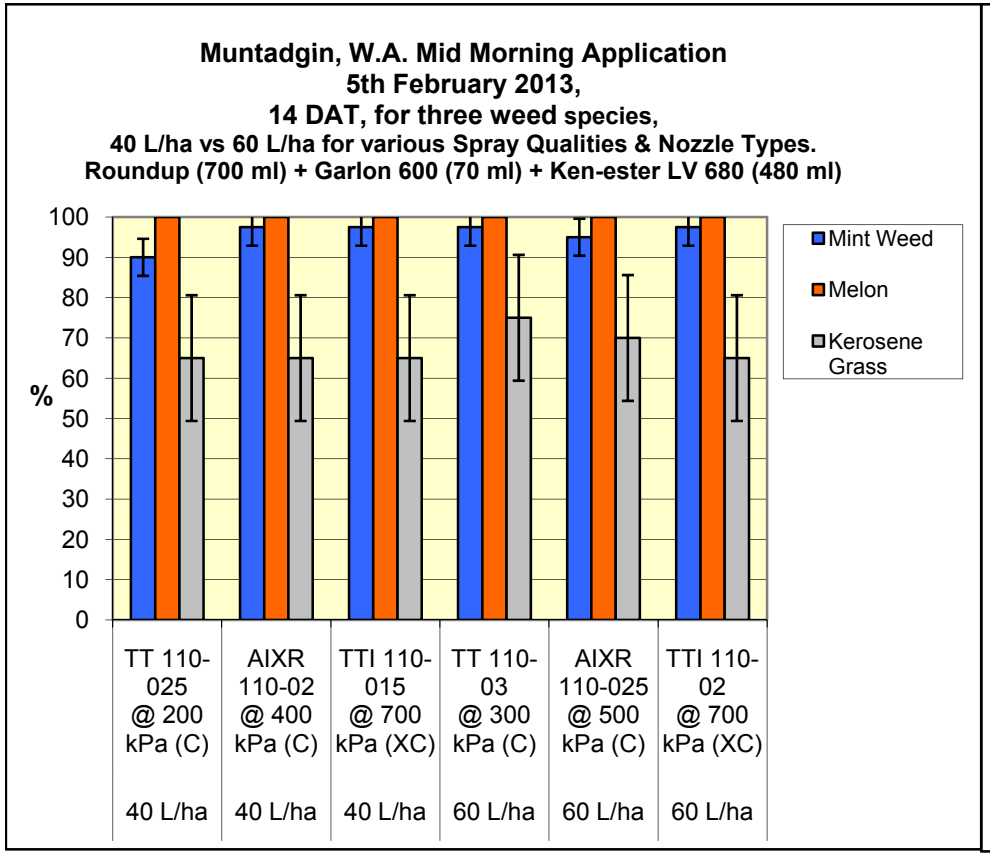
Control (% desiccation or stunting) of heliotrope Glyphosate/Phenoxy Mix vs. Sprayseed®, 60 L/ha vs. 90 L/ha using a range of nozzle types.

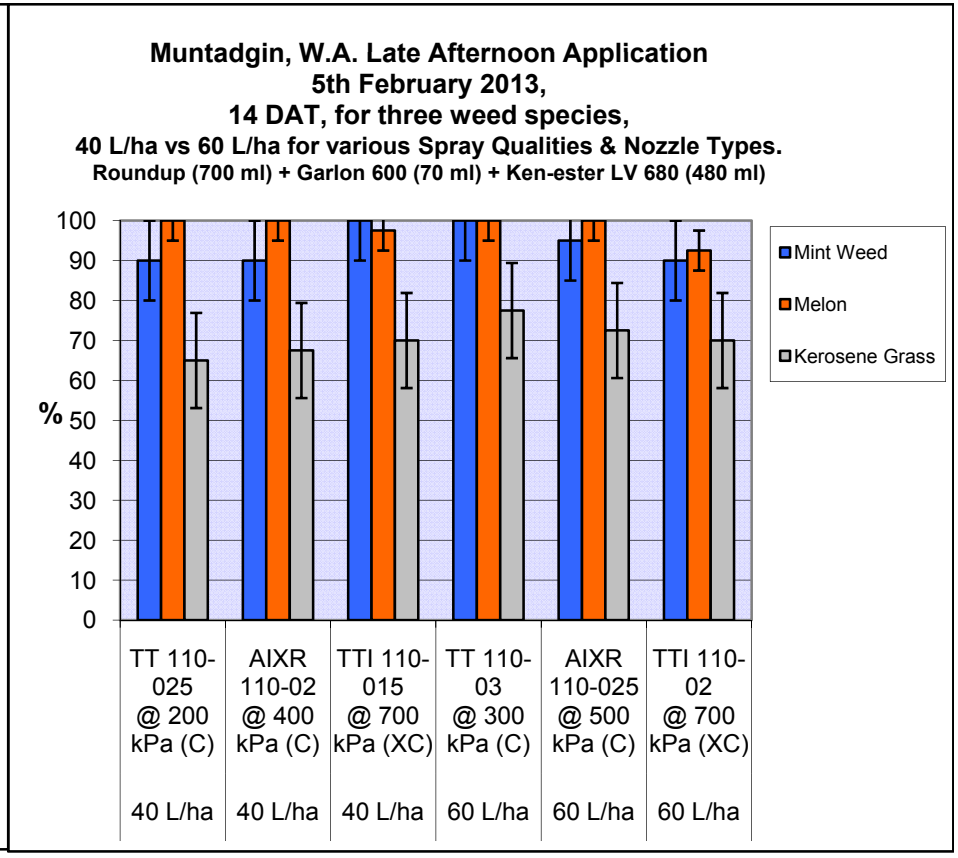
Mintaro, S.A. Feb,2012 Mid-Afternoon

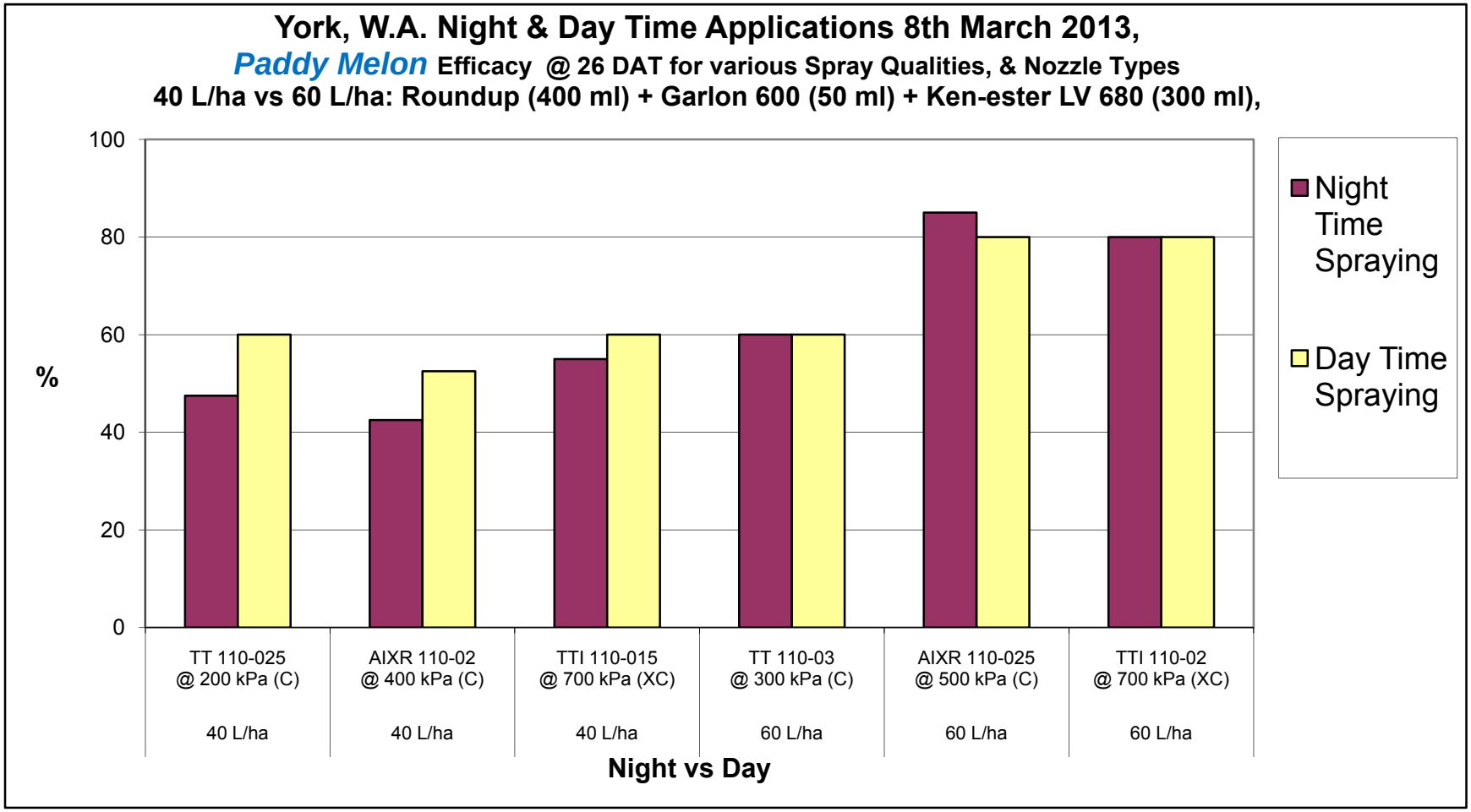
(Delta T = 14.5-15.5)

Water Rate (L/ha)	Nozzle Type and Size	Spray Quality	SpraySeed % dessication		Glyphosate Mix % Stunting	
			16 DAT	**24 DAT**	16 DAT	**24 DAT**
60 L/ha	Untreated Control		0.0	**0.0**	0.0	**0.0**
	TurboTeejet TT11002-VP (forward)	M	87.5	**92.5a**	27.5	**72.5ab**
	TeeJet AIXR11002VP	C	88.8	**98.0a**	30.0	**78.8a**
	TurboTwinJet TTJ60-11002VP	C	88.8	**94.0a**	30.0	**68.8ab**
	TeeJet AITTJ60-11002VP	C	92.5	**93.8a**	27.5	**70.0ab**
	TurboTeejet Induction TTI11002-VP (alternating forward and backward)	XC	72.5	**82.5b**	25.0	**63.8b**
90 L/ha	Untreated Control		0.0	**0.0**	0.0	**0.0**
	TurboTeejet TT110-025-VP (forward)	M	92.0	**94.5a**	23.8	**63.8b**
	TeeJet AIXR110025-VP	C	89.5	**95.5a**	25.0	**68.8ab**
	TurboTwinJet TTJ60-110025VP	C	85.0	**95.5a**	38.8	**72.5ab**
	Teejet AITTJ60-11002VP	C	94.8	**96.8a**	18.8	**61.2b**
	TurboTeejet Induction TTI1102-VP (alternating forward and backward)	XC	86.0	**92.3a**	21.2	**66.2b**
		LSD (0.05)	*8.6*	***5.9***	*8.3*	***11.5***

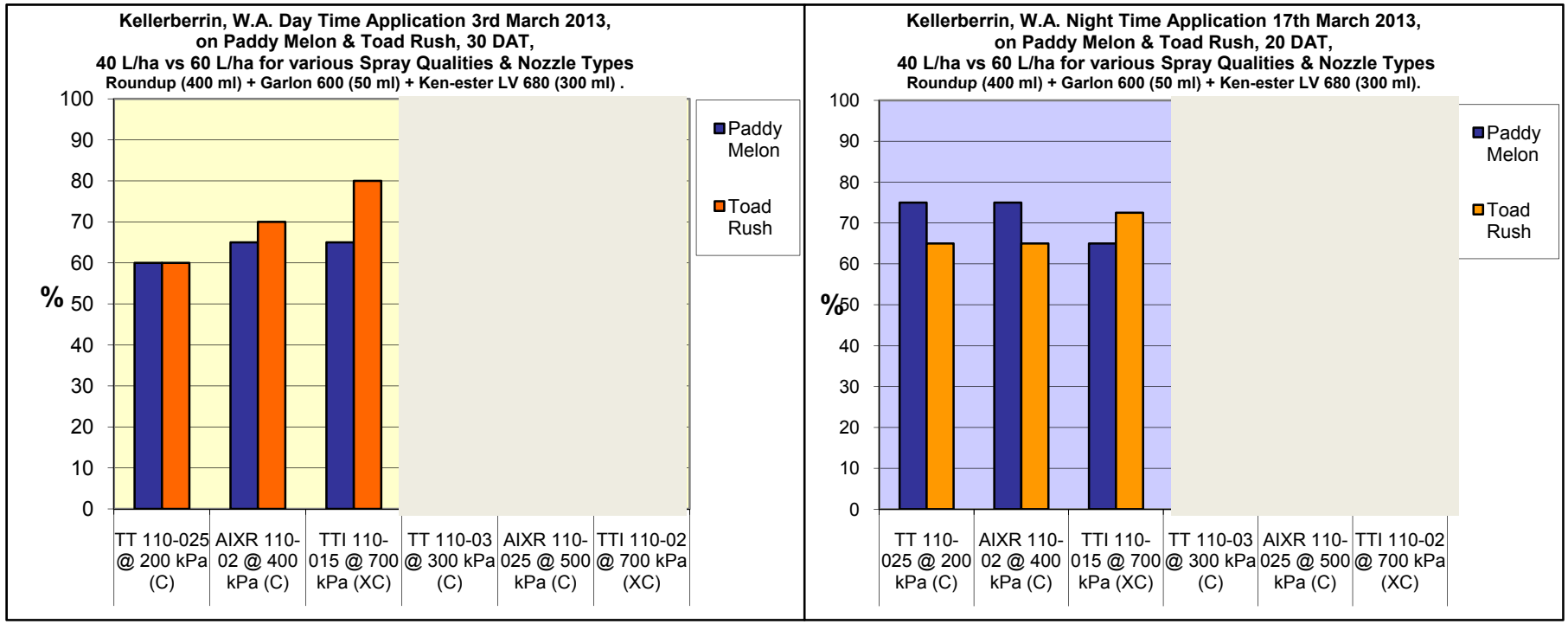
Morning vs Late afternoon Application



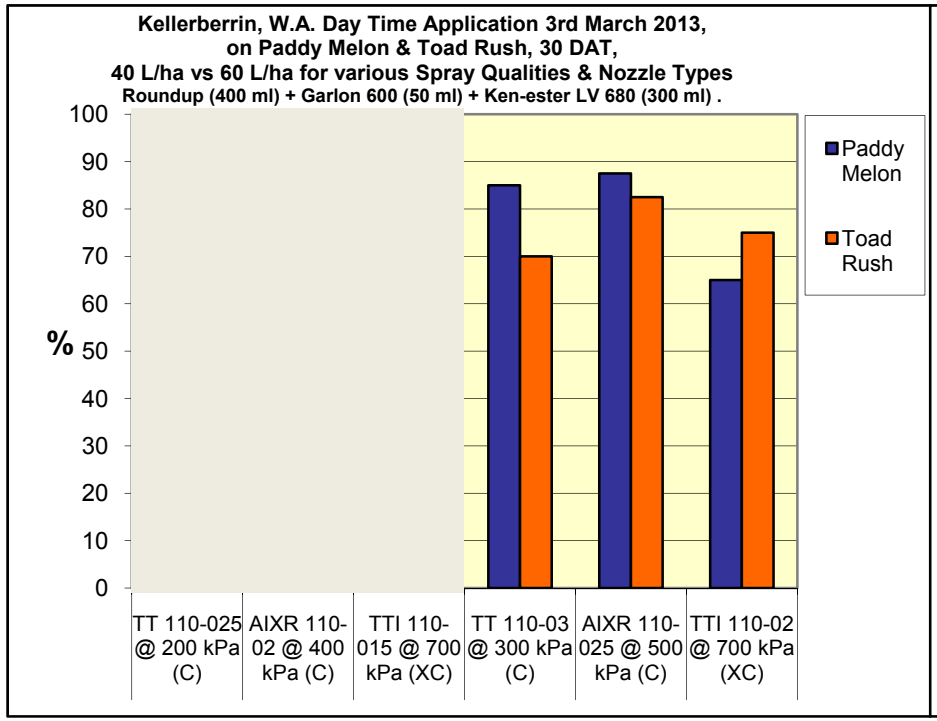


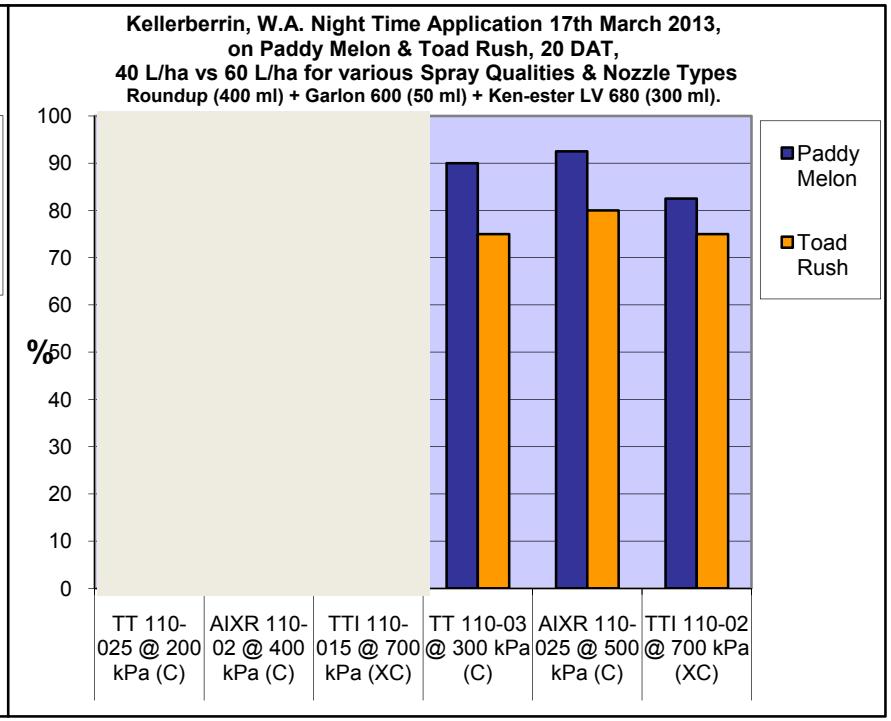

York, W.A. Night & Day Time Applications 8th March 2013,
Paddy Melon Efficacy @ 26 DAT for various Spray Qualities, & Nozzle Types
40 L/ha vs 60 L/ha: Roundup (400 ml) + Garlon 600 (50 ml) + Ken-ester LV 680 (300 ml),
100
80
60
40
20
0
%
Night Time Spraying
Day Time Spraying
TT 110-025 @ 200 kPa (C)
AIXR 110-02 @ 400 kPa (C)
TTI 110-015 @ 700 kPa (XC)
TT 110-03 @ 300 kPa (C)
AIXR 110-025 @ 500 kPa (C)
TTI 110-02 @ 700 kPa (XC)
40 L/ha
40 L/ha
40 L/ha
60 L/ha
60 L/ha
60 L/ha
Night vs Day

