

# Lessons Learnt from Summer Fallow Spraying: Factors affecting efficacy and drift



# GRDC

**Grains  
Research &  
Development  
Corporation**

Your GRDC working with you

Bill Gordon Consulting.

Lawrence, New South Wales, Australia

# Issues for Summer Fallow Spraying

- Risks Associated with Inversions in Summer
- Efficacy with Day Vs Night Spraying (knockdowns)
- Target Size, Stubble Load and Product Translocation should dictate Spray Quality & Application Volume
- Effects of Spraying Speed & Machines Effects
  - Deposition into Standing Stubble
  - Deposition near Wheel Tracks

**More ha/hour can = better timing,  
But can also = more risk of drift.**

**....especially if the weather  
conditions are NOT right.**

# Recognise and avoid Surface Temperature Inversions

**SURFACE TEMPERATURE INVERSIONS AND SPRAYING**  
FACT SHEET  
GRDC  
Grains Research & Development Corporation  
NOVEMBER 2011

## 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, or 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.

### Surface temperature inversions

Inversion conditions can differ significantly from the broader forecast weather patterns.

During the night the ground cools faster than the air above it (Figure 1). This results in the temperature profile 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, trapping the inversion layer from the normal weather situation, especially in the normal wind direction (Figure 2).

Surface temperature inversion conditions are unsafe for spraying as the air does not mix in the same way as during the day.

- air movement is much less turbulent.
- airborne droplets can remain concentrated in the inversion layer for long periods of time.
- the direction and distance pesticides movement is very hard to predict.
- the movement of airborne droplets will vary depending on the landscape and
- droplets or their remnants can move in different ways (Figure 3).

Research supported by the GRDC is further investigating the development and implications of temperature inversions in relation to spray application.

During daylight hours the temperature of the air 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 10 km/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 rising motion of the air across the ground surface. Mixing is also caused by thermal.

This mixing of the air assists in driving airborne droplets and helps to drive many of them back to the ground.

When this occurs, a safe buffer distance between the sprayed area and potentially sensitive areas downwind from the application can be estimated.

**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.

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# Weather essentials FOR pesticide application

BY GRAEME TEPPER  
MicroMeteorology Research and Educational Services

**GRDC**  
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**During a surface temperature inversion the airborne droplets can travel very long distances in Laminar Airflows**