Waiting for weeds to freshen up

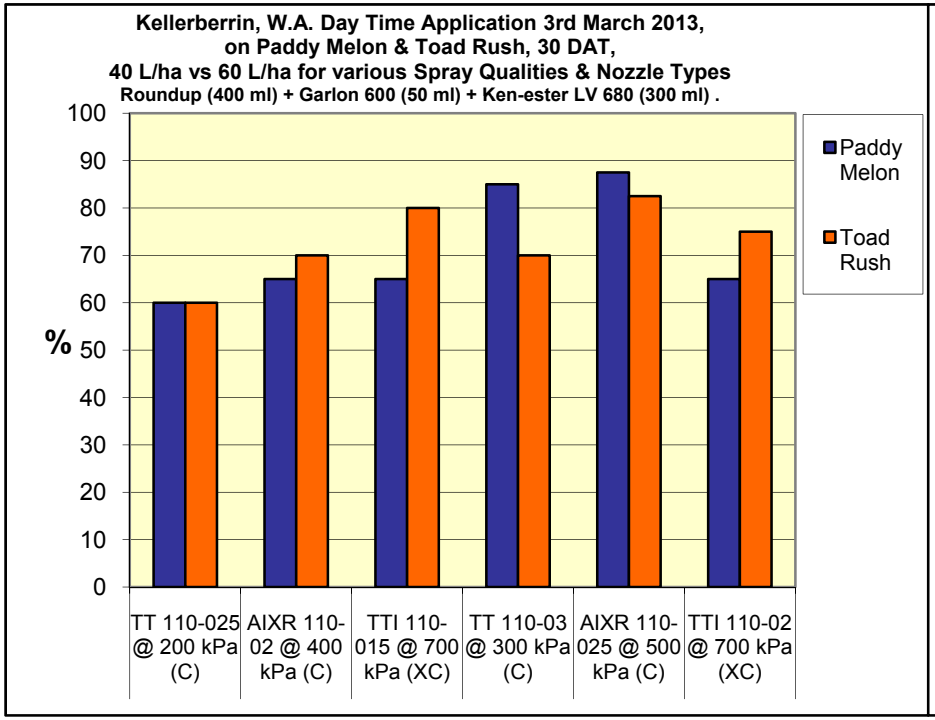


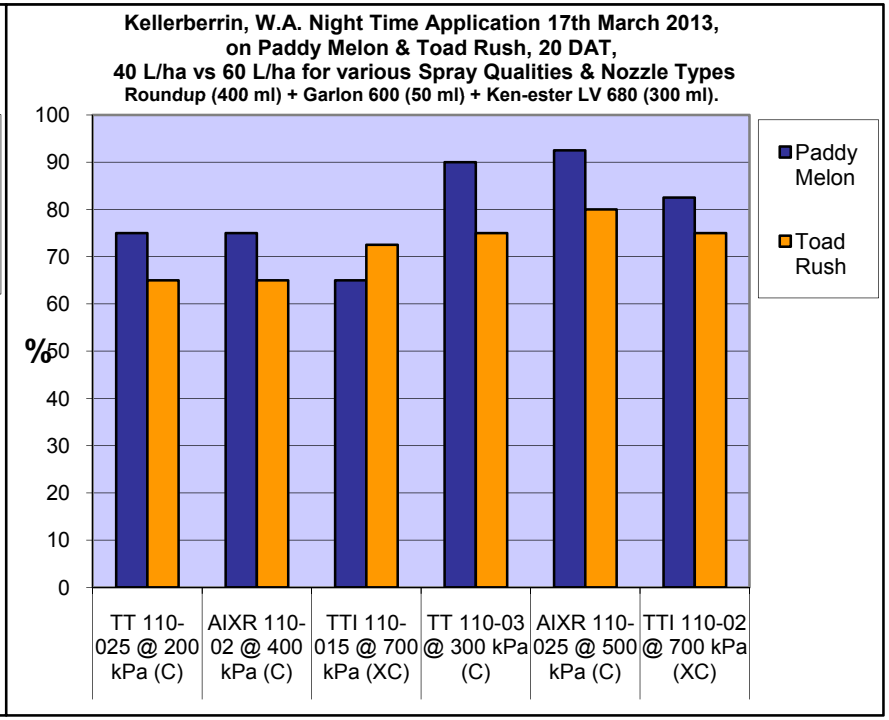
Waiting for weeds to freshen up





Waiting for weeds to freshen up



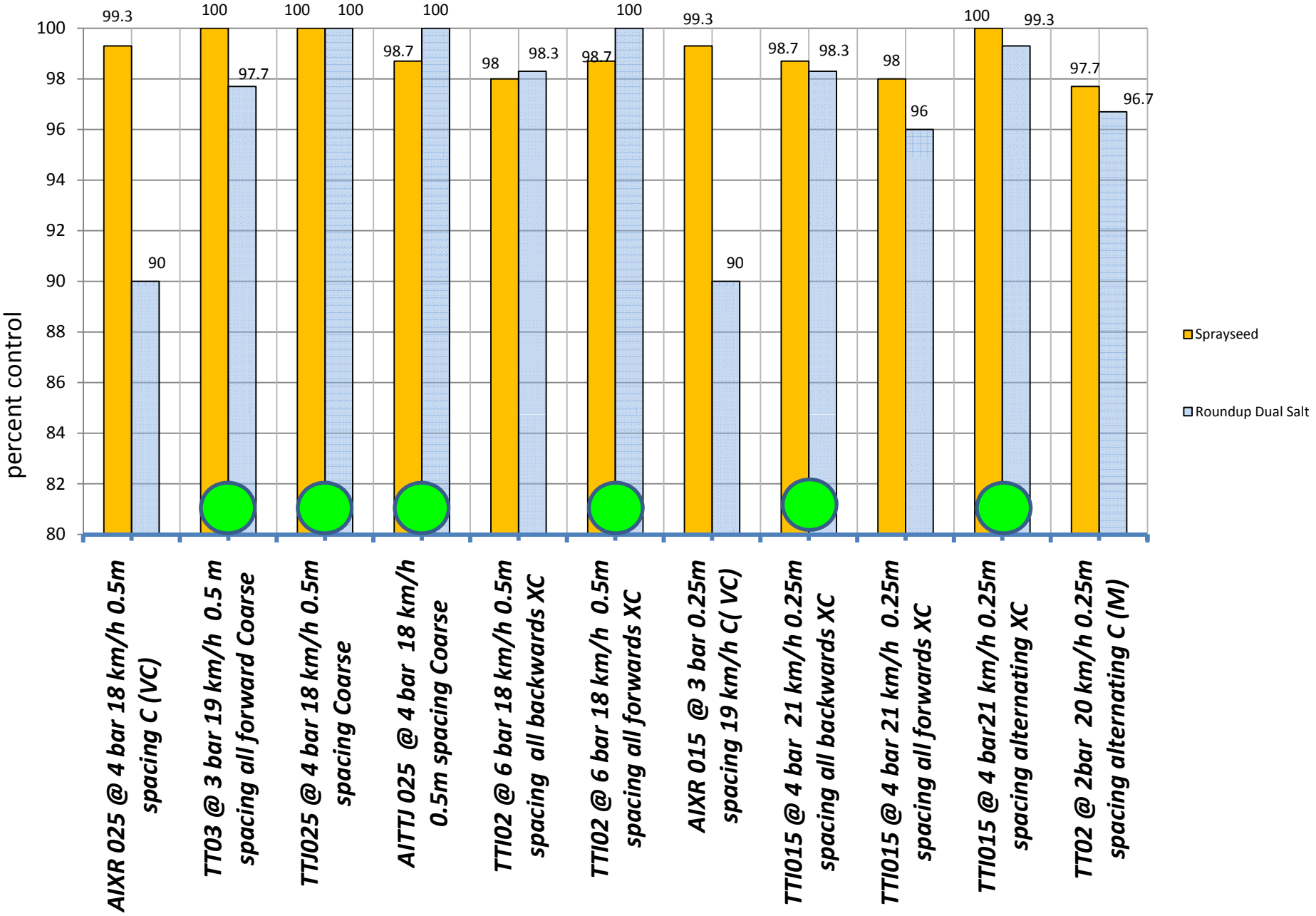


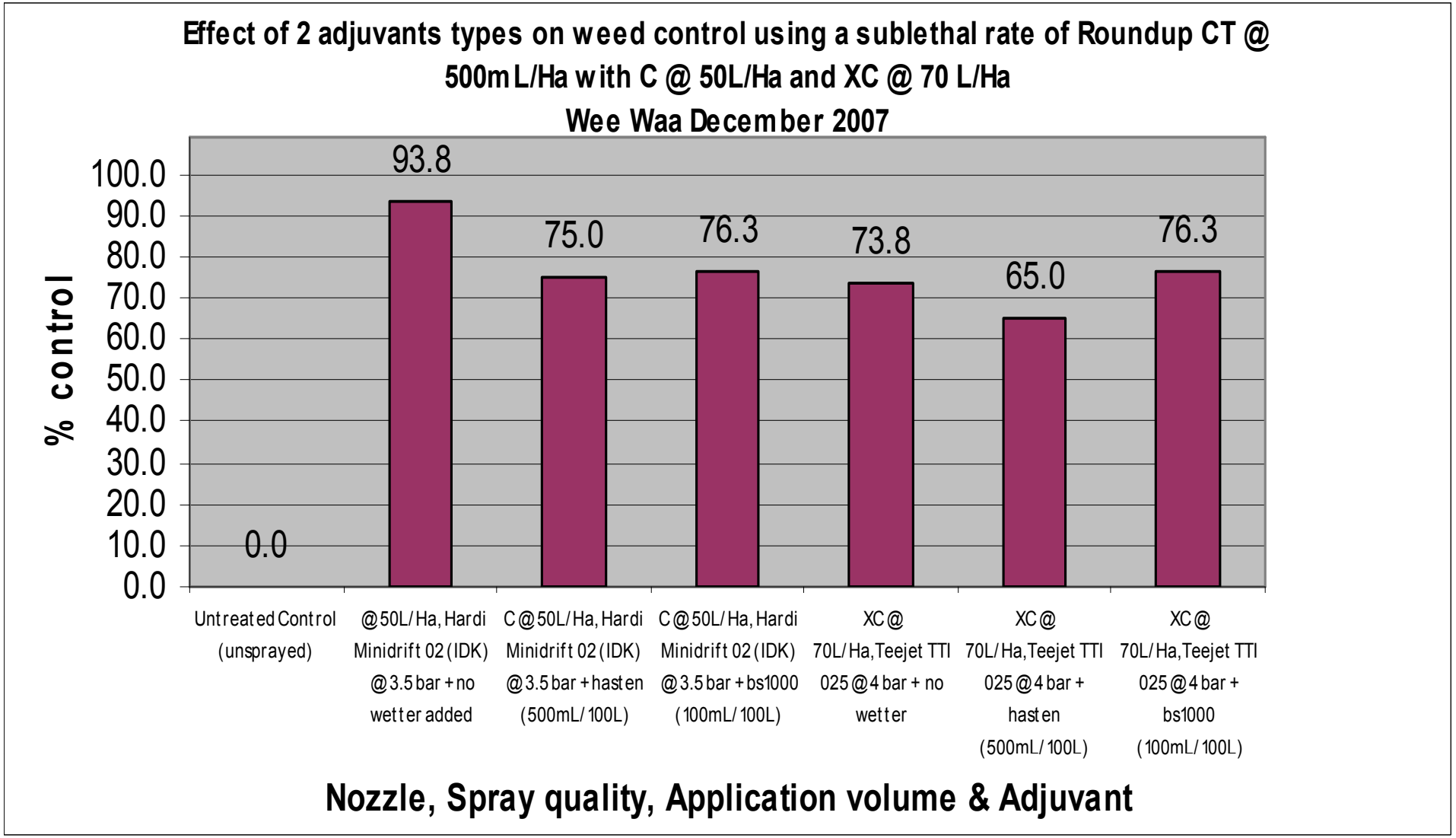
Comments about angled nozzles and travel speed by Professor Paul Miller NIAB-TAG (UK):

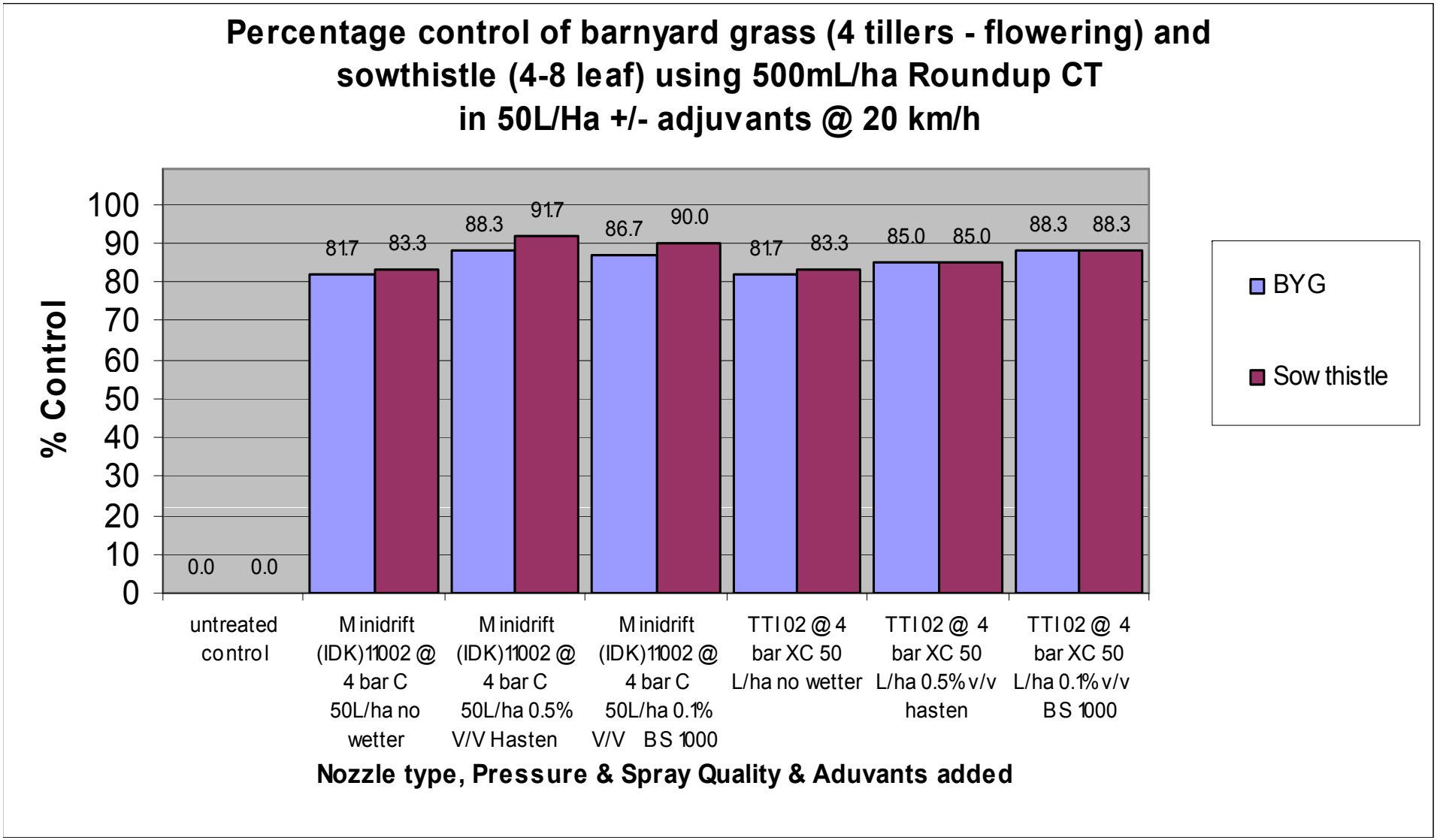
Angled Nozzles?

Angling nozzles will also generate horizontal spray movement but again care is needed to control the risk of drift by keeping the boom as low as possible. The minimum boom height will be lower when nozzles are angled than when they are directed straight down. **Alternating angled nozzles also reduces drift when compared with those all angled forwards or backwards.**

Level of Control Accross the whole plot of Canaray Seed (4-6 Tillers) from 2 trials:
Trial 1 Using Sprayseed @ 0.8 L/ha (14 DAT) *LSD 5% 1.8.* **Trial 2 Roundup Dual Salt @ 1L/ha (15 DAT)** *LSD 5% 6.4*
April 2011, Kalkee, Victoria.

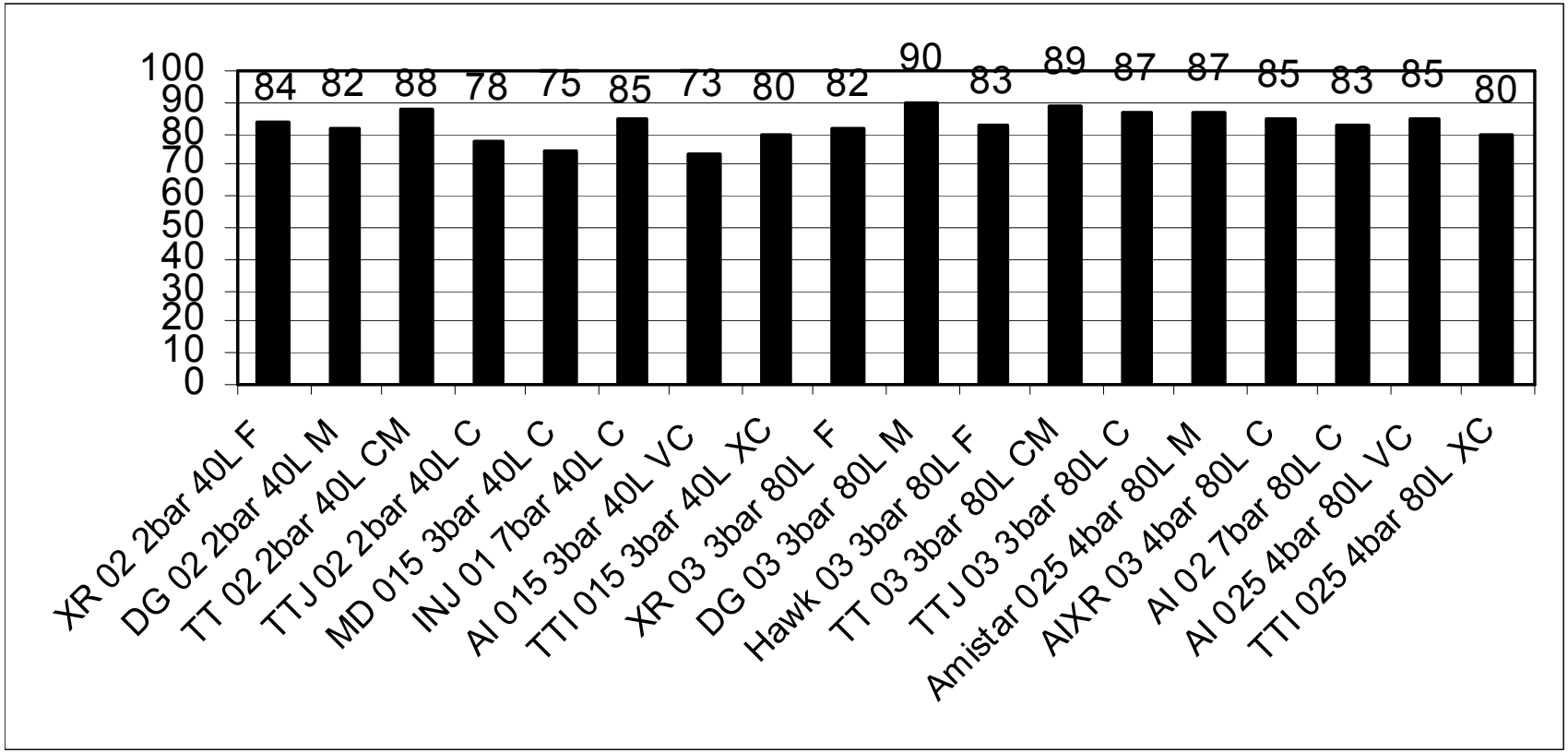



Effect of 2 adjuvants types on weed control using a sublethal rate of Roundup CT @ 500mL/Ha with C @ 50L/Ha and XC @ 70 L/Ha
Wee Waa December 2007
% control
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.0
93.8
75.0
76.3
73.8
65.0
76.3
Untreated Control (unsprayed)
@50L/Ha, Hardi Minidrift 02 (IDK) @3.5 bar + no wetter added
C @50L/Ha, Hardi Minidrift 02 (IDK) @3.5 bar + hasten (500mL/100L)
C @50L/Ha, Hardi Minidrift 02 (IDK) @3.5 bar + bs1000 (100mL/100L)
XC @ 70L/Ha, Teejet TTI 025 @4 bar + no wetter
XC @ 70L/Ha, Teejet TTI 025 @4 bar + hasten (500mL/100L)
XC @ 70L/Ha, Teejet TTI 025 @4 bar + bs1000 (100mL/100L)
Nozzle, Spray quality, Application volume & Adjuvant


Percentage control of barnyard grass (4 tillers - flowering) and sowthistle (4-8 leaf) using 500mL/ha Roundup CT in 50L/Ha +/- adjuvants @ 20 km/h
% Control
100
90
80
70
60
50
40
30
20
10
0
0.0
0.0
81.7
83.3
88.3
91.7
86.7
90.0
81.7
83.3
85.0
85.0
88.3
88.3
BYG
Sow thistle
untreated control
Minidrift (IDK)11002 @ 4 bar C 50L/ha no wetter
Minidrift (IDK)11002 @ 4 bar C 50L/ha 0.5% V/V Hasten
Minidrift (IDK)11002 @ 4 bar C 50L/ha 0.1% V/V BS 1000
TTI02 @ 4 bar XC 50 L/ha no wetter
TTI02 @ 4 bar XC 50 L/ha 0.5% v/v hasten
TTI02 @ 4 bar XC 50 L/ha 0.1% v/v BS 1000
Nozzle type, Pressure & Spray Quality & Aduvants added

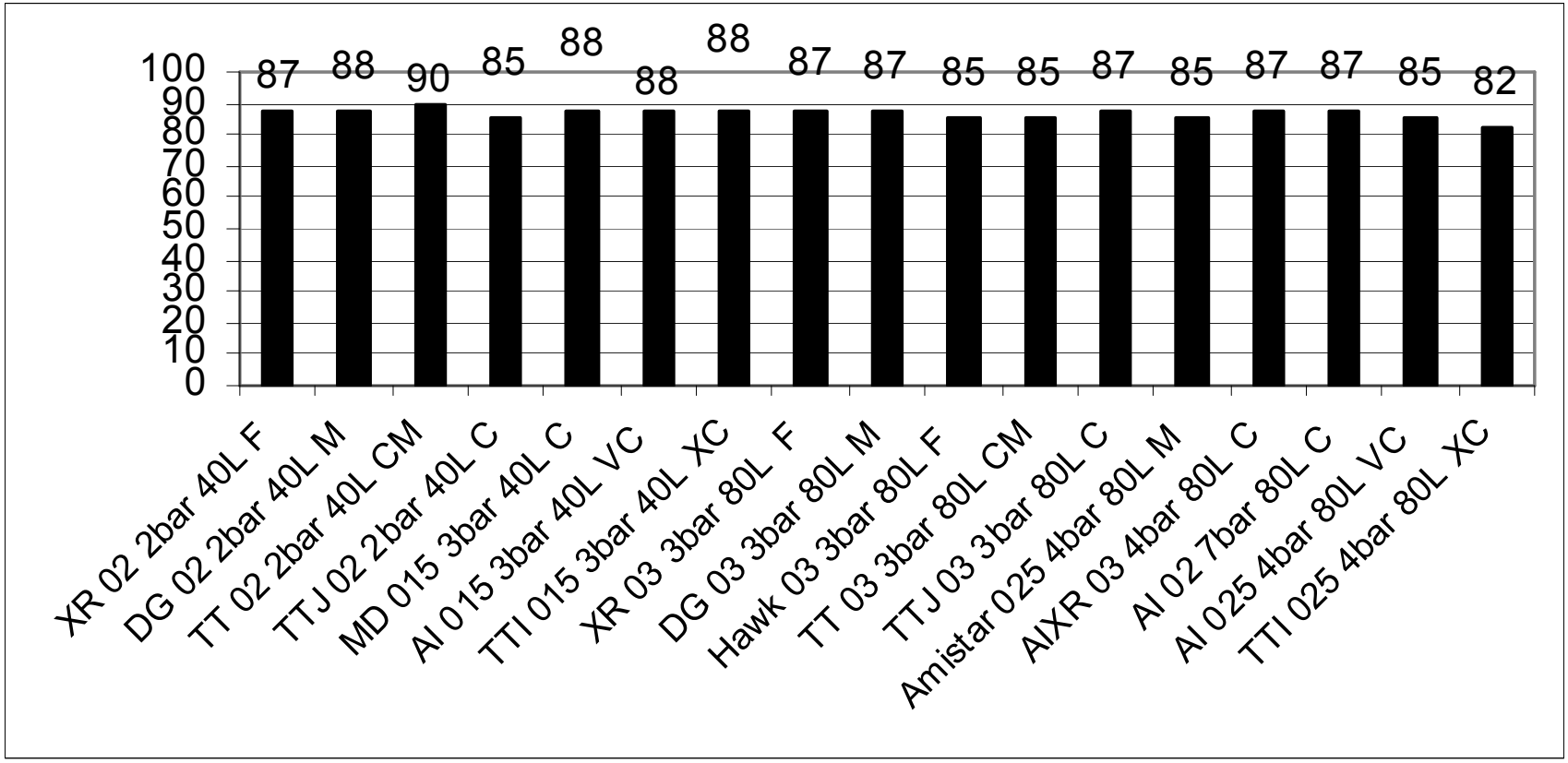
Trial Results presented by Jason Sabeeney of Syngenta at the 2008 GRDC Northern Region Updates (Spray Seed and Axial)

Figure 3: % Annual Ryegrass Control with Spray Seed, 1.2L/ha, 22 DAA, Paskeville, SA, 2007
Spray Quality: Fine (F), Medium (M), Coarse (C), Very Coarse (VC), Extremely Coarse (XC). Nozzle Type: TeeJet XR (XR), TeeJet Drift Guard (DG), Turbo TeeJet (TT), Turbo Twinjet (TTJ), Hardi MiniDrift (MD), Hardi INJET (INJ), TeeJet AI (AI), Turbo TeeJet Induction (TTI), TeeJet (AIXR). Nozzle Size: 01, 015, 02, 025, 03. Spray Volume: 40L/ha (40L), 80L/ha (80L).



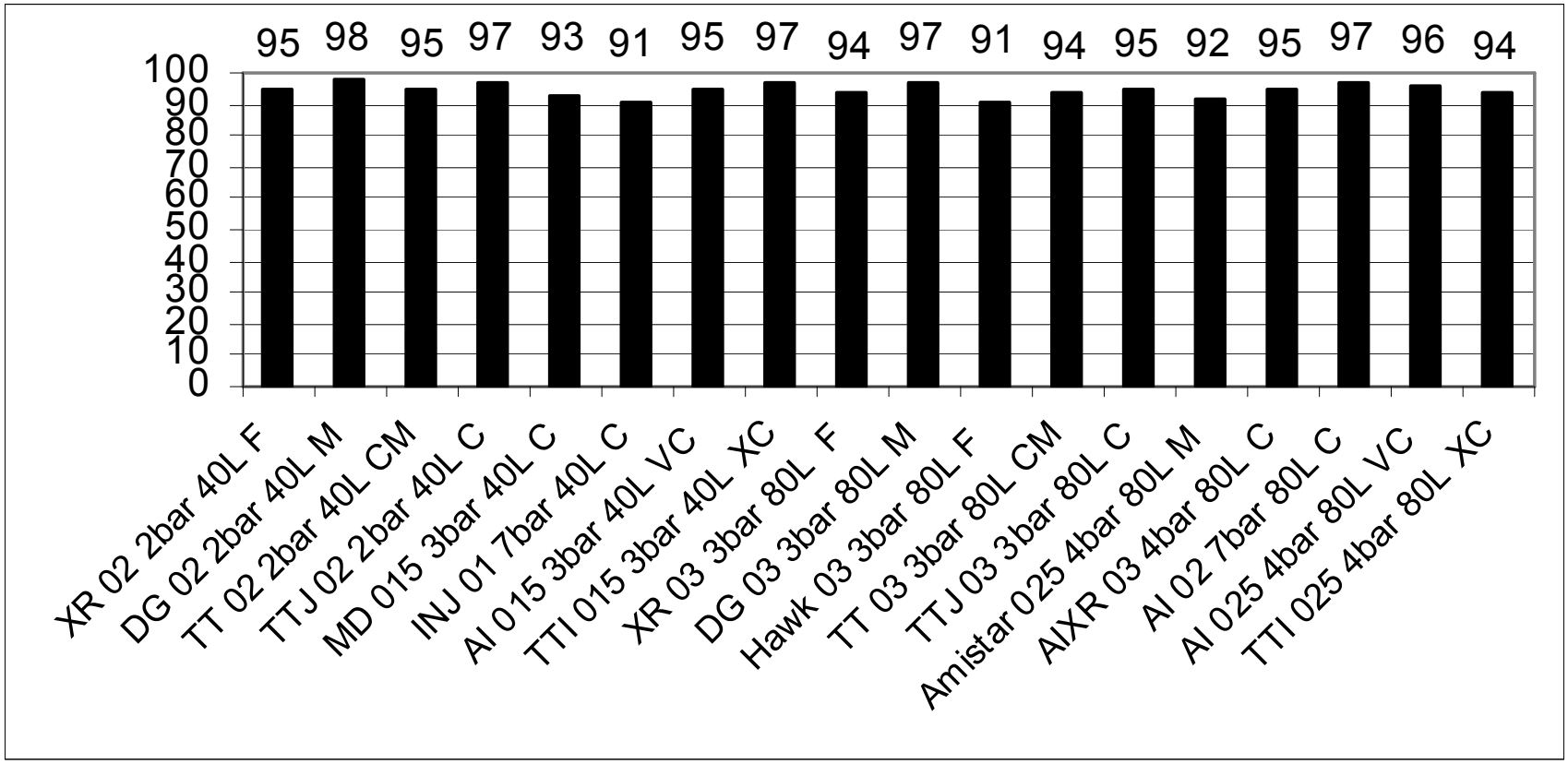
Trial Results presented by Jason Sabeeney of Syngenta at the 2008 GRDC Northern Region Updates (Spray Seed and Axial)

Figure 4: % Annual Ryegrass Control with Spray Seed, 1.2L/ha, 22 DAA, Harcourt, Vic, 2007
Spray Quality: Fine (F), Medium (M), Coarse (C), Very Coarse (VC), Extremely Coarse (XC). Nozzle Type: TeeJet XR (XR), TeeJet Drift Guard (DG), Turbo TeeJet (TT), Turbo Twinjet (TTJ), Hardi MiniDrift (MD), Hardi INJET (INJ), TeeJet AI (AI), Turbo TeeJet Induction (TTI), TeeJet (AIXR). Nozzle Size: 01, 015, 02, 025, 03. Spray Volume: 40L/ha (40L), 80L/ha (80L).



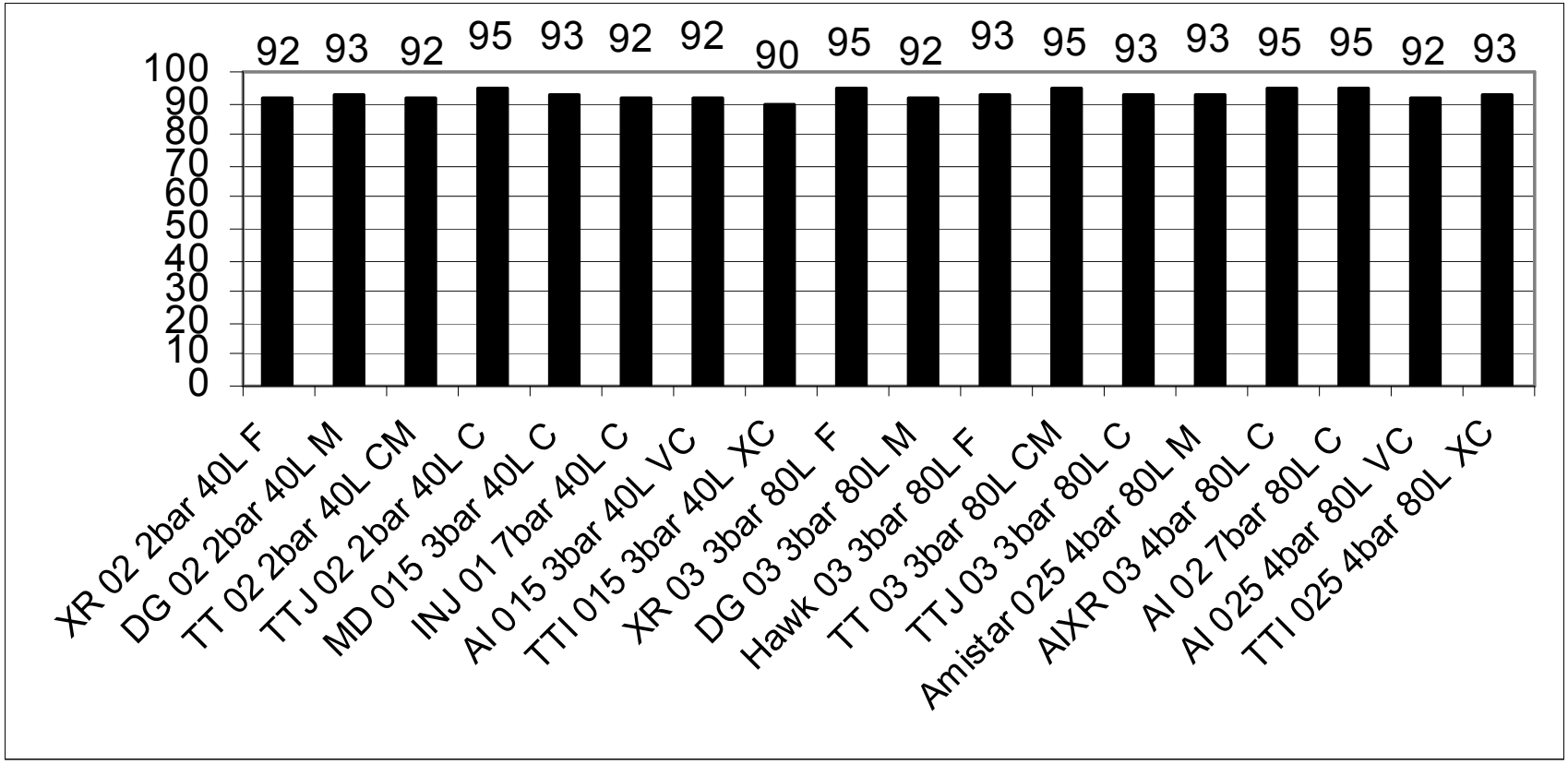
Trial Results presented by Jason Sabeeney of Syngenta at the 2008 GRDC Northern Region Updates (Spray Seed and Axial)

Figure 5: % Annual Ryegrass Control with Axial, 250mL/ha, 70 DAA Paskeville, SA, 2007 Spray Quality: Fine (F), Medium (M), Coarse (C), Very Coarse (VC), Extremely Coarse (XC). Nozzle Type: TeeJet XR (XR), TeeJet Drift Guard (DG), Turbo TeeJet (TT), Turbo Twinjet (TTJ), Hardi MiniDrift (MD), Hardi INJET (INJ), TeeJet AI (AI), Turbo TeeJet Induction (TTI), TeeJet (AIXR). Nozzle Size: 01, 015, 02, 025, 03. Spray Volume: 40L/ha (40L), 80L/ha (80L).



Trial Results presented by Jason Sabeeney of Syngenta at the 2008 GRDC Northern Region Updates (Spray Seed and Axial)

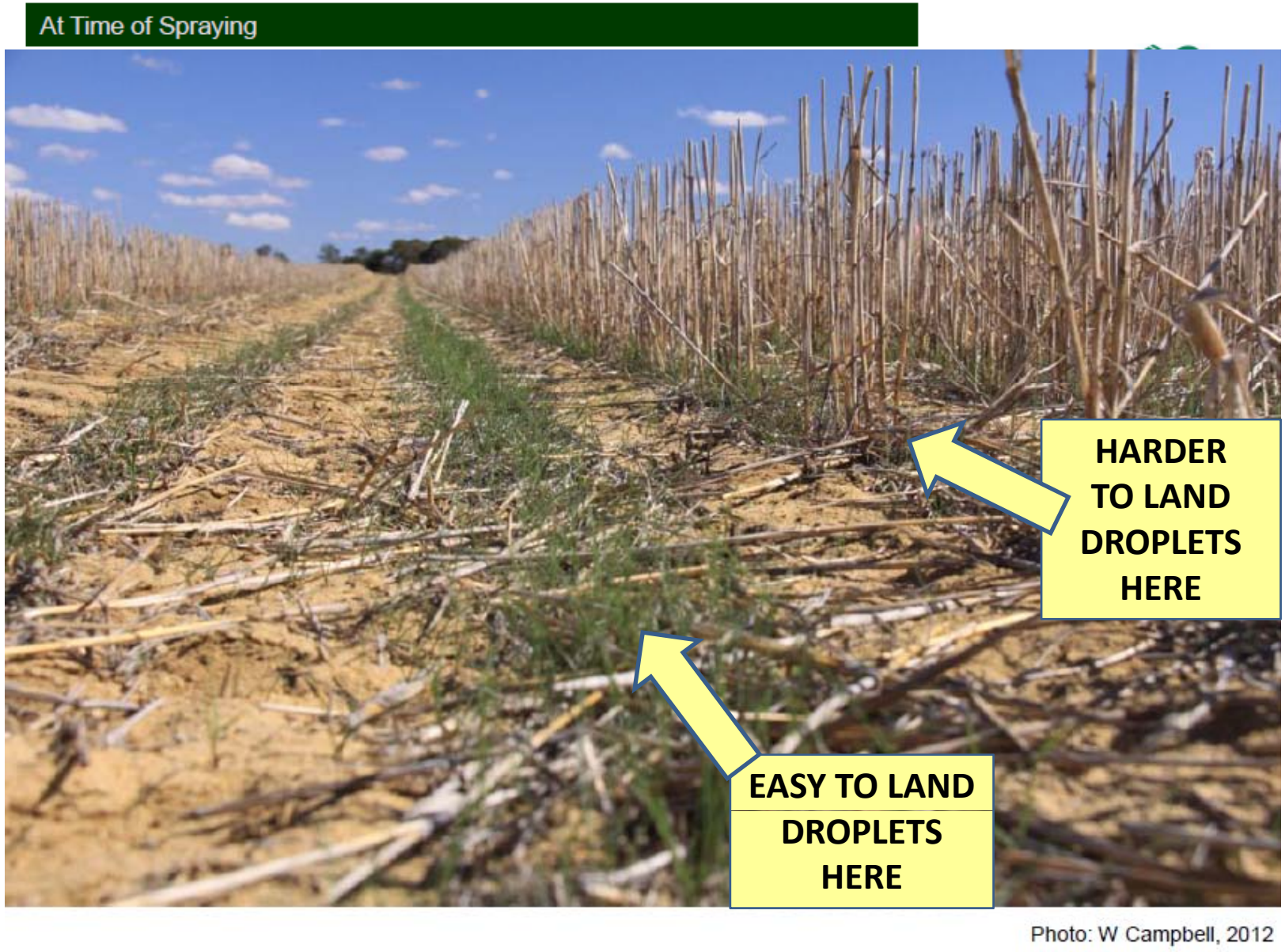
Figure 6: % Annual Ryegrass Control with Axial, 250mL/ha, 56 DAA Harcourt, Vic, 2007
Spray Quality: Fine (F), Medium (M), Coarse (C), Very Coarse (VC), Extremely Coarse (XC).
Nozzle Type: TeeJet XR (XR), TeeJet Drift Guard (DG), Turbo TeeJet (TT), Turbo Twinjet (TTJ), Hardi MiniDrift (MD), Hardi INJET (INJ), TeeJet AI (AI), Turbo TeeJet Induction (TTI), TeeJet (AIXR). Nozzle Size: 01, 015, 02, 025, 03. Spray Volume: 40L/ha (40L), 80L/ha (80L).



Typical Spray Quality and Application Volumes

Typical Application Volume	Medium Spray Quality (lower drift risk areas)	Coarse Spray Quality	Extremely Coarse Spray Quality (higher drift risk areas)
Lower range **50 -60 L/ha** **(Low stubble load)** **to** **70-80 L/ha** **(High stubble load)**	*Only where permitted on label: Fully translocated herbicides Small to medium sized targets.	Fallow Spraying Fully translocated herbicides such as Glyphosate, MCPA. Mandatory for 2,4-D,	Fully translocated herbicides, medium targets, Very sensitive areas or NIGHT SPRAYING
Higher range **70-80 L/ha** **(Low stubble load)** **to** **100 + L/ha** **(High stubble load/ dense crop canopy)**	*Only where permitted on label: Contact type products. Small targets. In crop spraying. Penetration and coverage in large & broadleaf crops.	Good stubble penetration. Pre-emergent's. Fully Translocated herbicides, Some contact herbicides at the higher application volumes.	Pre-emergent's. Medium sized targets with fully translocated summer fallow herbicides. Very sensitive areas or NIGHT SPRAYING

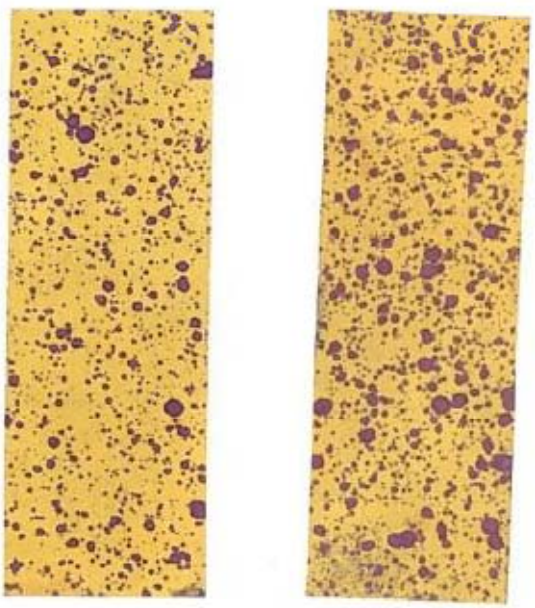
Where do the droplets need to land?