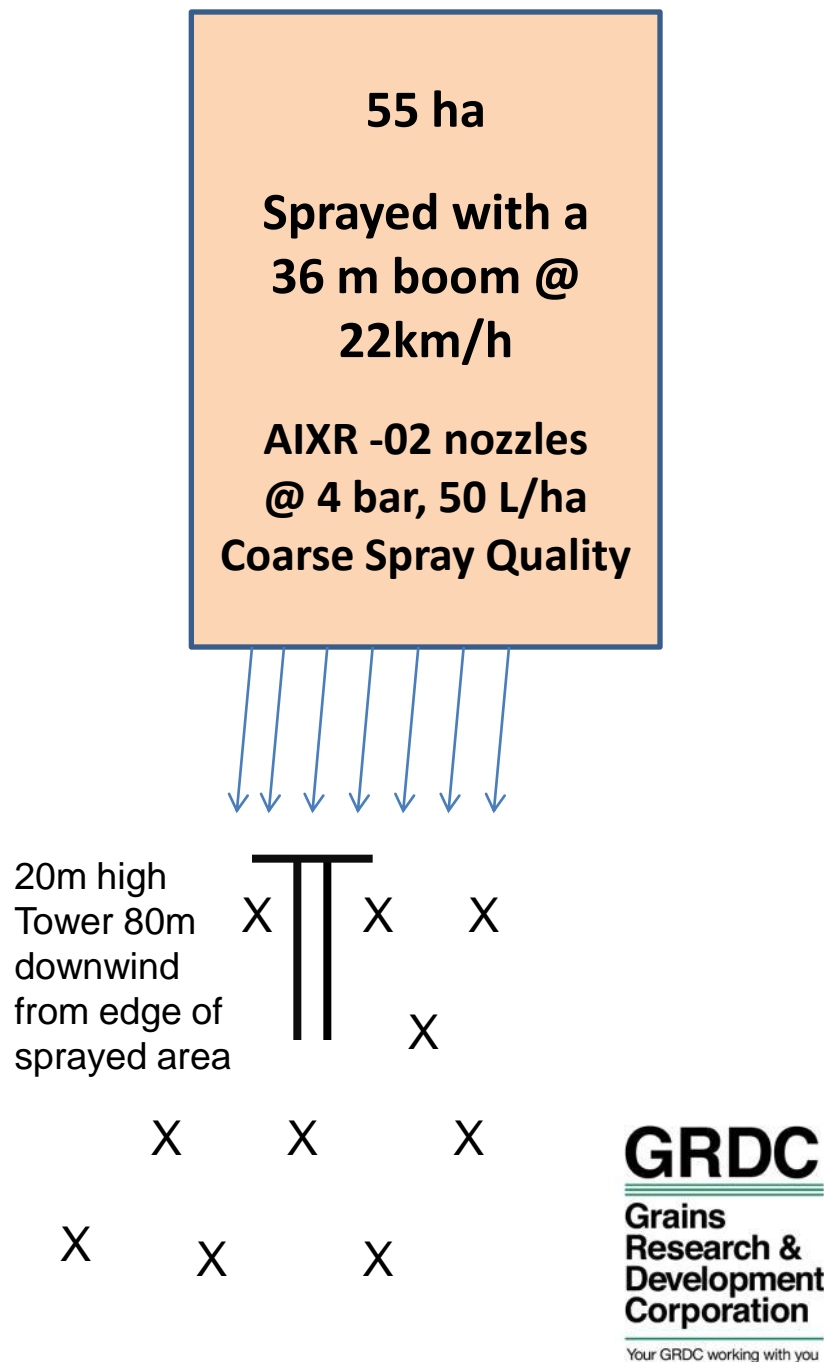




# Results of a Single Drift Study Comparing Night vs Day Spraying

*Millee NSW, Feb 2011*

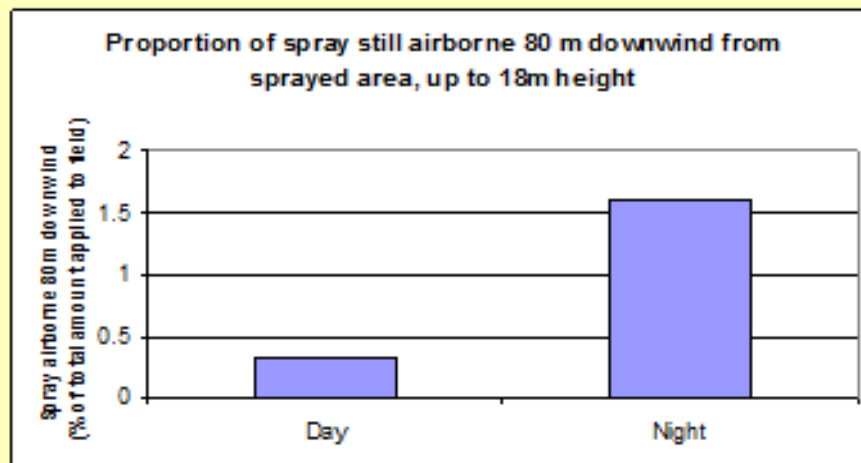
- *Night Time Spraying was conducted around 2.30am*
- *Daytime spraying was conducted around 7.30am*



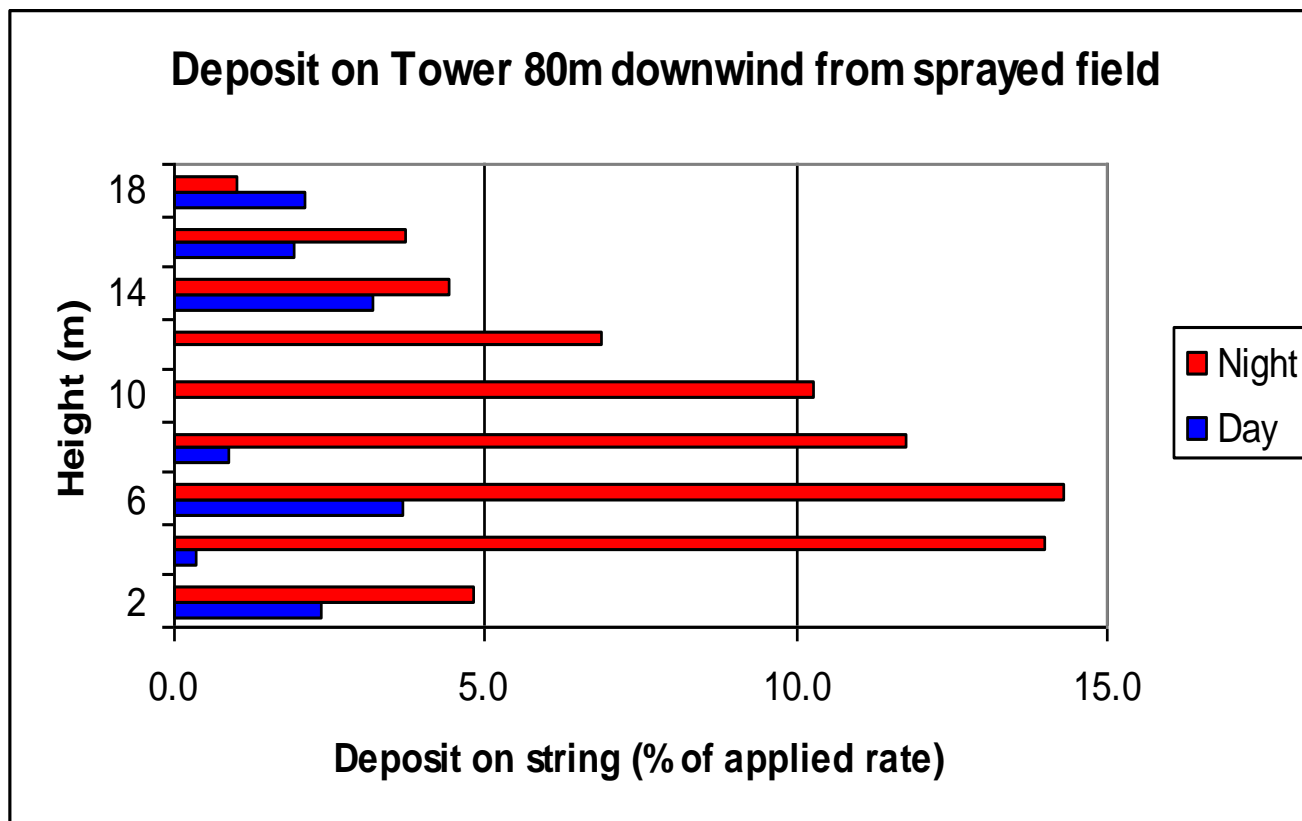
# *Measurements of spray drift from a single field study.*