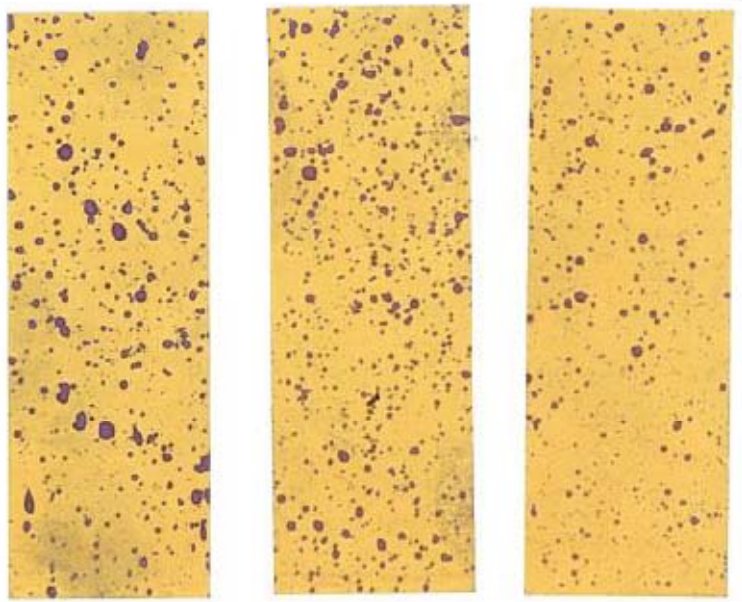
Effect on coverage from stubble- 75 liters Medium-

Dalwallinu May 2012- Knockdown investigation on Ryegrass- Bill Campbell, Nufarm, WA

Agrotop AM 110-01 at 2.2 bar with handboom



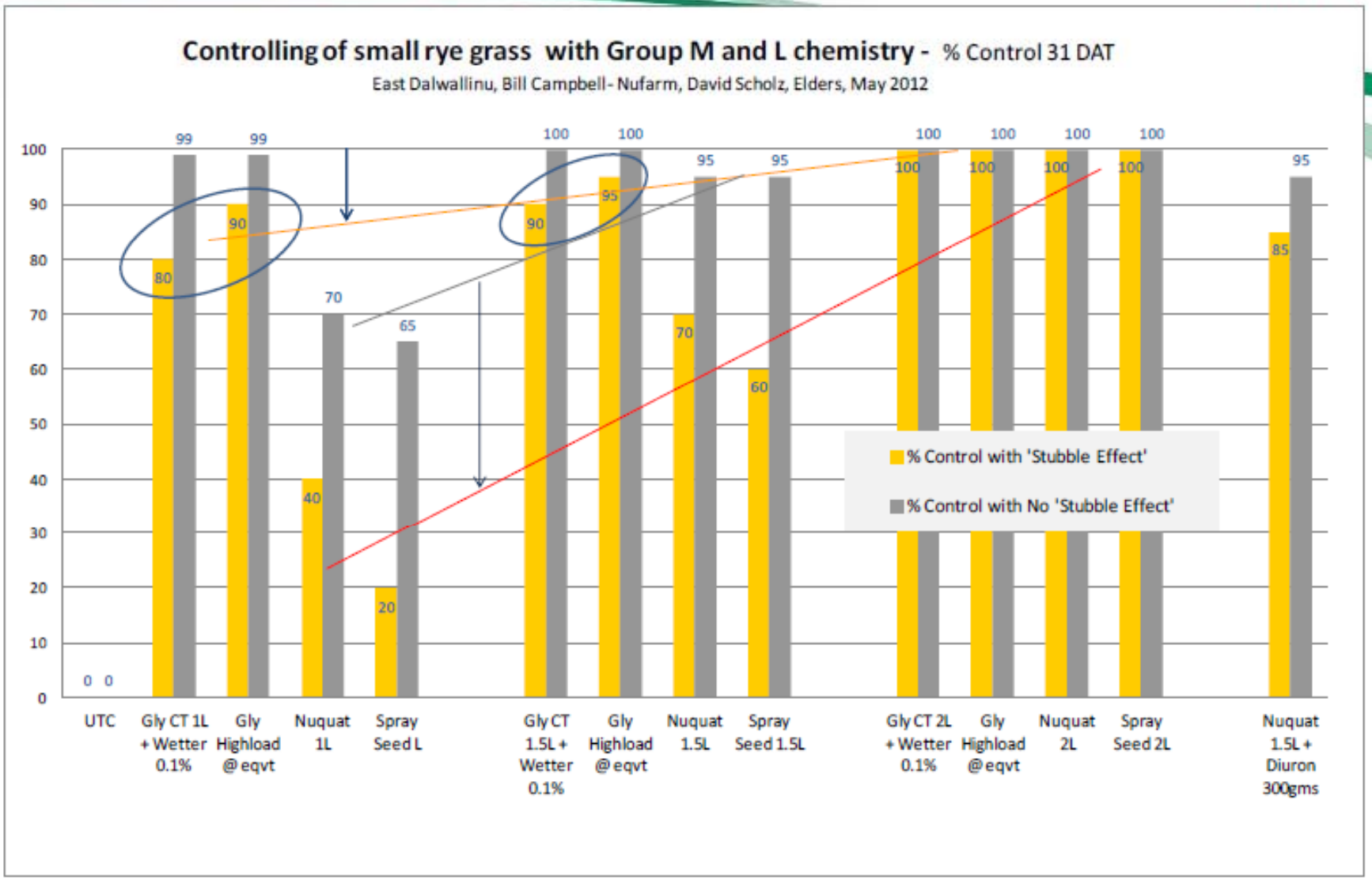
No stubble



Plus stubble

Combined date- with and without stubble effect

May 2012- Knockdown investigation on Ryegrass



Some effects of higher travel speeds and larger droplets on deposition

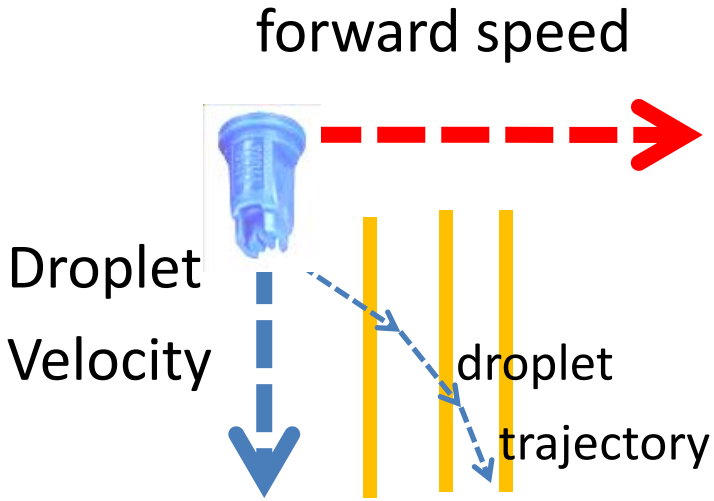
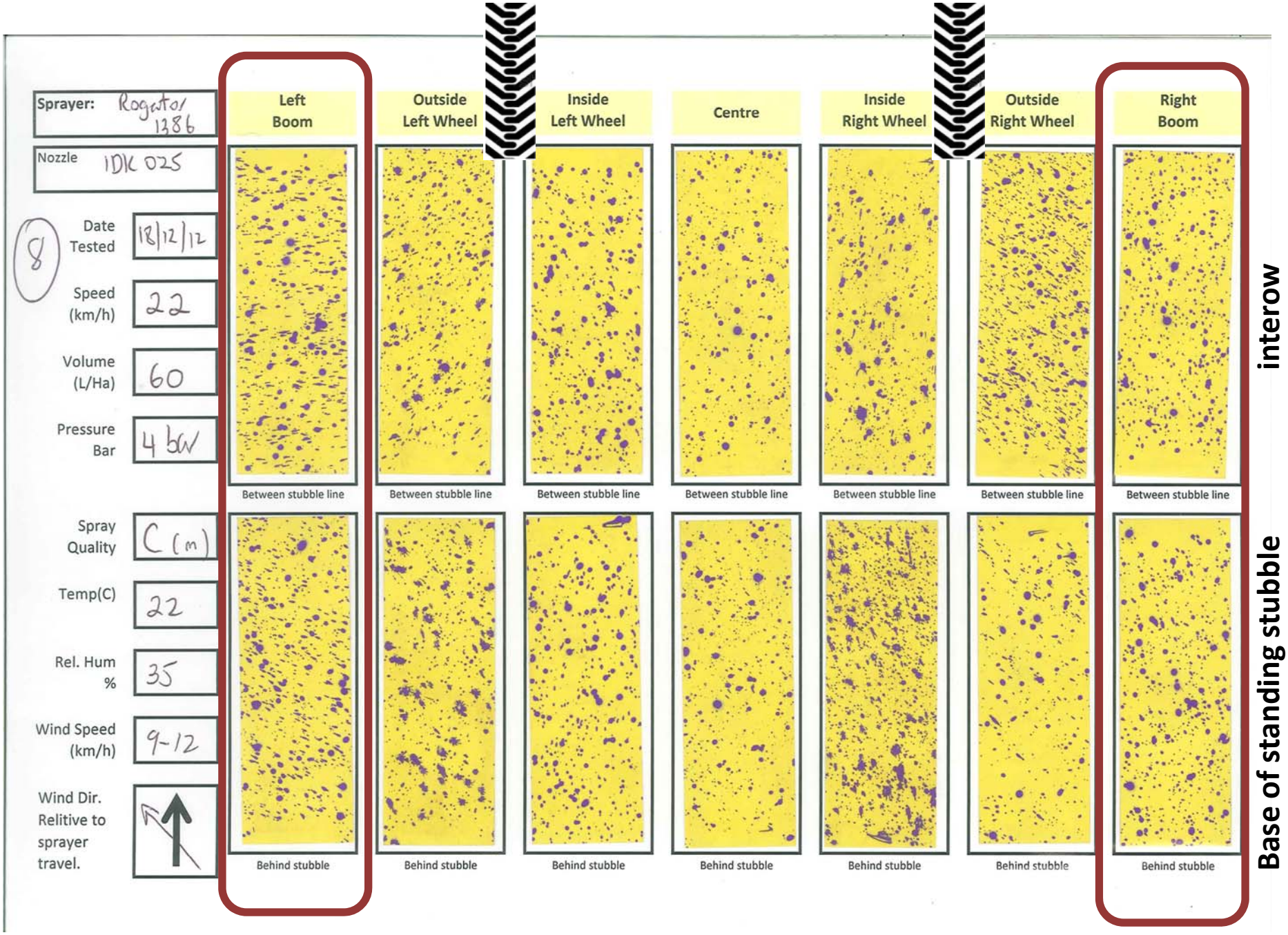
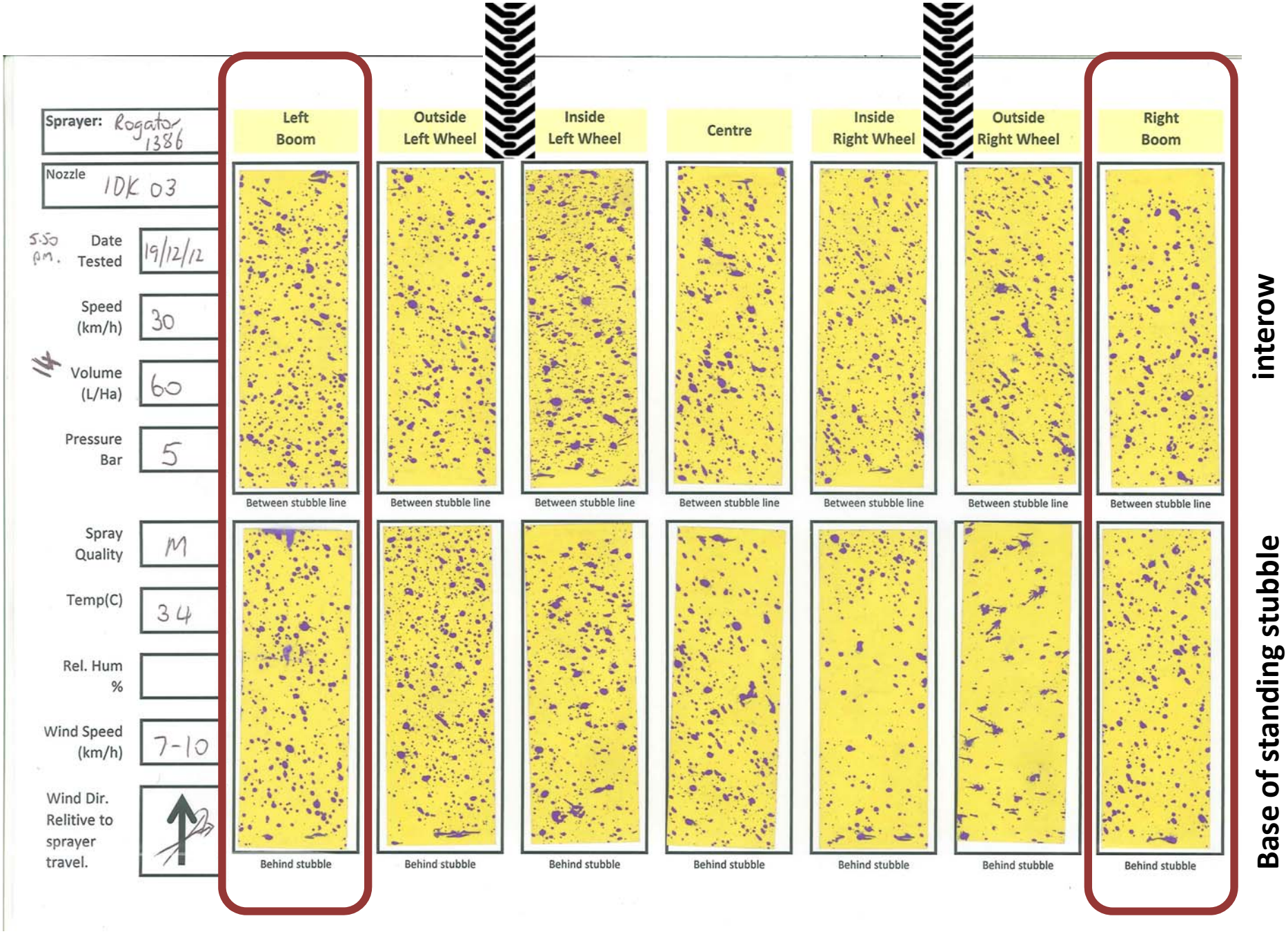
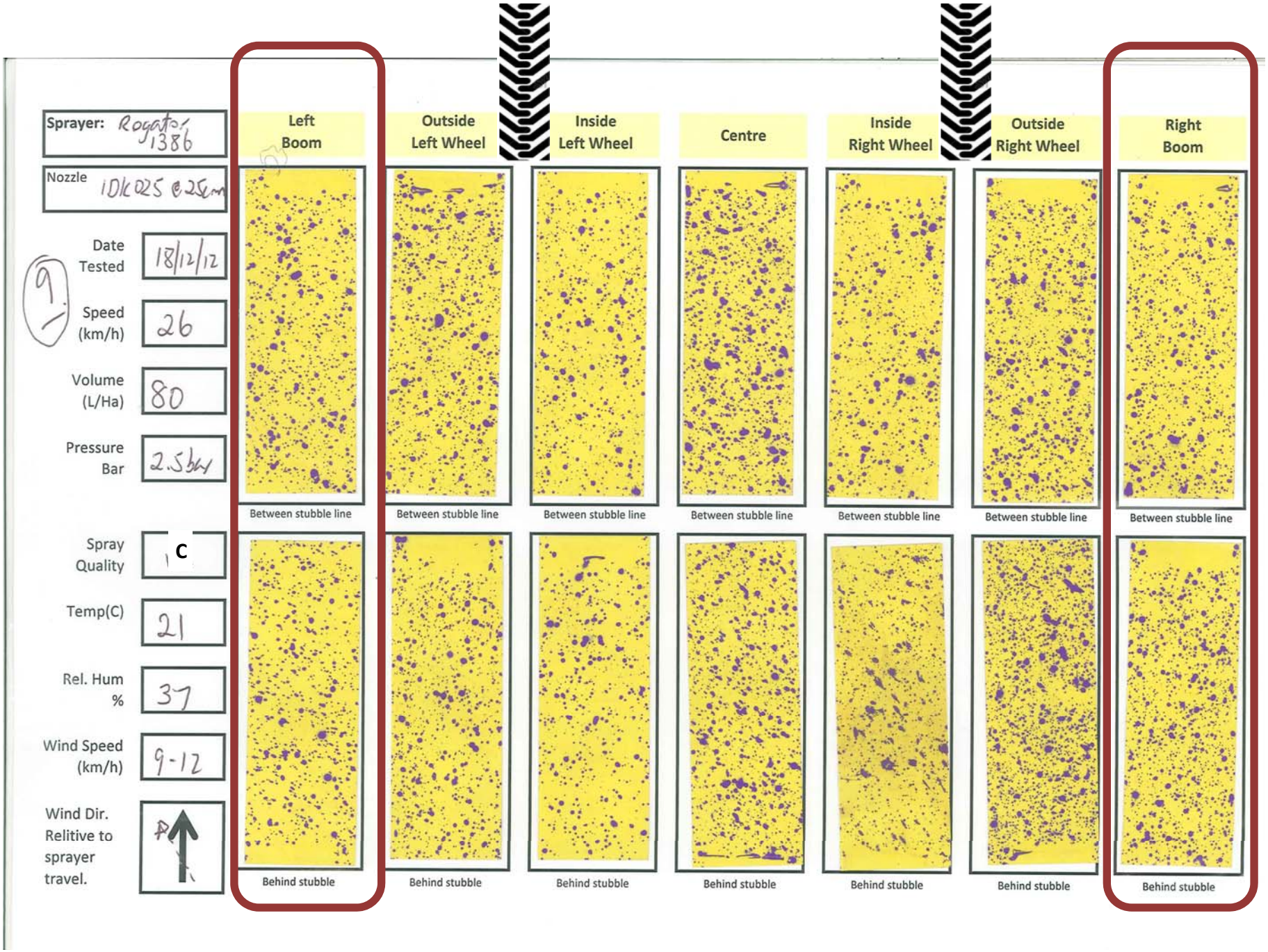


Photo by Simon Rogers (sprayed @ 33 km/h C/VC)

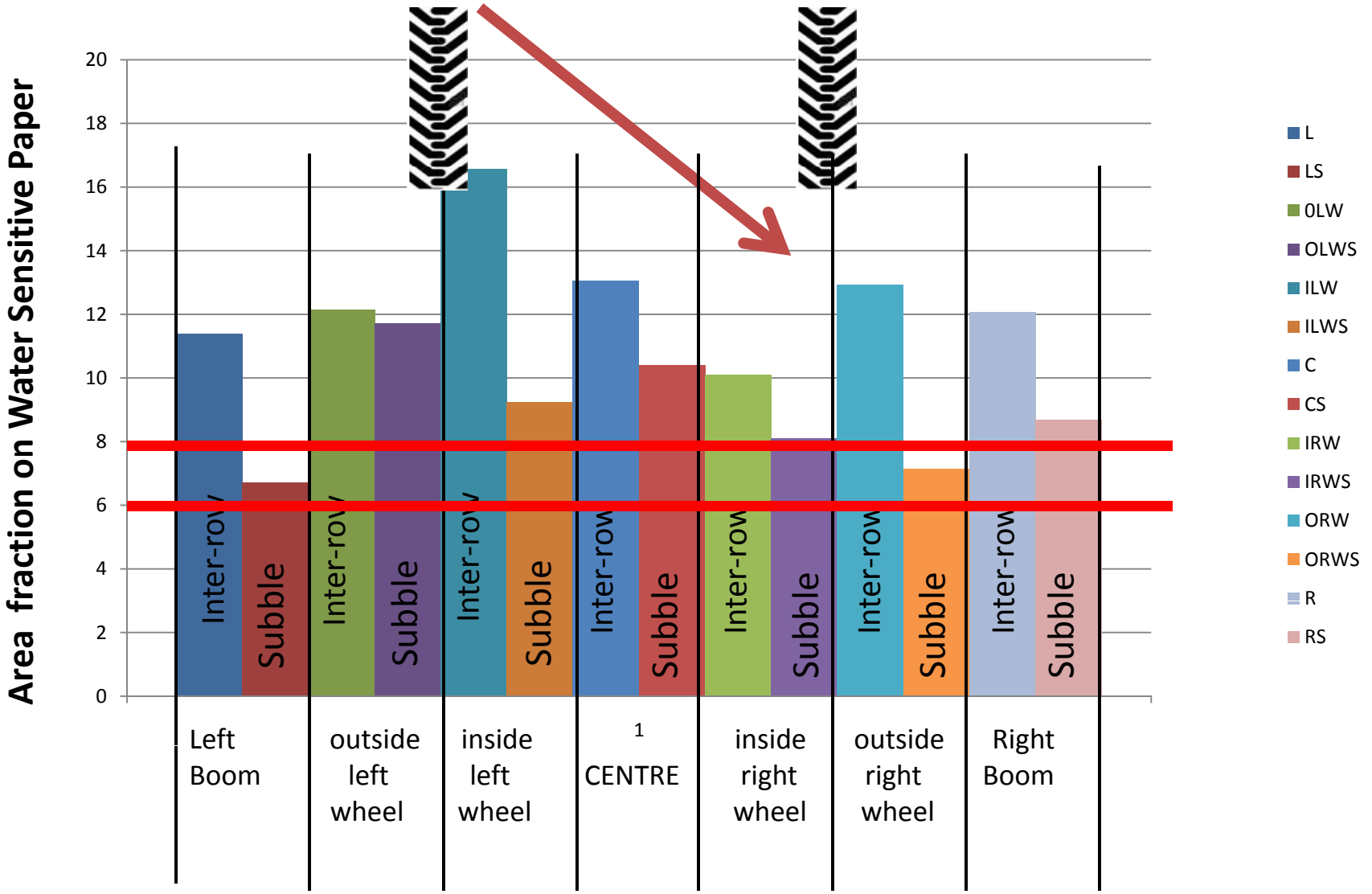
- increased interception by one side of the plants.
- increased shadowing behind standing stubble
- increased dust
- increased displacement of droplets by the tyres


Sprayer: Rogator 1386
Nozzle IDK 025
8
Date Tested 18/12/12
Speed (km/h) 22
Volume (L/Ha) 60
Pressure Bar 4 bar
Spray Quality C (m)
Temp(C) 22
Rel. Hum % 35
Wind Speed (km/h) 9-12
Wind Dir. Relitive to sprayer travel.
Left Boom
Outside Left Wheel
Inside Left Wheel
Centre
Inside Right Wheel
Outside Right Wheel
Right Boom
Between stubble line
Behind stubble
interow
Base of standing stubble

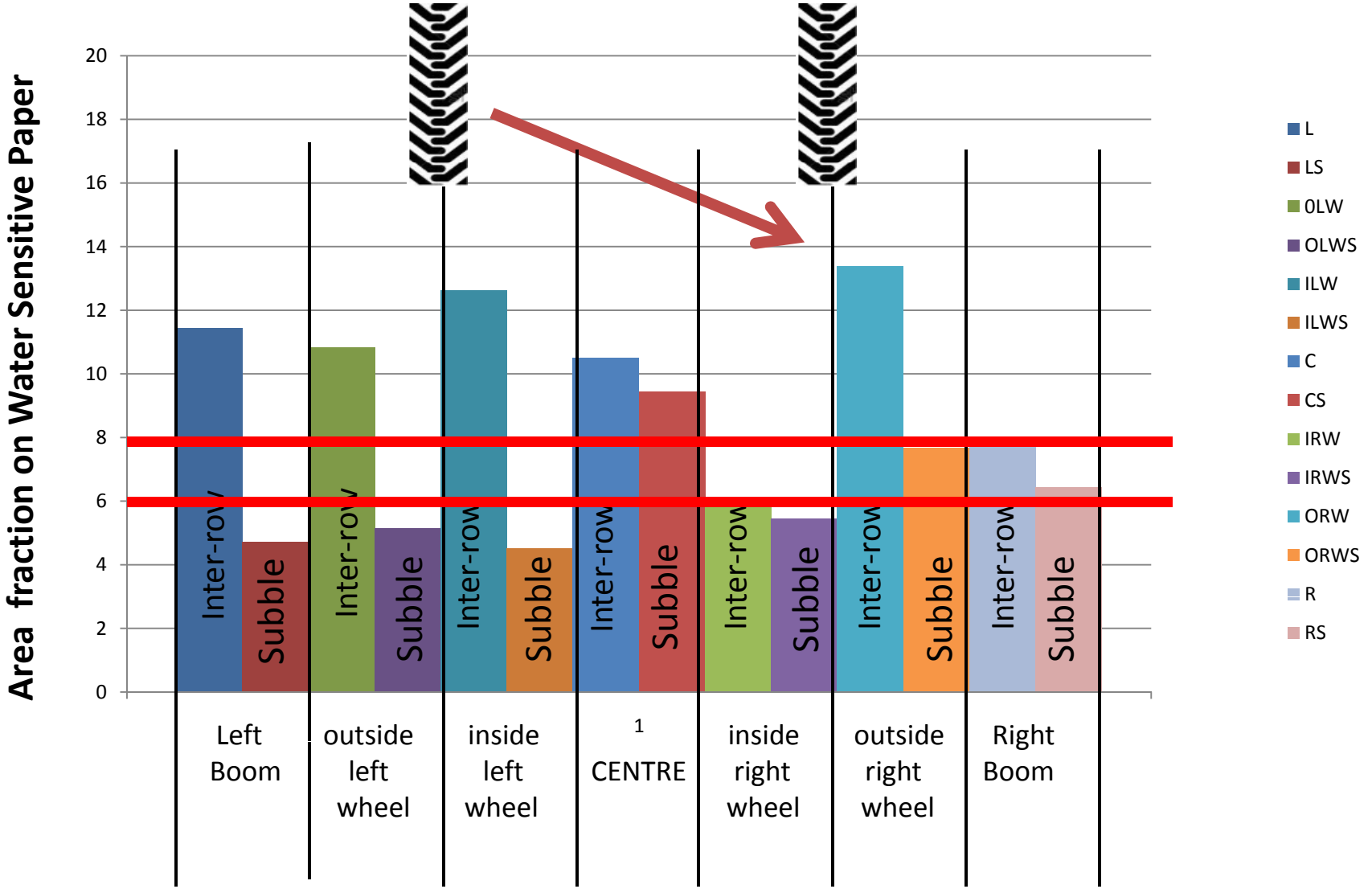

Sprayer: Rogator 1386
Nozzle 1DK 03
5.50 p.m.
Date Tested 19/12/12
Speed (km/h) 30
14
Volume (L/Ha) 60
Pressure Bar 5
Spray Quality M
Temp(C) 34
Rel. Hum %
Wind Speed (km/h) 7-10
Wind Dir. Relitive to sprayer travel.
Left Boom
Outside Left Wheel
Inside Left Wheel
Centre
Inside Right Wheel
Outside Right Wheel
Right Boom
Between stubble line
Behind stubble
interow
Base of standing stubble


Sprayer: Rogator 1386
Nozzle 10K025 @25cm
Date Tested 18/12/12
Speed (km/h) 26
Volume (L/Ha) 80
Pressure Bar 2.5bar
Spray Quality C
Temp(C) 21
Rel. Hum % 37
Wind Speed (km/h) 9-12
Wind Dir. Relitive to sprayer travel.
Left Boom
Outside Left Wheel
Inside Left Wheel
Centre
Inside Right Wheel
Outside Right Wheel
Right Boom
Between stubble line
Behind stubble
interow
Base of standing stubble

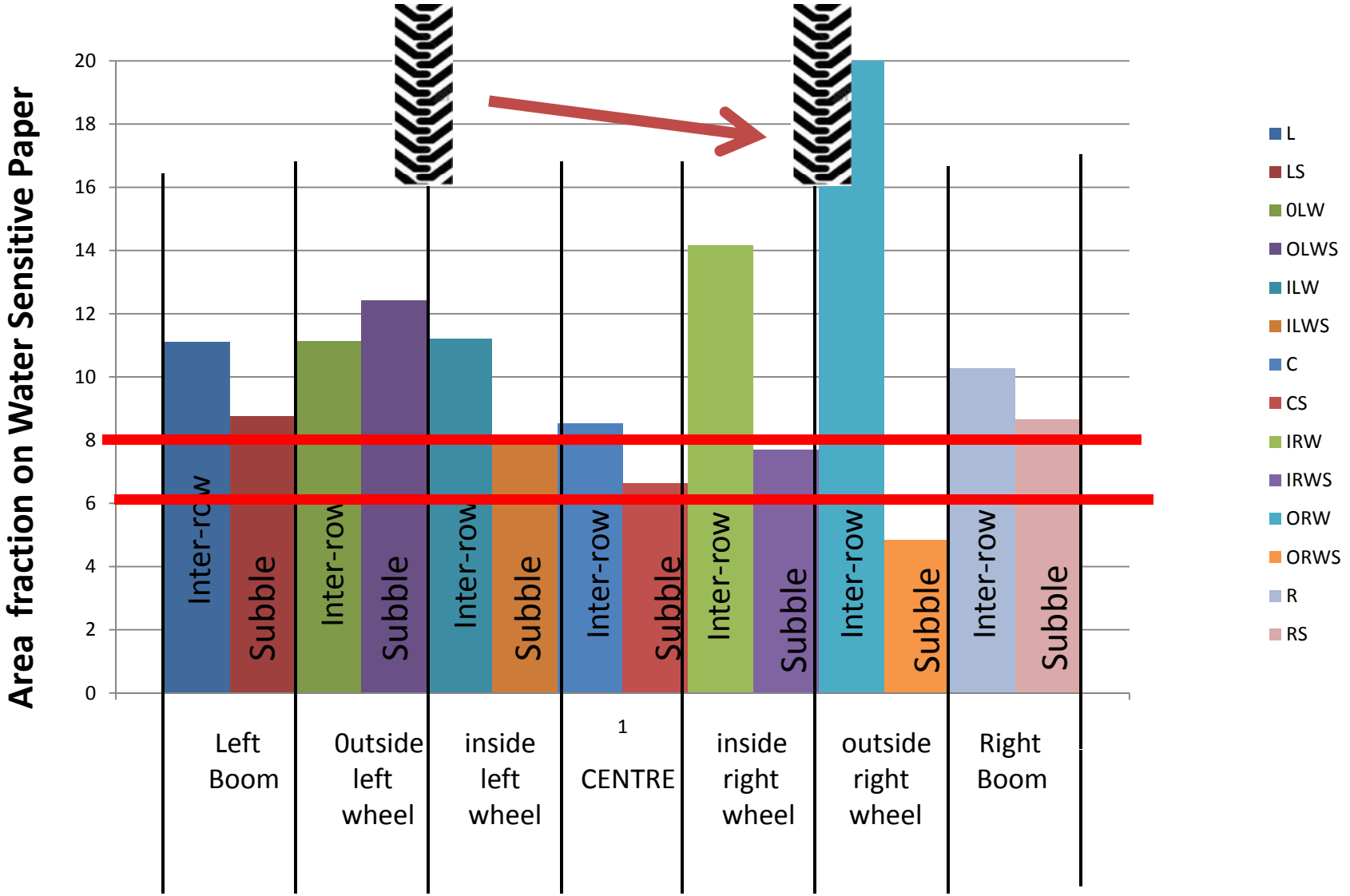
18 km/h, 60 L/ha, 50cm spacing
AIXR 02 @ 4 bar (small end of Coarse)



26 km/h, 60 L/ha, 25cm spacing
AIXR 015 and 02 @ 2.5bar (very coarse)



31 km/h, 60 L/ha, 25cm spacing
AIXR 015 and 02 @ 4 bar (small end of coarse)



Results from a single trial evaluating efficacy in standing stubble

(Awnless Barnyard Grass & other weeds) Narrabri - 2014

North ↑

wind direction at application ↓

Direction of sprayer travel ←

Strip length 166m x 12m

Subsamples 4 m x 25 cm, row spacing 33 cm

Strip 7			UTC				
Strip 6	6	5	TTJ60 025 27 kph	4	3	2	1
Strip 5	6	5	AIXR 025 27 kph	4	3	2	1
Strip 4	6	5	TTI025 27 kph	4	3	2	1
Strip 3	6	5	TTJ60 20 kph	4	3	2	1
Strip 2	6	5	TTI 02 20kph	4	3	2	1
strip 1	6	5	AIXR 02 20 kph	4	3	2	1

Trt No.		Rate	Nozzle Type and size	Application speed	Volume
1	Weedmaster DST	1 L/ha	AIXR02	20 kph	50 L/ha
2	Weedmaster DST	1 L/ha	TTI02	20 kph	50 L/ha
2	Weedmaster DST	1 L/ha	TTJ602	20 kph	50 L/ha
4	Weedmaster DST	1 L/ha	TTI025	27 kph	50 L/ha
5	Weedmaster DST	1 L/ha	AIXR025	27 kph	50 L/ha
6	Weedmaster DST	1 L/ha	TTJ6025	27 kph	50 L/ha
7	Untreated Control	-	-	-	

Efficacy results in stubble

Table 1 Barnyard grass - Counts per m^2 27 DAT - Distance Downwind from Wheel Track

Sampling Zone		% Reduction*
3 m from wheel track	3.9 b	16.5%
50 cm from wheel track	2.4 a	
Centre boom	2.8 a	
Fprob - cov	<.001	
F Prob - Tment	<.001	
LSD	0.755	

* Untreated control omitted from analysis, Percent reduction in efficacy calculated on weed numbers

Table 2 Barnyard grass - Counts per m^2 27 DAT - Nozzle Effect

Nozzles		Nozzles - No UTC		% Reduction
AIXR	2.6 a	AIXR	2.8 a	
TTI	3.7 b	TTI	3.7 b	12.0%
TTJ60	2.4 a	TTJ60	2.5 a	
UTC	3.2 a		*	
		Fprob - cov	<.001	
F Prob - Tment	0.019	F Prob - Tment	0.008	
LSD	1.013	LSD	0.775	

Percent reduction in efficacy calculated on weed numbers

Table 3 Barnyard grass - Counts per m^2 27 DAT - Distance from wheel track x Application Speed Interaction

Sampling Zone	20 kph	% Reduction* 20 kph	27 kph	
3 m from wheel track	4.2 b	26%	Centre boom	3.5 a
50 cm from wheel track	2.1 a		50 cm from tyre	2.7 a
Centre boom	2.1 a		3 m from tyre	3.5 a
Fprob - cov	<.001			
F Prob - Tment	0.02			
LSD	1.071			

* Untreated control omitted from analysis, Percent reduction in efficacy calculated on weed numbers

Table 4 Wireweed - Counts per m^2 27 DAT - Nozzle Effect

Nozzles		% Reduction*
AIXR	0.48 a	
TTI	0.96 b	33%
TTJ60	0.37 a	
Fprob - cov	<.001	
F Prob - Tment	0.012	
LSD	0.41	

* Untreated control omitted from analysis, Percent reduction in efficacy calculated on weed numbers

Table 5 Yellowvine - Counts per m^2 27 DAT - Distance Downwind from Wheel Track

Sampling Zone		% Reduction*
3 m from wheel track	0.426 b	42%
50 cm from wheel track	0.181 ab	29%
Centre boom	0.004 a	
Fprob - cov	<.001	
F Prob - Tment	0.037	
LSD	0.323	

* Untreated control omitted from analysis, Percent reduction in efficacy calculated on weed numbers

Table 6 Total Weeds - Counts per m^2 27 DAT - Nozzle Effect

Nozzles		% Reduction*
AIXR	3.3 a	
TTI	4.8 b	13%
TTJ60	3.8 a	
Fprob - cov	<.001	
F Prob - Tment	<.001	
LSD	0.718	

* Untreated control omitted from analysis, Percent reduction in efficacy calculated on weed numbers

Interactions:

Table 7 Total Weed Population - Counts per m^2 27 DAT - Distance from wheel track x Application Speed Interaction

sampling zone.speed	20 kph	% Reduction*	27 kph	% Reduction
3 m from tyre	4.7 b	10%	3.2 a	
50 cm from tyre	4.1 a		4.1 a	
Centre boom	3.5 a		4.3 b	9.4%
Fprob - cov	<.001			
F Prob - Tment	0.007			
LSD	1.005			

* Untreated control omitted from analysis, Percent reduction in efficacy calculated on weed numbers

Table 8 Total Weed Population - Counts per m^2 27 DAT - Speed x Nozzle Interaction

speed.nozzle	AIXR	TTI	TTJ60	% Reduction
20 kph	3.0 a	4.9 a	4.4 b	16%
27 kph	3.6 a	4.8 a	3.2 a	
Fprob - cov	<.001			
F Prob - Tment	0.047			
LSD	1.014			

Notes: Means followed by the same letter do not significantly differ (P > 0.05). Only significant results are presented. Percent reduction in control is relative to the best result and is calculated using the difference between the best and worst value divided by the total.

- Wake effect

APRIL 2018

GRDC
Grains Research & Development Corporation
Your GRDC working with you

WEED CONTROL IN WHEEL TRACKS
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

IMPROVING WEED CONTROL IN WHEEL TRACKS DURING SUMMER FALLOW SPRAYING

KEY POINTS

- Poor control of weeds in the sprayer's wheel tracks and the adjacent areas during summer fallow applications can be the result of poor spray deposition, excessive dust or a combination of the two.
- Using additional wheel track nozzles for knock down herbicides (non-residual) can improve deposition and the level of control in the wheel tracks and adjacent areas
- Generally, dust is only reduced when soil moisture is present, speed is reduced or more permanent wheel tracks are used.

Reduced travel speeds will generally decrease the level of dust raised by the sprayer to increase spray performance.

Factors contributing to a reduced level of weed control in the wheel tracks

Poor weed control in the wheel tracks of the sprayer can result from a number of factors, such as those below, which often interact with each other.

- The additional stress placed on the weeds due to the physical damage to the plant that occurs when they are run over. This leads to poorer uptake and translocation of many products.
- Poor deposition of spray resulting from droplets being pushed away from the wheel track by air displaced by the sprayer's tyres. This effect increases with increased travel speed, wider tyres and more aggressive lug patterns.
- Increased dust produced by higher travel speeds and dry soil can interact with many products on the leaf surface (such as glyphosate and paraquat), potentially reducing their efficacy.

These factors should not be confused with secondary germinations of weeds that may occur shortly after the application.

Secondary germinations occur as a result of increased contact between the soil and the weed seed when the weight on the sprayer's tyres acts to produce a 'press wheel' effect on the soil.

Careful monitoring of weed germinations after an application, particularly in the wheel track, is required to determine if this is contributing to apparent poor control.

Timing of sprays and drift potential

It is common for many spray operators who have problems with dust during summer fallow spraying to spray when the wind speed is low and the soil surface is moist. Spraying after a rainfall event, provided the target weeds are not too wet, can result in excellent weed control.

However, many applicators also make applications during periods of low wind speed immediately after an early morning dew event and after a clear night. Unfortunately this is also a time where there is a very high risk that a surface

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | T +61 2 6166 4500 | F +61 2 6166 4599 | E grdc@grdc.com.au | W www.grdc.com.au

What can improve deposition around the wheels?

- Higher clearance sprayers
- Front mounted booms (up to 22 km/h)
- Wheel track Nozzles (for knockdowns)
- Narrower nozzle spacing (25cm vs 50cm), at least adjacent to the wheels
- Higher Application Volumes
- Slower travel speeds
- Mud guards & tread patterns?

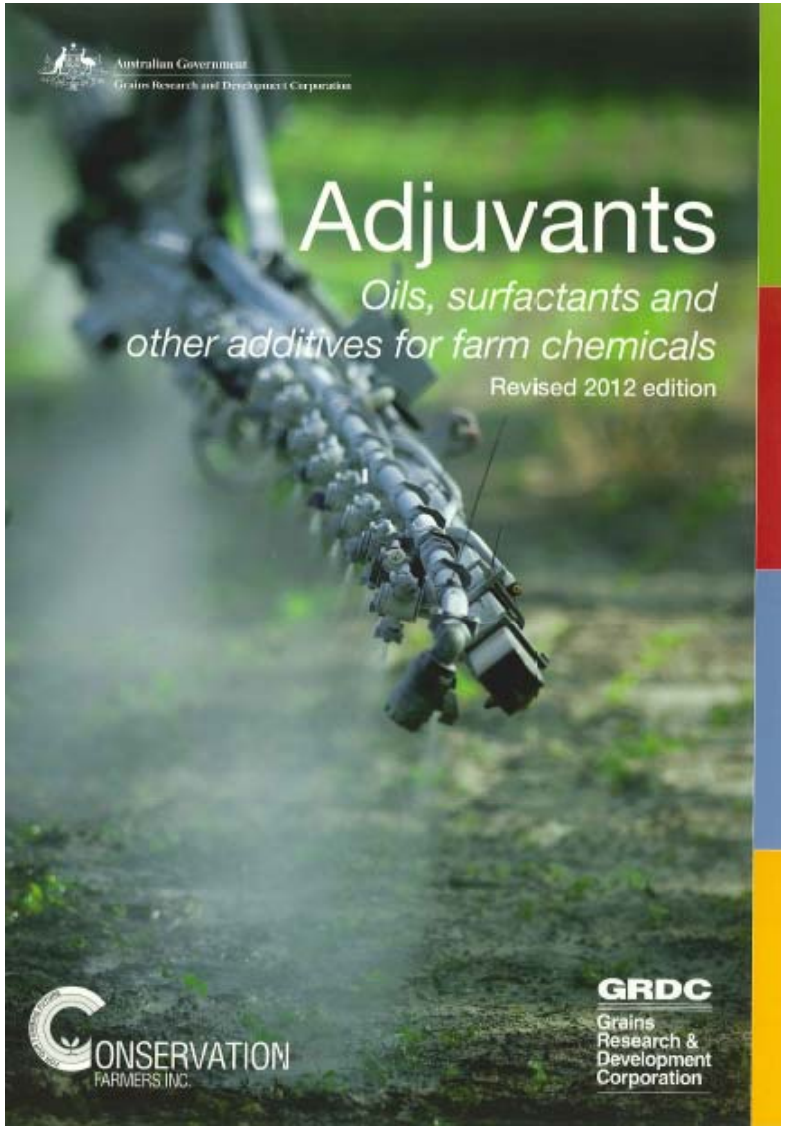
What can improve droplet deposition into standing stubble ?

- A cross wind (wind direction is a big factor)
- Nozzles at the smaller end of the Coarse spectrum
- Narrower nozzle spacing (25cm vs 50cm)
- Higher water rates (>60L/ha, 80L/ha better!)
- Minimising boom height (but must be at least double overlap)
- Slower travel speeds

Other things to consider

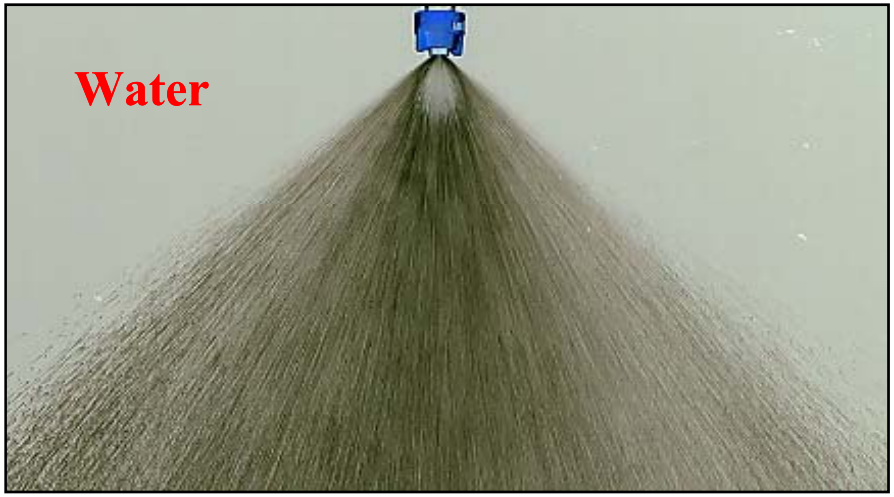
When selecting your nozzles and products, especially ***adjuvants***

...think about the impact that may have on the droplet size and drift potential?