## 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



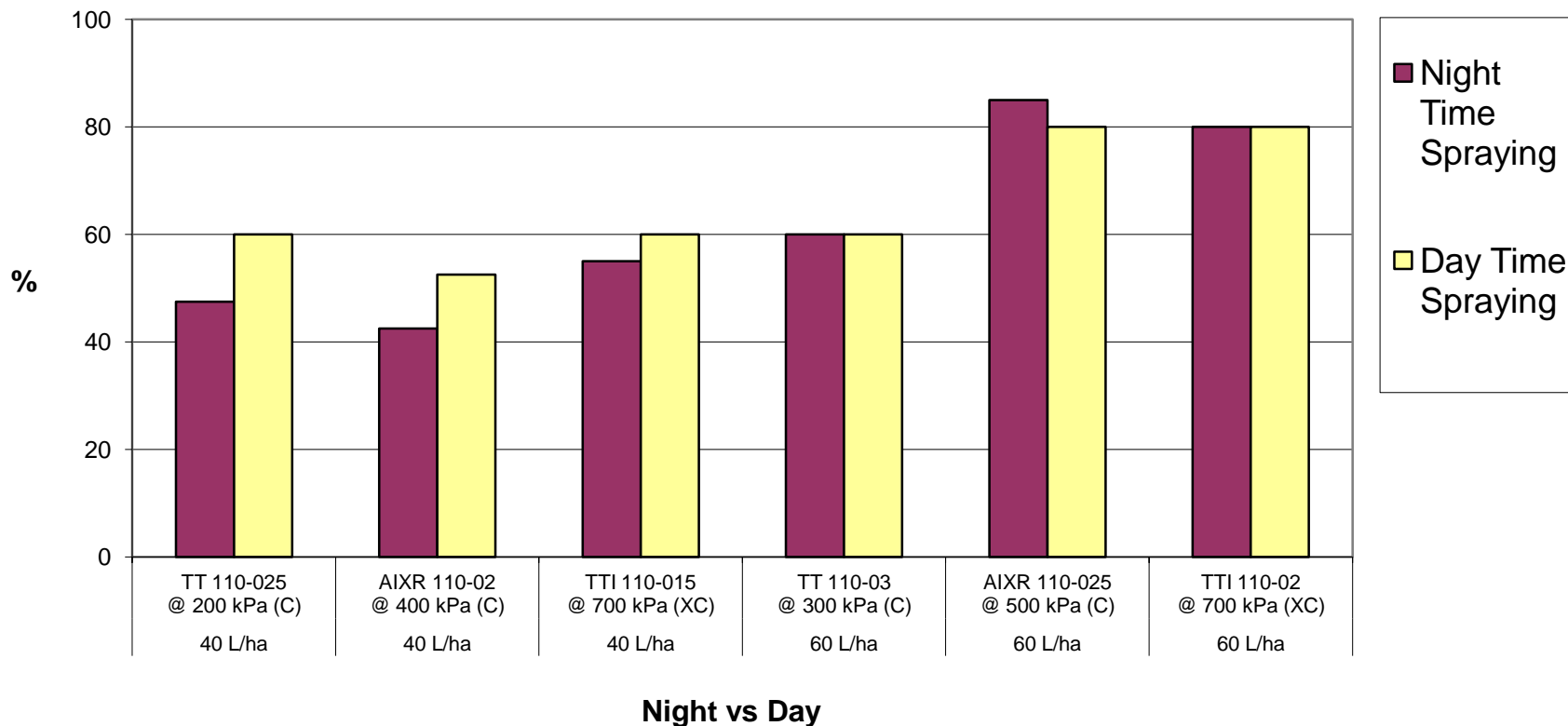
	Wind Speed (km/hr)	Wind Direction (°)	Temperature (°C)	Relative Humidity (%)	Stability Ratio
Night	11.6	19	25.5	64	0.26
Day	18.3	4	28.7	61	-0.29