Adjuvants / Formulation affect Spray Uniformity

& droplet size by changing the sheet

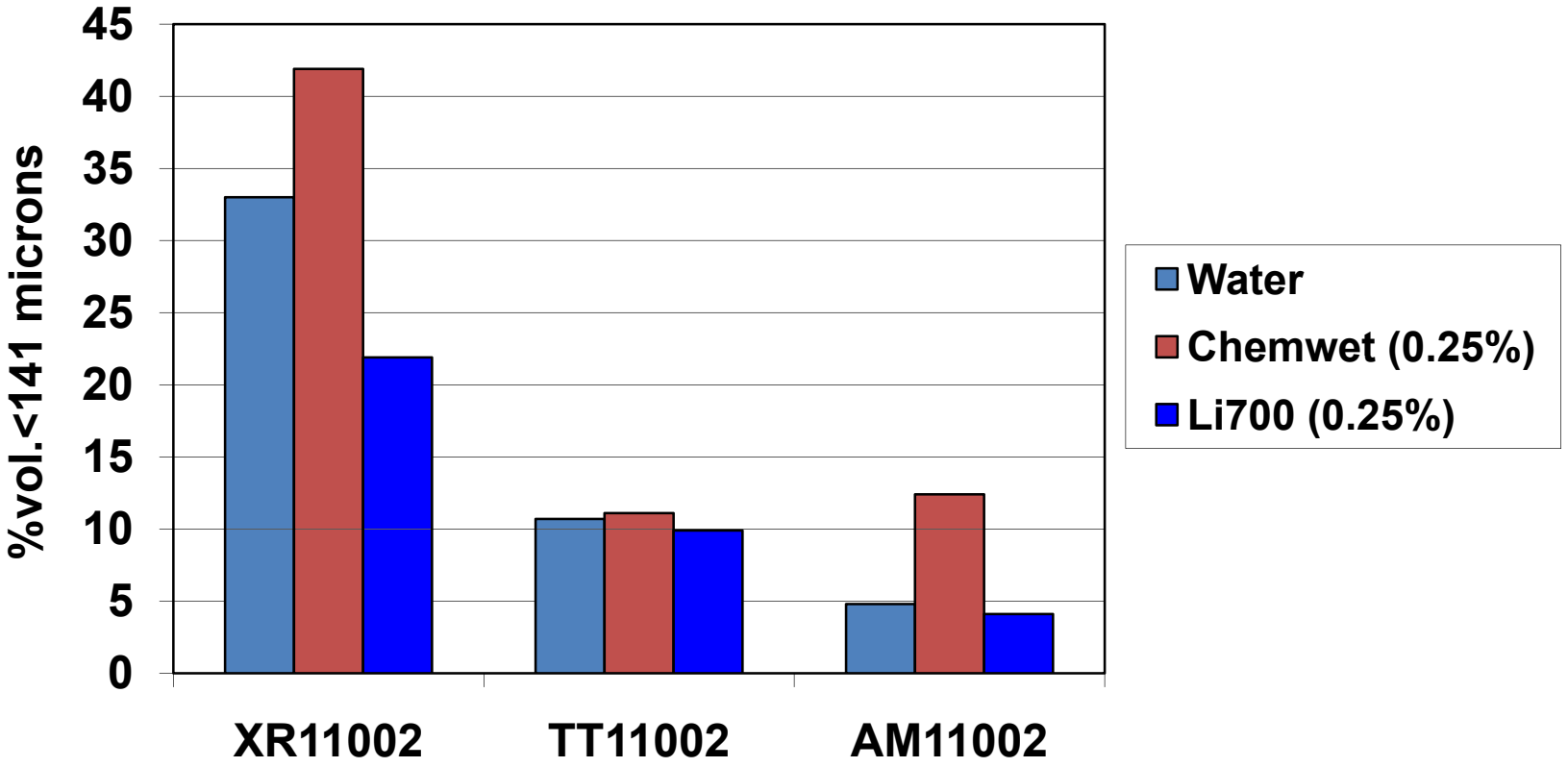


Source : FRI, New Zealand

Adjuvants - effect on spray quality

What is the key message on this graph ?

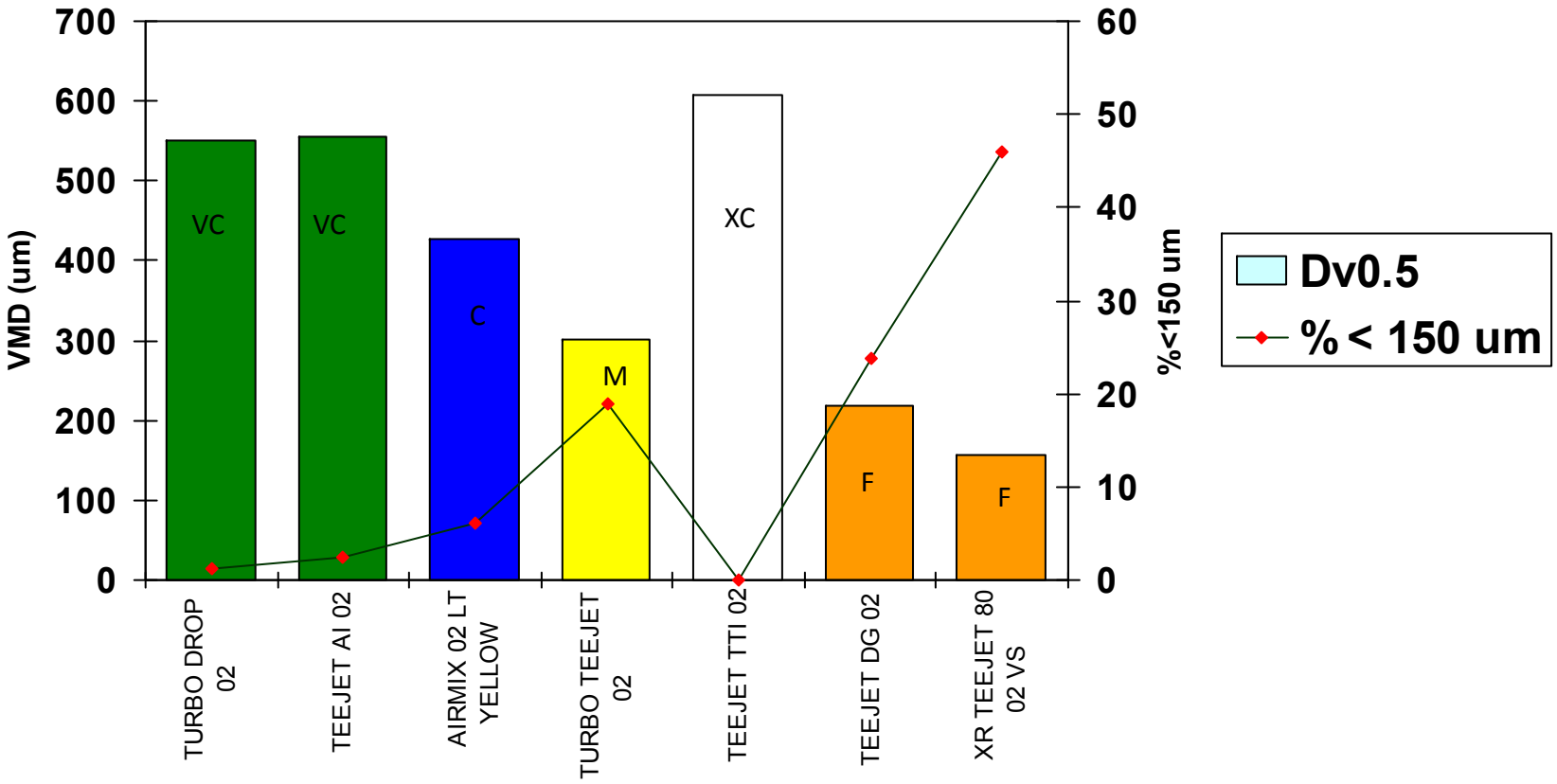
Ground application – 20 km/h, 200 kPa Water + adjuvants



Source : Droplet Spectrum Analysis conducted for Nufarm by CPAS, 2003

Nozzle selection with 2,4 D – low pressure

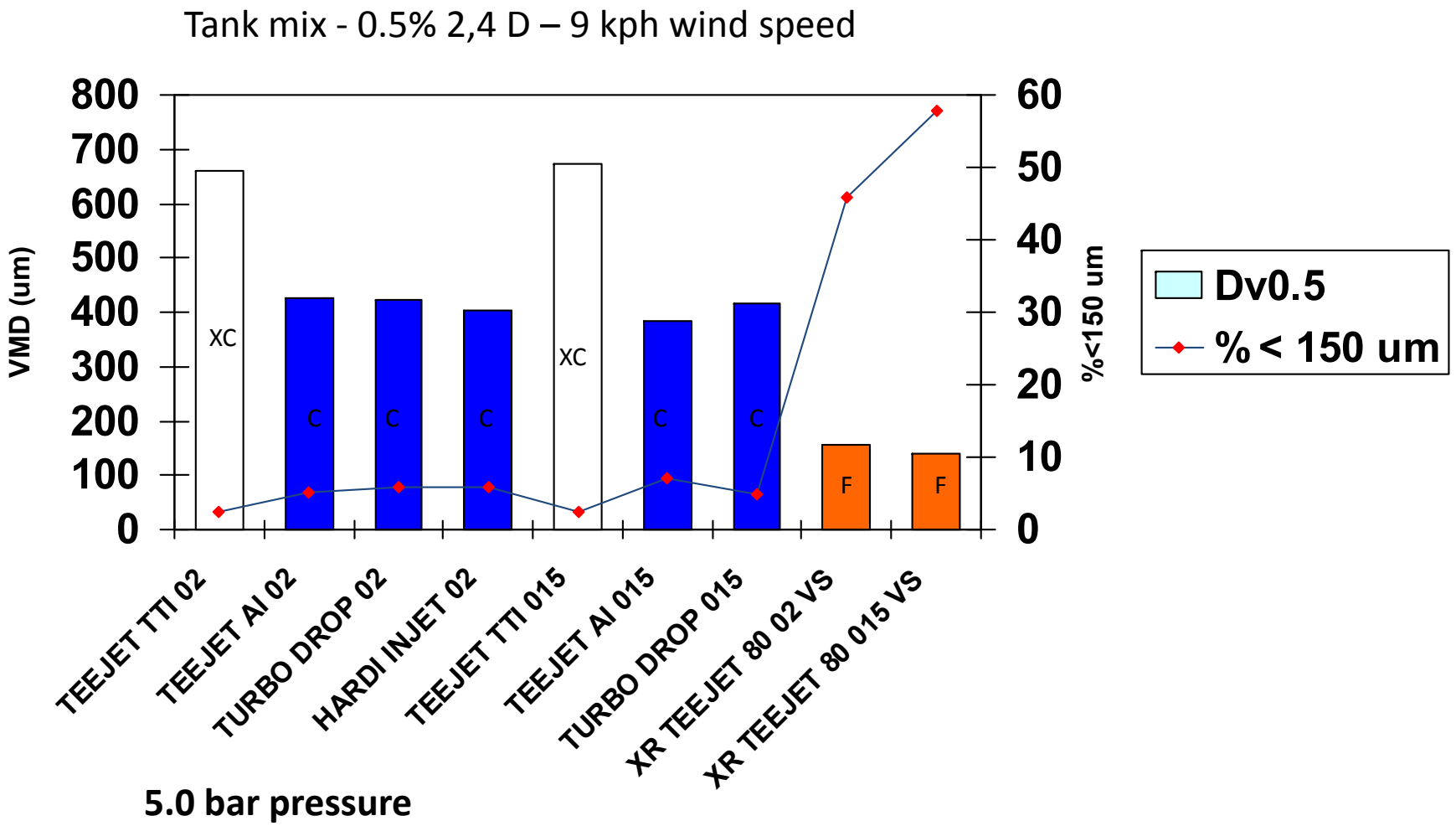
Tank mix - 0.5% 2,4 D – 9 kph wind speed



2.75 bar pressure

Source : C-PAS GRDC Project UQ 00032

Nozzle selection with 2,4 D – high pressure



Source : C-PAS GRDC Project UQ 00032

Water quality and Adjuvants

- pH (solubility, alkaline hydrolysis, stability)
- Hardness
  (Calcium, Magnesium, Bicarbonates)
- Turbidity (suspended solids)
- Salt (EC)
- Temperature

MARCH 2012

GRDC Grains Research & Development Corporation

SPRAY WATER QUALITY
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

WATER QUALITY FOR SPRAYING OPERATIONS

KEY POINTS

- Poor water quality can adversely affect many products. Always consult product labels and the manufacturer's technical information about water quality requirements.
- Water testing should be done on a regular basis when using bore water, water from streams and rivers, reticulated (piped) water sourced from ground water, and water stored in unlined dams or concrete tanks.
- Water tests should analyse the following to be useful: pH, total hardness (including a measure of bi-carbonate levels) and total dissolved salts (TDS) or salinity (electrical conductivity).

Water quality test strips can be used to assess pH and water hardness in the field.

Why test water quality?

The quality of the water used for spraying operations can be critical to ensuring the best spray results for many farm chemicals. Many products can be affected by poor water quality.

When considering if the water quality is suitable for a particular product, you need to have accurate information about what may be present in the water that could affect the products you intend using.

The starting point should always be an accurate water test from a reputable laboratory and a thorough check of the product label and technical information from the manufacturer.

What should tests measure?

Water tests for spraying operations should include:

- pH;
- total hardness;
- bicarbonate levels; and
- either total dissolved salts (TDS) or salinity (EC or electrical conductivity.

While pH levels and total hardness can be assessed in the field using water test strips or simple titrations (jar tests), other measurements will typically require laboratory analysis.

If using test strips it may be useful to compare laboratory results to test strip results by wetting extra water collected for analysis to check the accuracy of the strips. The strips can then be used to assess if significant changes in water quality have occurred and when another laboratory test may be required.

Commonly available water test strips include those supplied by Hach Pty Ltd (ranging from simple pool test strips to more accurate individual test strips and titration kits) or individual pH and hardness test strips supplied by Rowe Scientific Pty Ltd.

Typically, these will be able to measure hardness or pH at varying levels of precision depending on the type of strips purchased. It is worth researching which may best suit your situation after receiving results from a laboratory.

pH

- pH is a Logarithmic scale (10 x between units)

Acid 1 2 3 4 5 6 7 8 9 10 11 12 13 14 Alkaline

Unstable
Tank Mixes

neutral

Alkaline Hydrolysis
changes solubility
Poor droplet contact angle

- High pH's, due to the increased solubility of some salts tends to make problems with hardness even worse.

Water hardness

- Mainly due to the presence of Calcium and Magnesium in the water, these are positively charged ions (cations)

+ Ca + + Mg +

- many products, like glyphosate are negatively charged and will bind with the cations.

- Gly -

MARCH 2012

GRDC Grains Research & Development Corporation

SPRAY WATER QUALITY
FACT SHEET

NORTHERN, SOUTHERN AND WESTERN REGIONS

WATER QUALITY FOR SPRAYING OPERATIONS

KEY POINTS

- Poor water quality can adversely affect many products. Always consult product labels and the manufacturer's technical information about water quality requirements.
- Water testing should be done on a regular basis when using bore water, water from streams and rivers, reticulated (piped) water sourced from ground water, and water stored in unlined dams or concrete tanks.
- Water tests should analyse the following to be useful: pH, total hardness (including a measure of bi-carbonate levels) and total dissolved salts (TDS) or salinity (electrical conductivity).

Water quality test strips can be used to assess pH and water hardness in the field.

Why test water quality?

The quality of the water used for spraying operations can be critical to ensuring the best spray results for many farm chemicals. Many products can be affected by poor water quality.

When considering if the water quality is suitable for a particular product, you need to have accurate information about what may be present in the water that could affect the products you intend using.

The starting point should always be an accurate water test from a reputable laboratory and a thorough check of the product label and technical information from the manufacturer.

What should tests measure?

Water tests for spraying operations should include:

- pH;
- total hardness;
- bicarbonate levels; and
- either total dissolved salts (TDS) or salinity (EC or electrical conductivity).

While pH levels and total hardness can be assessed in the field using water test strips or simple titrations (jar tests), other measurements will typically require laboratory analysis.

If using test strips it may be useful to compare laboratory results to test strip results by wetting wide water collected for analysis to check the accuracy of the strips. The strips can then be used to assess if significant changes in water quality have occurred and when another laboratory test may be required.

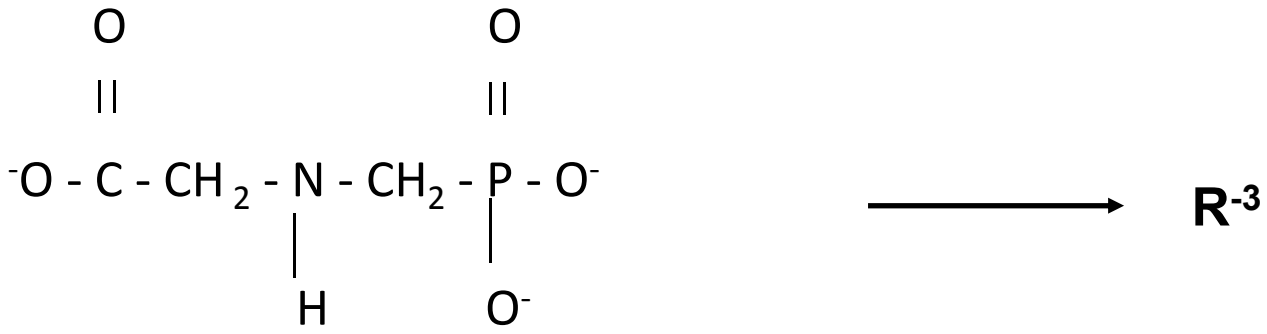
Commonly available water test strips include those supplied by Hach Pty Ltd (ranging from simple pool test strips to more accurate individual test strips and titration kits) or individual pH and hardness test strips supplied by Rowe Scientific Pty Ltd.

Typically, these will be able to measure hardness or pH at varying levels of precision depending on the type of strips purchased. It is worth researching which may best suit your situation after receiving results from a laboratory.

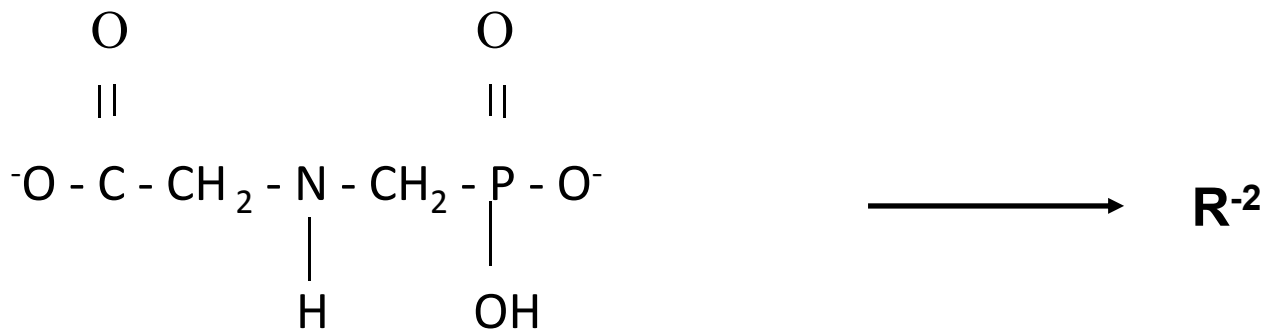
GLYPHOSATE RESPONSE TO DECREASING THE pH OF THE SPRAY SOLUTION

Disassociation States

At pH 8 - 12, net charge: -3



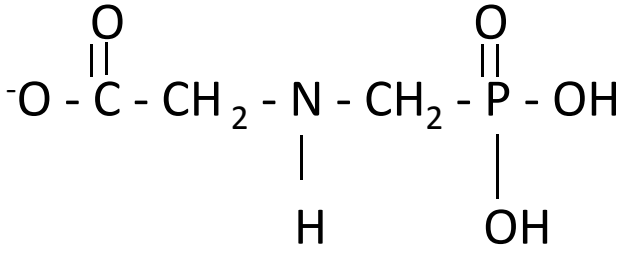
At pH 4 - 8, net charge: -2



GLYPHOSATE RESPONSE TO DECREASING THE pH OF THE SPRAY SOLUTION

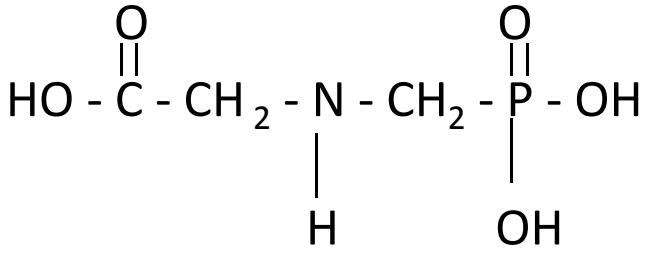
Dissociation State, continued

At pH 2.3 - 4, net charge: -1



R^{-1}

Extremely low pH (<2), net charge: 0



R^{0}

Nozzle Selection

GRDC Grains Research & Development Corporation
Your GRDC working with you

NOZZLE SELECTION GUIDE

GRDC Grains Research & Development Corporation
Your GRDC working with you

Brand	Extended Range Fans			Pre-Orifice (RUN ABOVE 1.5-2 BAR)							Low Pressure Air Induction (RUN ABOVE 2-3 BAR)											High Pressure Air Induction (RUN ABOVE 3-4 BAR)						
MODEL	Teejet XR-110	Hardi F-110	Teejet XR-80	Teejet DGTJ60 twinjet	Teejet DG-110	Lechler AD-110	Albuz ADI-110	Hardi LD-110	Teejet TT-110	Teejet TTJ-60	Lechler IDKT twinjet	Hypro/ Spray-master Drift Bota / ULD	Agrotop Airmix	Albuz CVI	Lechler IDK-120	Hardi Miniddrift-DUO twinjet	Hardi Miniddrift	Hypro Gaurdian Air	Hypro Gaurdian Twin Air	Bolle-rissy bubble-jet	Teejet ADR	ARAG SFA	Lechler ID	Teejet AITTJ60 twinjet	Albuz AVI	Agrotop Turbo-drop TD	Hardi Injet	Teejet AI	TeeJet TTI
Nozzle Size / BAR																												
1.5	F	F	F					M	C		1.5																	
2.0	F	F	F				M	M	M		2.0		M		C					VC		VC	2.0						
3.0	F	F	F	not available in this size	not available in this size	not available in this size	M	M	F	not available in this size	3.0	not available in this size	M	not available in this size	C	not available in this size	not available in this size	not available in this size	not available in this size	C	not available in this size	C	3.0	C	not available in this size	VC		VC	not available in this size	not available in this size
01 Orange 4.0	VF	F	F				F	M	F		4.0		F		M					C		C	4.0	C		C	data not available	VC		
5.0		F						F	F		5.0		F		M					C		C	5.0	C		C		VC		
6.0									F		6.0		F		F					C			6.0	C		C		C		
7.0											7.0									M			7.0	M		C		C		
8.0											8.0												8.0	M		C		C		
1.5	F	M	M			M		M	C		1.5				C			C	XC		VC		1.5						
2.0	F	F	M	F	M	M	M	M	M		2.0		C	XC	C	C		C	VC	XC	C	VC	2.0						UC	UC
3.0	F	F	F	F	M	M	M	M	M	not available in this size	3.0	not available in this size	C	C	C	C	not available in this size	C	C	C	C	C	3.0	VC	not available in this size	VC		VC	XC	UC
015 GREEN 4.0	F	F	F	F	M	M	M	M	M		4.0		M	C	C	M		M	M	not available in this size	C	C	4.0	C		C	C	VC	XC	XC
5.0		F			F	F	F	M	F		5.0		M	C	C	M		M	M		C	M	C	5.0	C		C	C	VC	XC	XC
6.0					F				F		6.0		M	M		F		M			C	M		6.0	C		C	C	VC	VC	XC
7.0											7.0		F					M			C			7.0	C		C	C	VC	C	XC
8.0											8.0		F					M						8.0	M		C	C	C	C	
1.5	F	M	M			C		M	C	C	1.5	XC				VC	VC	VC	XC		XC	XC		1.5		XC					UC
2.0	F	M	M	M	M	M	M	M	C	C	2.0	VC	C	C	C	C	C	C	VC	VC	C	VC	VC	2.0		VC				UC	UC
3.0	F	M	M	F	M	M	M	M	C	C	3.0	C	C	C	C	C	C	C	C	C	C	VC	VC	3.0	VC	VC			VC	XC	UC
02 YELLOW 4.0	F	F	M	F	M	M	M	M	M	M	4.0	C	C	M	C	M	C	C	M	C	M	C	VC	4.0	C	C	VC	C	VC	XC	UC
5.0		F		F	F			M	M	M	5.0	M	M	M	M	M	M	M	M	M	C	C	5.0	C	C	C	C	VC	VC	XC
6.0				F					F	M	6.0	M	M	M		M	M	M	M	M	M		6.0	C	C	C	C	VC	VC	XC
7.0											7.0		M	M					M	M			7.0	C	M	C	C	VC	C	XC
8.0											8.0		F						M	M			8.0	C		C	C	VC	C	
1.5	M	M						C	C	VC	1.5	VC				VC	VC	VC	XC		XC	XC		1.5		UC					UC
2.0	F	M						C	C	C	2.0	VC	VC	VC	C	VC	VC	VC	VC	VC	XC	XC	VC	2.0		XC				UC	UC
3.0	F	M		not available in this size	not available in this size	not available in this size	not available in this size	M	M	C	3.0	C	C	C	C	C	C	C	C	C	VC	VC	VC	3.0	VC	VC	VC		VC	XC	UC
04 RED 4.0	F	M	not available in this size					M	M	C	4.0	C	C	C	C	C	C	C	C	C	C	C	VC	4.0	VC	VC	C	VC	VC	XC	UC
5.0		M						M	M	C	5.0	M	C	C	C	M	M	C	C	C	C	C	VC	5.0	VC	C	C	VC	VC	XC	XC
6.0									M	M	6.0	F	M	M		M	M	M	M	M	C	C		6.0	C	C	C	C	VC	VC	XC
7.0											7.0		M	M					M	M	C			7.0	C	C	C	C	VC	C	XC
8.0											8.0		M						M	M				8.0	C		C	C	VC	C	
1.5	M	C	C					C	VC	VC	1.5	VC				XC	VC	VC	XC		XC	XC		1.5		UC					UC
2.0	M	C	M		C			C	C	C	2.0	VC	VC	VC		VC	C	VC	VC	VC	XC	XC	VC	2.0		XC				UC	UC
3.0	M	M	M		C			C	C	C	3.0	C	VC	C		VC	C	VC	C	C	VC	XC	VC	3.0	XC	VC	XC		VC	XC	UC
05 BROWN 4.0	M	M	M	not available in this size	M	data not available	data not available	C	C	C	4.0	C	C	C	data not available	C	M	C	C	C	VC	VC	VC	4.0	XC	VC	VC	data not available	VC	XC	UC
5.0		M			M			C	C	C	5.0	M	C	M		C	M	C	C	C	C	C	VC	5.0	VC	C	VC		VC	VC	XC
6.0									M	C	6.0	M	C	M		M	M	C	M	M	C	C		6.0	VC	C	VC		VC	C	XC
7.0											7.0		M						M	M	C			7.0	VC	C	VC		VC	C	XC
8.0											8.0		M						M	M				8.0	VC		VC		VC	C	

All data has been sourced from the manufacturer's websites as at JANUARY 2014, except for the Agrotop Turbodrop TD and Airmix which were sourced from Nufarm Spraywise Publications dated 2012.
Published 2014. Compiled by Bill Gordon Consulting Pty Ltd bill.gordon@bigpond.com 0429 976 565

Nozzle Types	Images	Main Uses	Examples & Pressure Ranges	Drift Control:
Pre-orifice		Mostly used for in-crop spraying or for products requiring a medium spray quality. Larger orifices may produce coarse spray qualities at lower pressures (for sprayers with limited pressure *e.g. < 3 bar maximum*)	TeeJet® DG 2 - 4 bar, HARDI ISO LD 1.5 - 5 bar TeeJet® TT 1 - 6 bar ***best above 2 bar***	***Poor to Moderate.***
Low Pressure Air Induction		Mostly used for fallow spraying and some in-crop spraying. Most produce a coarse spray quality, but some can produce a medium spray quality at higher pressures.	HARDI ISO MINIDRIFT agrotop AirMix® TeeJet® AIXR Lechler IDK 2 - 5 or 6 bar, ***best above 3 bar***	***Moderate to Good***
High Pressure Air Induction		Good for fallow spraying with fully translocated products and for pre-emergent applications. Good drift control, mostly coarse to very coarse spray qualities.	TeeJet® AI, HARDI INJET, Lechler ID. 2 - 8 bar, ***best above 5 bar, never below 3 bar***	***Good to Very Good***
Extended Range Flat Fans		Not legal for many herbicide applications. Larger orifices may be suitable for some foliar applications where a medium spray quality is required at higher volumes.	Hardi F, TeeJet® XR 1 - 1.5 bar to 4 or 5 bar	***VERY POOR***

How many sets of nozzles do you need? (Broad-acre example).

Typical Application Volume	Medium Spray Quality (lower drift risk areas)	Coarse Spray Quality	Extremely Coarse Spray Quality (higher drift risk areas)
Lower range **50 -60 L/ha** **(Low stubble load)** **to** **70-80 L/ha** **(High stubble load)**	*Only where permitted on label: Fully translocated herbicides Small to medium sized targets.	Fallow Spraying Fully translocated herbicides such as Glyphosate, MCPA. Mandatory for 2,4-D,	Fully translocated herbicides, medium targets, Very sensitive areas or NIGHT SPRAYING
Higher range **70-80 L/ha** **(Low stubble load)** **to** **100 + L/ha** **(High stubble load/ dense crop canopy)**	*Only where permitted on label: Contact type products. Small targets. In crop spraying. Penetration and coverage in large & broadleaf crops.	Good stubble penetration. Pre-emergent's. Fully Translocated herbicides, Some contact herbicides at the higher application volumes.	Pre-emergent's. Medium sized targets with fully translocated summer fallow herbicides. Very sensitive areas or NIGHT SPRAYING

An example of trying to find a suitable nozzle with a 36m @ 50cm nozzle spacing & automatic rate controller

(USING A STANDARD NOZZLE CHART FOR 50CM NOZZLE SPACING)

- Suppose I wanted to do a summer fallow spray for broadleaves & grasses with Roundup Attack and Amicide Advance 700 at a total volume of 75L/Ha with an average speed of 18 km/h.

- I have a few heavy patches and a couple of trees in the paddock, so I expect my speed might drop down several km/h.

What nozzle/s could I use ?

			speed (km/h)											
nozzle size	**pressure** (bar)	**flowrate** (L/min/nozzle)	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
O1 1	2	0.32	48	38	32	27	24	21	19	17	16	15	14	13
	3	0.39	59	47	39	33	29	26	23	21	20	18	17	16
	4	0.45	68	54	45	39	34	30	27	25	23	21	19	18
	5	0.5	75	60	50	43	38	33	30	27	25	23	21	20
	6	0.55	83	66	55	47	41	37	33	30	28	25	24	22
	7	0.59	89	71	59	51	44	39	35	32	30	27	25	24
O15	2	0.48	72	58	48	41	36	32	29	26	24	22	21	19
	3	0.59	88	70	59	50	44	39	35	32	29	27	25	23
	4	0.68	101	81	68	58	51	45	41	37	34	31	29	27
	5	0.75	113	90	75	64	56	50	45	41	38	35	32	30
	6	0.83	124	99	83	71	62	55	50	45	41	38	35	33
	7	0.89	133	106	89	76	66	59	53	48	44	41	38	35
O2	2	0.64	96	77	64	55	48	43	38	35	32	30	27	26
	3	0.78	117	94	78	67	59	52	47	43	39	36	33	31
	4	0.90	135	108	90	77	68	60	54	49	45	42	39	36
	5	1.00	150	120	100	86	75	67	60	55	50	46	43	40
	6	1.10	165	132	110	94	83	73	66	60	55	51	47	44
	7	1.18	177	142	118	101	89	79	71	64	59	54	51	47
O25 2.5	2	0.80	120	96	80	69	60	53	48	44	40	37	34	32
	3	0.98	146	117	98	84	73	65	59	53	49	45	42	39
	4	1.13	169	135	113	96	84	75	68	61	56	52	48	45
	5	1.25	188	150	125	107	94	83	75	68	63	58	54	50
	6	1.38	206	165	138	118	103	92	83	75	69	63	59	55
	7	1.48	221	177	148	126	111	98	89	80	74	68	63	59
O3 3	2	0.96	144	115	96	82	72	64	58	52	48	44	41	38
	3	1.17	176	140	117	100	88	78	70	64	59	54	50	47
	4	1.35	203	162	135	116	101	90	81	74	68	62	58	54
	5	1.50	225	180	150	129	113	100	90	82	75	69	64	60
	6	1.65	248	198	165	141	124	110	99	90	83	76	71	66
	7	1.77	266	212	177	152	133	118	106	97	89	82	76	71
O4	2	1.28	192	154	128	110	96	85	77	70	64	59	55	51
	3	1.56	234	187	156	134	117	104	94	85	78	72	67	62
	4	1.80	270	216	180	154	135	120	108	98	90	83	77	72
	5	2.00	300	240	200	171	150	133	120	109	100	92	86	80
	6	2.20	330	264	220	189	165	147	132	120	110	102	94	88
	7	2.36	354	283	236	202	177	157	142	129	118	109	101	94

Spray Quality Information for Selected Nozzles

Teejet AI	Bar										
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0
01	Not available in this size										
015	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C
02	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C
03	UC	UC	XC	XC	XC	XC	VC	VC	VC	C	C
04	UC	UC	XC	XC	XC	XC	VC	VC	VC	C	C

Hardi ISO Injet	Bar					
	3.0	4.0	5.0	6.0	7.0	8.0
01	VC	VC	VC	C	C	C
015	VC	VC	VC	VC	VC	C
02	VC	VC	VC	VC	VC	VC
025	VC	VC	VC	VC	VC	VC
03	VC	VC	VC	VC	VC	VC

TurboTeejt Induction (TTI)	Bar										
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
015	UC	UC	UC	UC	XC	XC	XC	XC	XC	XC	XC
02	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC
025	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC
03	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC
04	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC

Hardi ISO Minidrift	Bar					
	1.5	2.0	2.5	3.0	4.0	5.0
015	C	C	C	C	M	M
02	VC	C	C	C	C	M
025	VC	VC	C	C	C	M
03	VC	VC	VC	C	C	C
04	VC	VC	VC	VC	C	C

AIXR TeeJet	Bar								
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
015	VC	C	C	C	C	M	M	M	M
02	VC	VC	C	C	C	C	C	M	M
025	XC	XC	VC	C	C	C	C	C	C
03	XC	XC	VC	VC	C	C	C	C	C
04	XC	XC	XC	VC	VC	VC	C	C	C

Hardi ISO LD	Bar					
	1.5	2.0	2.5	3.0	4.0	5.0
015	M	M	M	M	M	M
02	M	M	M	M	M	M
025	C	C	M	M	M	M
03	C	C	C	C	M	M
04	C	C	C	C	C	M

TurboTeejet	Bar										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
015	C	C	M	M	M	M	M	F	F	F	F
02	C	C	C	M	M	M	M	M	M	M	F
025	VC	C	C	M	M	M	M	M	M	M	M
03	VC	C	C	C	C	M	M	M	M	M	M
04	XC	VC	C	C	C	C	C	C	M	M	M

Hardi ISO F-110	Bar					
	1.5	2.0	2.5	3.0	4.0	5.0
015	M	F	F	F	F	F
02	M	M	F	F	F	F
025	M	M	M	M	F	F
03	M	M	M	M	M	M
04	M	M	M	M	M	M

GRDC Grains Research & Development Corporation
Your GRDC working with you

NOZZLE SELECTION GUIDE

GRDC Grains Research & Development Corporation
Your GRDC working with you

Extended Range Fans

Brand	Teejet	Hardi	Teejet
MODEL	XR-110	F-110	XR-80

Nozzle Size	BAR			
01 Orange	1.5	F	F	F
	2.0	F	F	F
	3.0	F	F	F
	4.0	VF	F	F
	5.0		F	
	6.0			
	7.0			
	8.0			
015 GREEN	1.5	F	M	M
	2.0	F	F	M
	3.0	F	F	F
	4.0	F	F	F
	5.0		F	
	6.0			
	7.0			
	8.0			
02 YELLOW	1.5	F	M	M
	2.0	F	M	M
	3.0	F	F	M
	4.0	F	F	M
	5.0		F	
	6.0			
	7.0			
	8.0			
025 LILAC	1.5	M	M	
	2.0	F	M	
	3.0	F	M	
	4.0	F	F	not available in this size
	5.0		F	
	6.0			
	7.0			
	8.0			
03 BLUE	1.5	M	M	M
	2.0	F	M	M
	3.0	F	M	M
	4.0	F	M	M
	5.0		M	
	6.0			
	7.0			
	8.0			
04 RED	1.5	M	M	M
	2.0	M	M	M
	3.0	M	M	M
	4.0	F	M	M
	5.0		M	
	6.0			
	7.0			
	8.0			
05 BROWN	1.5	M	C	C
	2.0	M	C	M
	3.0	M	M	M
	4.0	M	M	M
	5.0		M	
	6.0			
	7.0			
	8.0			

Pre-Orifice (RUN ABOVE 1.5-2 BAR)

Brand	Teejet	Teejet	Lechler	Albuz	Hardi	Teejet	Teejet
MODEL	DGTJ60 twinjet	DG-110	AD-110	ADI-110	LD-110	TT-110	TTJ-60

Nozzle Size	BAR							
01 Orange	1.5					M	C	
	2.0				M	M	M	
	3.0	not available in this size	not available in this size	not available in this size	M	M	F	not available in this size
	4.0				F	M	F	
	5.0					F	F	
	6.0						F	
	7.0							
	8.0							
015 GREEN	1.5			M		M	C	
	2.0	F	M	M	M	M	M	
	3.0	F	F	M	M	M	M	not available in this size
	4.0	F	F	F	M	M	M	
	5.0		F	F	F	M	F	
	6.0			F			F	
	7.0							
	8.0							
02 YELLOW	1.5			C		M	C	C
	2.0	M	M	M	M	M	C	C
	3.0	F	M	M	M	M	M	C
	4.0	F	M	M	M	M	M	M
	5.0		F	F		M	M	M
	6.0			F			F	M
	7.0							
	8.0							
025 LILAC	1.5					C	C	VC
	2.0					C	C	C
	3.0	not available in this size	not available in this size	not available in this size	not available in this size	M	M	C
	4.0					M	M	C
	5.0					M	M	M
	6.0						M	M
	7.0							
	8.0							
03 BLUE	1.5			C		C	C	VC
	2.0	C	C	C	C	C	C	C
	3.0	M	M	M	M	C	C	C
	4.0	M	M	M	M	M	M	C
	5.0		M	M		M	M	C
	6.0			F			M	M
	7.0							
	8.0							
04 RED	1.5			C		C	VC	VC
	2.0	C	C	C	VC	C	C	C
	3.0	C	M	C	C	C	C	C
	4.0	C	M	M	C	C	C	C
	5.0		M	M		M	M	C
	6.0			M			M	M
	7.0							
	8.0							
05 BROWN	1.5					C	VC	VC
	2.0	not available in this size	C			C	C	C
	3.0		C			C	C	C
	4.0		M	data not available	data not available	C	C	C
	5.0		M			C	C	C
	6.0						M	C
	7.0							
	8.0							

Low Pressure Air Induction (RUN ABOVE 2-3 BAR)

Brand	Lechler	Hypro/ Spray-master	Agrotop	Albuz	Lechler	Hardi	Hardi	Hypro	Hypro	Bollo-rosay	Teejet	ARAG
MODEL	IDKT twinjet	Drift Bete / ULD	Airmix	CVI	IDK-120	Minidrift-DUO twinjet	Minidrift	Gaurdian Air	Gaurdian Twin Air	bubble-jet	ADR	SFA

Nozzle Size	BAR												
01 Orange	1.5												
	2.0			M		C					VC		VC
	3.0	not available in this size	not available in this size	M	not available in this size	C	not available in this size	not available in this size	not available in this size	not available in this size	C	not available in this size	C
	4.0			F		M					C		C
	5.0			F		M					C		C
	6.0			F		F					C		
	7.0										M		
	8.0												
015 GREEN	1.5					C		C	XC			VC	
	2.0	not available in this size	C	XC	C	C		C	VC		XC	C	VC
	3.0		C	C	C	C	not available in this size	C	C	not available in this size	VC	C	VC
	4.0		M	C	C	M		M	M		C	C	C
	5.0		M	C	C	M		M	M		C	M	C
	6.0		M	M		F		M	M		C	M	
	7.0		F						M		C		
	8.0		F						M				
02 YELLOW	1.5	XC				VC	VC	VC	XC		VC	XC	
	2.0	VC	C	C	C	C	C	C	VC	VC	C	VC	VC
	3.0	C	C	C	C	C	C	C	C	C	C	C	VC
	4.0	C	C	M	C	M	C	C	M	C	M	C	VC
	5.0	M	M	M	M	M	M	M	M	M	M	C	C
	6.0	M	M	M		M	M	M	M	M	M	M	
	7.0		M	M					M	M	M		
	8.0		F						M	M			
025 LILAC	1.5	VC				VC	VC	VC	XC		XC	XC	
	2.0	VC	VC	VC	C	VC	VC	VC	VC	VC	XC	XC	VC
	3.0	C	C	C	C	C	C	C	C	C	VC	VC	VC
	4.0	C	C	C	C	C	C	C	C	C	C	C	VC
	5.0	M	C	M	M	M	M	M	C	C	C	C	C
	6.0	M	M	M		M	M	M	M	M	C	C	
	7.0		M						M	M	C		
	8.0		M						M	M			
03 BLUE	1.5	C				VC	VC	VC	XC		XC	XC	
	2.0	C	VC	VC	C	VC	VC	VC	VC	VC	XC	XC	VC
	3.0	C	C	C	C	C	C	C	C	C	VC	VC	VC
	4.0	M	C	C	C	C	M	C	C	C	C	C	VC
	5.0	M	C	C	M	M	M	C	C	C	C	C	VC
	6.0	F	M	M		M	M	M	M	M	C	C	
	7.0		M	M					M	M	C		
	8.0		M						M	M			
04 RED	1.5	VC				VC	VC	VC	XC		XC	XC	
	2.0	C	VC	VC	C	VC	C	VC	VC	VC	VC	XC	VC
	3.0	C	VC	C	C	VC	C	VC	C	C	C	VC	VC
	4.0	M	C	C	C	C	M	C	C	C	C	VC	VC
	5.0	M	C	C	M	C	M	C	C	C	C	C	VC
	6.0	M	C	M		M	M	C	M	M	C	C	
	7.0		M						M	M	C		
	8.0		M						M	M			
05 BROWN	1.5	VC				XC	VC	VC	XC		XC	XC	
	2.0	VC	VC	VC		VC	C	VC	VC	VC	XC	XC	VC
	3.0	C	VC	C		VC	C	VC	C	C	VC	XC	VC
	4.0	C	C	C	data not available	C	M	C	C	C	C	VC	VC
	5.0	M	C	M		C	M	C	C	C	C	C	VC
	6.0	M	C	M		M	M	C	M	M	C	C	
	7.0		M						M	M	C		
	8.0		M						M	M			

High Pressure Air Induction (RUN ABOVE 3-4 BAR)

Brand	Lechler	Teejet	Albuz	Agrotop	Hardi	Teejet	TeeJet
MODEL	ID	AITTJ60 twinjet	AVI	Turbo-drop TD	Injet	AI	TTI

Nozzle Size	BAR							
01 Orange	1.5							
	2.0							
	3.0	C	not available in this size	VC	data not available	VC	not available in this size	not available in this size
	4.0	C		C		VC		
	5.0	C		C		VC		
	6.0	C		C		C		
	7.0	M		C		C		
	8.0	M		C		C		
015 GREEN	1.5							UC
	2.0						UC	UC
	3.0	VC	not available in this size	VC		VC	XC	UC
	4.0	C		C	C	VC	XC	XC
	5.0	C		C	C	VC	VC	XC
	6.0	C		C	C	VC	VC	XC
	7.0	C		C	C	VC	C	XC
	8.0	M		C	C	C	C	
02 YELLOW	1.5		XC					UC
	2.0		VC				UC	UC
	3.0	VC	VC			VC	XC	UC
	4.0	C	C	VC	C	VC	XC	UC
	5.0	C	C	C	C	VC	VC	XC
	6.0	C	C	C	C	VC	VC	XC
	7.0	C	M	C	C	VC	C	XC
	8.0	C		C	C	VC	C	
025 LILAC	1.5		UC					UC
	2.0		XC				UC	UC
	3.0	VC	VC	VC		VC	XC	UC
	4.0	VC	VC	C	VC	VC	XC	UC
	5.0	VC	C	C	VC	VC	VC	XC
	6.0	C	C	C	VC	VC	VC	XC
	7.0	C	M	C	VC	VC	C	XC
	8.0	C		C	VC	VC	C	
03 BLUE	1.5		UC					UC
	2.0		XC				UC	UC
	3.0	VC	VC	VC		VC	XC	UC
	4.0	VC	VC	C	VC	VC	XC	UC
	5.0	VC	C	C	C	VC	VC	XC
	6.0	C	C	C	C	VC	VC	XC
	7.0	C	C	C	C	VC	C	XC
	8.0	C		C	C	VC	C	
04 RED	1.5		UC					UC
	2.0		XC				UC	UC
	3.0	XC	VC	XC		VC	XC	UC
	4.0	VC	VC	C	VC	VC	XC	UC
	5.0	VC	C	C	VC	VC	VC	XC
	6.0	VC	C	C	VC	VC	VC	XC
	7.0	C	C	C	C	VC	C	XC
	8.0	C		C	C	VC	C	
05 BROWN	1.5		UC					UC
	2.0		XC				UC	UC
	3.0	XC	VC	XC		VC	XC	UC
	4.0	XC	VC	VC	data not available	VC	XC	UC
	5.0	VC	C	VC		VC	VC	XC
	6.0	VC	C	VC		VC	VC	XC
	7.0	VC	C	VC		VC	C	XC
	8.0	VC		VC		VC	C	

All data has been sourced from the manufacturer's websites as at JANUARY 2014, except for the Agrotop Turbodrop TD and Airmix which were sourced from Nufarm Spraywise Publications dated 2012.

Published 2014. Compiled by Bill Gordon Consulting Pty Ltd bill.gordon@bigpond.com 0429 976 565

Nozzle Spacing on the Boom:		Average Speed (km/h)		Application Volume (L/ha)		Spray Quality Required	
Number of Nozzles on the Boom:							

Speed & Spray Quality: Compare up to *Three Nozzle Size and Pressure Choices* for the selected L/ha

Give an Example of a ***HIGH PRESSURE AIR INDUCTION*** *nozzle*			***Pressure***	2	3	4	5	6	7	8
Orifice Size	***Pressure (BAR)***	***Name of the Nozzle Chosen***	***Speed***							
			Spray Quality							

Give an Example of a ***LOW PRESSURE AIR INDUCTION*** *nozzle*			***Pressure***	2	3	4	5	6	7	8
Orifice Size	***Pressure (BAR)***	***Name of the Nozzle Chosen***	***Speed***							
			Spray Quality							

Give an Example of a ***PRE-ORIFICE or XR FAN*** *nozzle*			***Pressure***	1.5	2	3	4	5	6	7
Orifice Size	***Pressure (BAR)***	***Name of the Nozzle Chosen***	***Speed***							
			Spray Quality							

Select **ONE** of these nozzles and determine what the **minimum speed and controller settings** should be for this nozzle

Name of Nozzle Chosen	***Suggested Minimum Pressure***	***Determine Minimum Speed (km/h)*** *from the nozzle chart*	***Calculate the Total Flowrate (L/min) through the boom at the minimum pressure = (L/min/nozzle @ min. pressure X the no. of nozzles on the boom)***

			speed (km/h)											
nozzle size	**pressure** (bar)	**flowrate** (L/min/nozzle)	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
O1 1	2	0.32	48	38	32	27	24	21	19	17	16	15	14	13
	3	0.39	59	47	39	33	29	26	23	21	20	18	17	16
	4	0.45	68	54	45	39	34	30	27	25	23	21	19	18
	5	0.5	75	60	50	43	38	33	30	27	25	23	21	20
	6	0.55	83	66	55	47	41	37	33	30	28	25	24	22
	7	0.59	89	71	59	51	44	39	35	32	30	27	25	24
O15	2	0.48	72	58	48	41	36	32	29	26	24	22	21	19
	3	0.59	88	70	59	50	44	39	35	32	29	27	25	23
	4	0.68	101	81	68	58	51	45	41	37	34	31	29	27
	5	0.75	113	90	75	64	56	50	45	41	38	35	32	30
	6	0.83	124	99	83	71	62	55	50	45	41	38	35	33
	7	0.89	133	106	89	76	66	59	53	48	44	41	38	35
O2	2	0.64	96	77	64	55	48	43	38	35	32	30	27	26
	3	0.78	117	94	78	67	59	52	47	43	39	36	33	31
	4	0.90	135	108	90	77	68	60	54	49	45	42	39	36
	5	1.00	150	120	100	86	75	67	60	55	50	46	43	40
	6	1.10	165	132	110	94	83	73	66	60	55	51	47	44
	7	1.18	177	142	118	101	89	79	71	64	59	54	51	47
O25 2.5	2	0.80	120	96	80	69	60	53	48	44	40	37	34	32
	3	0.98	146	117	98	84	73	65	59	53	49	45	42	39
	4	1.13	169	135	113	96	84	75	68	61	56	52	48	45
	5	1.25	188	150	125	107	94	83	75	68	63	58	54	50
	6	1.38	206	165	138	118	103	92	83	75	69	63	59	55
	7	1.48	221	177	148	126	111	98	89	80	74	68	63	59
O3 3	2	0.96	144	115	96	82	72	64	58	52	48	44	41	38
	3	1.17	176	140	117	100	88	78	70	64	59	54	50	47
	4	1.35	203	162	135	116	101	90	81	74	68	62	58	54
	5	1.50	225	180	150	129	113	100	90	82	75	69	64	60
	6	1.65	248	198	165	141	124	110	99	90	83	76	71	66
	7	1.77	266	212	177	152	133	118	106	97	89	82	76	71
O4	2	1.28	192	154	128	110	96	85	77	70	64	59	55	51
	3	1.56	234	187	156	134	117	104	94	85	78	72	67	62
	4	1.80	270	216	180	154	135	120	108	98	90	83	77	72
	5	2.00	300	240	200	171	150	133	120	109	100	92	86	80
	6	2.20	330	264	220	189	165	147	132	120	110	102	94	88
	7	2.36	354	283	236	202	177	157	142	129	118	109	101	94

Nozzle Spacing on the Boom:		Average Speed (km/h)		Application Volume (L/ha)		Spray Quality Required	
Number of Nozzles on the Boom:							

Average Speed: Compare up to *Three Nozzle Size and Pressure Choices* for the selected L/ha

Give an Example of a ***HIGH PRESSURE AIR INDUCTION*** *nozzle*			***Pressure***	2	3	4	5	6	7	8
Orifice Size	***Pressure (BAR)***	***Name of the Nozzle Chosen***	***Speed***							
			Spray Quality							

Give an Example of a ***LOW PRESSURE AIR INDUCTION*** *nozzle*			***Pressure***	2	3	4	5	6	7	8
Orifice Size	***Pressure (BAR)***	***Name of the Nozzle Chosen***	***Speed***							
			Spray Quality							

Give an Example of a ***PRE-ORIFICE or XR FAN*** *nozzle*			***Pressure***	1.5	2	3	4	5	6	7
Orifice Size	***Pressure (BAR)***	***Name of the Nozzle Chosen***	***Speed***							
			Spray Quality							

Select **ONE** of these nozzles and determine what the **minimum speed and controller settings** should be for this nozzle

Name of Nozzle Chosen	***Suggested Minimum Pressure***	***Determine Minimum Speed (km/h)*** *from the nozzle chart*	***Calculate the Total Flowrate (L/min) through the boom at the minimum pressure = (L/min/nozzle @ min. pressure X the no. of nozzles on the boom)***

ozzle spacing in (m enter → 0.5

speed (km/h)

nozzle size	pressure (bar)	flowrate (L/min/nozzle)	8	10	12	14	16	18	20	22	24	26	28	30
O1 1	2	0.32	48	38	32	27	24	21	19	17	16	15	14	13
	3	0.39	59	47	39	33	29	26	23	21	20	18	17	16
	4	0.45	68	54	45	39	34	30	27	25	23	21	19	18
	5	0.5	75	60	50	43	38	33	30	27	25	23	21	20
	6	0.55	83	66	55	47	41	37	33	30	28	25	24	22
	7	0.59	89	71	59	51	44	39	35	32	30	27	25	24
O15	2	0.48	72	58	48	41	36	32	29	26	24	22	21	19
	3	0.59	88	70	59	50	44	39	35	32	29	27	25	23
	4	0.68	101	81	68	58	51	45	41	37	34	31	29	27
	5	0.75	113	90	75	64	56	50	45	41	38	35	32	30
	6	0.83	124	99	83	71	62	55	50	45	41	38	35	33
	7	0.89	133	106	89	76	66	59	53	48	44	41	38	35
O2	2	0.64	96	77	64	55	48	43	38	35	32	30	27	26
	3	**0.78**	117	[illegible]	78	67	59	52	47	43	39	36	33	31
	4	0.90	135	108	90	77	68	60	54	49	45	42	39	36
	5	1.00	150	120	100	86	75	67	60	55	50	46	43	40
	6	1.10	165	132	110	94	83	73	66	60	55	51	47	44
	7	1.18	177	142	118	101	89	79	71	64	59	54	51	47
O25 2.5	2	**0.80**	120	[illegible]	80	69	60	53	48	44	40	37	34	32
	3	0.98	146	117	98	84	73	65	59	53	49	45	42	39
	4	1.13	169	135	113	96	84	75	68	61	56	52	48	45
	5	1.25	188	150	125	107	94	83	75	68	63	58	54	50
	6	1.38	206	165	138	118	103	92	83	75	69	63	59	55
	7	1.48	221	177	148	126	111	98	89	80	74	68	63	59
O3 3	2	**0.96**	144	115	96	82	72	64	58	52	48	44	41	38
	3	1.17	176	140	117	100	88	78	70	64	59	54	50	47
	4	1.35	203	162	135	116	101	90	81	74	68	62	58	54
	5	1.50	225	180	150	129	113	100	90	82	75	69	64	60
	6	1.65	248	198	165	141	124	110	99	90	83	76	71	66
	7	1.77	266	212	177	152	133	118	106	97	89	82	76	71
O4	2	1.28	192	154	128	110	96	85	77	70	64	59	55	51
	3	1.56	234	187	156	134	117	104	94	85	78	72	67	62
	4	1.80	270	216	180	154	135	120	108	98	90	83	77	72
	5	2.00	300	240	200	171	150	133	120	109	100	92	86	80
	6	2.20	330	264	220	189	165	147	132	120	110	102	94	88

Spray Quality Information for Selected Nozzles

Teejet AI	Bar										
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0
01	Not available in this size										
015	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C
02	UC	XC	XC	XC	XC	VC	VC	VC	VC	C	C
03	UC	UC	XC	XC	XC	XC	VC	VC	VC	C	C
04	UC	UC	XC	XC	XC	XC	VC	VC	VC	C	C

Hardi ISO Injet	Bar					
	3.0	4.0	5.0	6.0	7.0	8.0
01	VC	VC	VC	C	C	C
015	VC	VC	VC	VC	VC	C
02	VC	VC	VC	VC	VC	VC
025	VC	VC	VC	VC	VC	VC
03	VC	VC	VC	VC	VC	VC

TurboTeejt Induction (TTI)	Bar										
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
015	UC	UC	UC	UC	XC	XC	XC	XC	XC	XC	XC
02	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC
025	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC
03	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC
04	UC	UC	UC	UC	UC	UC	XC	XC	XC	XC	XC

Hardi ISO Minidrift	Bar					
	1.5	2.0	2.5	3.0	4.0	5.0
015	C	C	C	C	M	M
02	VC	C	C	C	C	M
025	VC	VC	C	C	C	M
03	VC	VC	VC	C	C	C
04	VC	VC	VC	VC	C	C

AIXR TeeJet	Bar								
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
015	VC	C	C	C	C	M	M	M	M
02	VC	VC	C	C	C	C	C	M	M
025	XC	XC	VC	C	C	C	C	C	C
03	XC	XC	VC	VC	C	C	C	C	C
04	XC	XC	XC	VC	VC	VC	C	C	C

Hardi ISO LD	Bar					
	1.5	2.0	2.5	3.0	4.0	5.0
015	M	M	M	M	M	M
02	M	M	M	M	M	M
025	C	C	M	M	M	M
03	C	C	C	C	M	M
04	C	C	C	C	C	M

TurboTeejet	Bar										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
015	C	C	M	M	M	M	M	F	F	F	F
02	C	C	C	M	M	M	M	M	M	M	F
025	VC	C	C	M	M	M	M	M	M	M	M
03	VC	C	C	C	C	M	M	M	M	M	M
04	XC	VC	C	C	C	C	C	C	M	M	M

Hardi ISO F-110	Bar					
	1.5	2.0	2.5	3.0	4.0	5.0
015	M	F	F	F	F	F
02	M	M	F	F	F	F
025	M	M	M	M	F	F
03	M	M	M	M	M	M
04	M	M	M	M	M	M

What are your nozzle choices?

Typical Application Volume	Medium Spray Quality (lower drift risk areas)	Coarse Spray Quality	Extremely Coarse Spray Quality (higher drift risk areas)
Your Lower range **(Low stubble load)** **(High stubble load)**	*Only where permitted on label: Fully translocated herbicides Small to medium sized targets.	Fallow Spraying Fully translocated herbicides such as Glyphosate, MCPA. Mandatory for 2,4-D,	Fully translocated herbicides, medium targets, Very sensitive areas or NIGHT SPRAYING
Your Higher range **(Low stubble load)** **To** **(High stubble load/ dense crop canopy)**	*Only where permitted on label: Contact type products. Small targets. In crop spraying. Penetration and coverage in large & broadleaf crops.	Good stubble penetration. Pre-emergent's. Fully Translocated herbicides, Some contact herbicides at the higher application volumes.	Pre-emergent's. Medium sized targets with fully translocated summer fallow herbicides. Very sensitive areas or NIGHT SPRAYING

		.	speed (km/h)													
nozzle size	**pressure** (bar)	**flowrate** (L / min /nozzle)	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**
0 1	2	0.32	64.0	48.0	38.4	32.0	27.4	24.0	21.3	19.2	17.5	16.0	14.8	13.7	12.8	12.0
	3	0.39	78.0	58.5	46.8	39.0	33.4	29.3	26.0	23.4	21.3	19.5	18.0	16.7	15.6	14.6
	4	0.45	90.0	67.5	54.0	45.0	38.6	33.8	30.0	27.0	24.5	22.5	20.8	19.3	18.0	16.9
	5	0.5	100.0	75.0	60.0	50.0	42.9	37.5	33.3	30.0	27.3	25.0	23.1	21.4	20.0	18.8
	6	0.55	110.0	82.5	66.0	55.0	47.1	41.3	36.7	33.0	30.0	27.5	25.4	23.6	22.0	20.6
	7	0.59	118.0	88.5	70.8	59.0	50.6	44.3	39.3	35.4	32.2	29.5	27.2	25.3	23.6	22.1
0 1.5	2	0.48	96.0	72.0	57.6	48.0	41.1	36.0	32.0	28.8	26.2	24.0	22.2	20.6	19.2	18.0
	3	0.59	117.0	87.8	70.2	58.5	50.1	43.9	39.0	35.1	31.9	29.3	27.0	25.1	23.4	21.9
	4	0.68	135.0	101.3	81.0	67.5	57.9	50.6	45.0	40.5	36.8	33.8	31.2	28.9	27.0	25.3
	5	0.75	150.0	112.5	90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5	34.6	32.1	30.0	28.1
	6	0.83	165.0	123.8	99.0	82.5	70.7	61.9	55.0	49.5	45.0	41.3	38.1	35.4	33.0	30.9
	7	0.89	177.0	132.8	106.2	88.5	75.9	66.4	59.0	53.1	48.3	44.3	40.8	37.9	35.4	33.2
0 2	2	0.64	128.0	96.0	76.8	64.0	54.9	48.0	42.7	38.4	34.9	32.0	29.5	27.4	25.6	24.0
	3	0.78	156.0	117.0	93.6	78.0	66.9	58.5	52.0	46.8	42.5	39.0	36.0	33.4	31.2	29.3
	4	0.90	180.0	135.0	108.0	90.0	77.1	67.5	60.0	54.0	49.1	45.0	41.5	38.6	36.0	33.8
	5	1.00	200.0	150.0	120.0	100.0	85.7	75.0	66.7	60.0	54.5	50.0	46.2	42.9	40.0	37.5
	6	1.10	220.0	165.0	132.0	110.0	94.3	82.5	73.3	66.0	60.0	55.0	50.8	47.1	44.0	41.3
	7	1.18	236.0	177.0	141.6	118.0	101.1	88.5	78.7	70.8	64.4	59.0	54.5	50.6	47.2	44.3
TOO LOW	2	1.12	224.0	168.0	134.4	112.0	96.0	84.0	74.7	67.2	61.1	56.0	51.7	48.0	44.8	42.0
0 3.5	3	1.37	273.0	204.8	163.8	136.5	117.0	102.4	91.0	81.9	74.5	68.3	63.0	58.5	54.6	51.2
	4	1.58	315.0	236.3	189.0	157.5	135.0	118.1	105.0	94.5	85.9	78.8	72.7	67.5	63.0	59.1
	5	1.75	350.0	262.5	210.0	175.0	150.0	131.3	116.7	105.0	95.5	87.5	80.8	75.0	70.0	65.6
	6	1.93	385.0	288.8	231.0	192.5	165.0	144.4	128.3	115.5	105.0	96.3	88.8	82.5	77.0	72.2
	7	2.07	413.0	309.8	247.8	206.5	177.0	154.9	137.7	123.9	112.6	103.3	95.3	88.5	82.6	77.4

QJS SERIES

MULTIPLE OUTLET NOZZLE BODIES