**Is spraying at night better  
for efficacy?**

**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),**



# Mid morning vs late afternoon

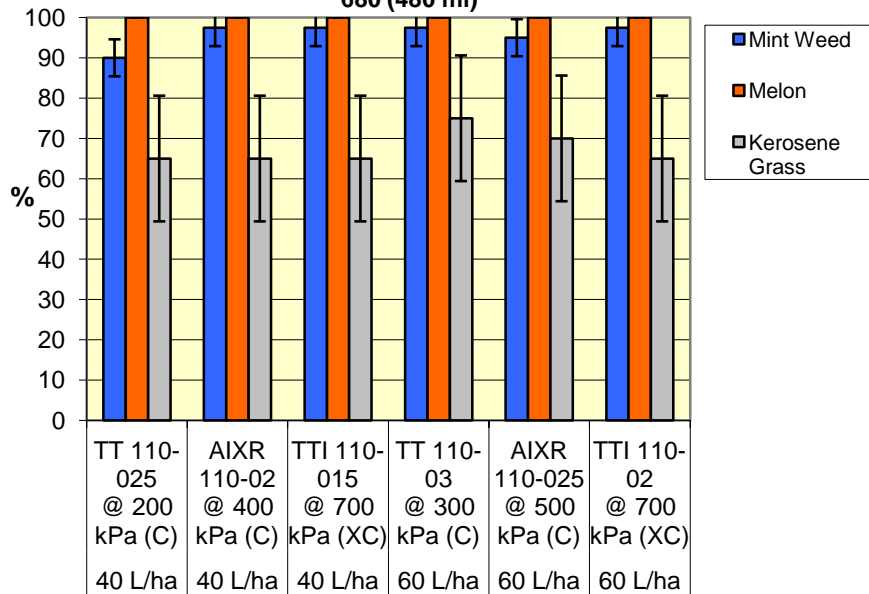
## Muntadgin, W.A. Mid Morning Application

5th February 2013,

14 DAT, for three weed species,

40 L/ha vs 60 L/ha for various Spray Qualities & Nozzle

Types. Roundup (700 ml) + Garlon 600 (70 ml) + Ken-ester LV  
680 (480 ml)



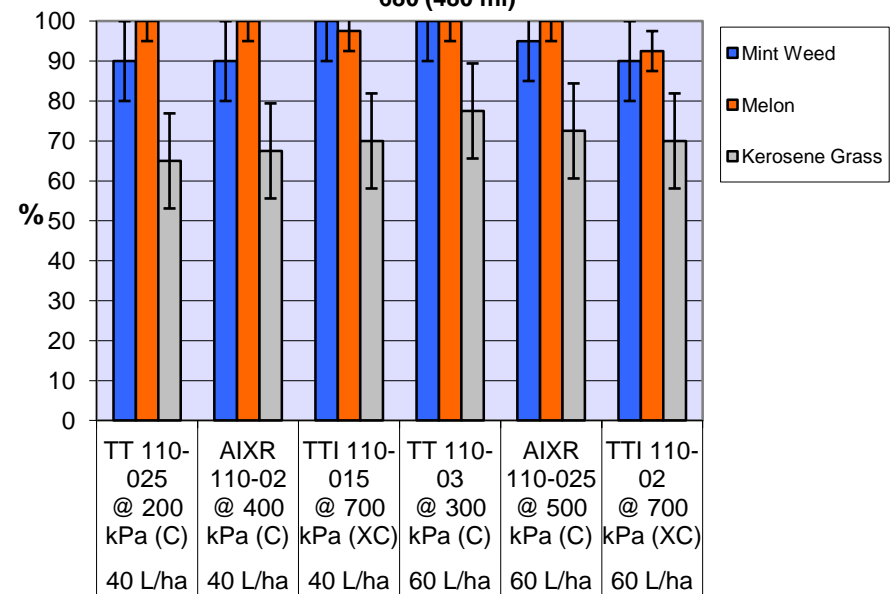
## Muntadgin, W.A. Late Afternoon Application

5th February 2013,

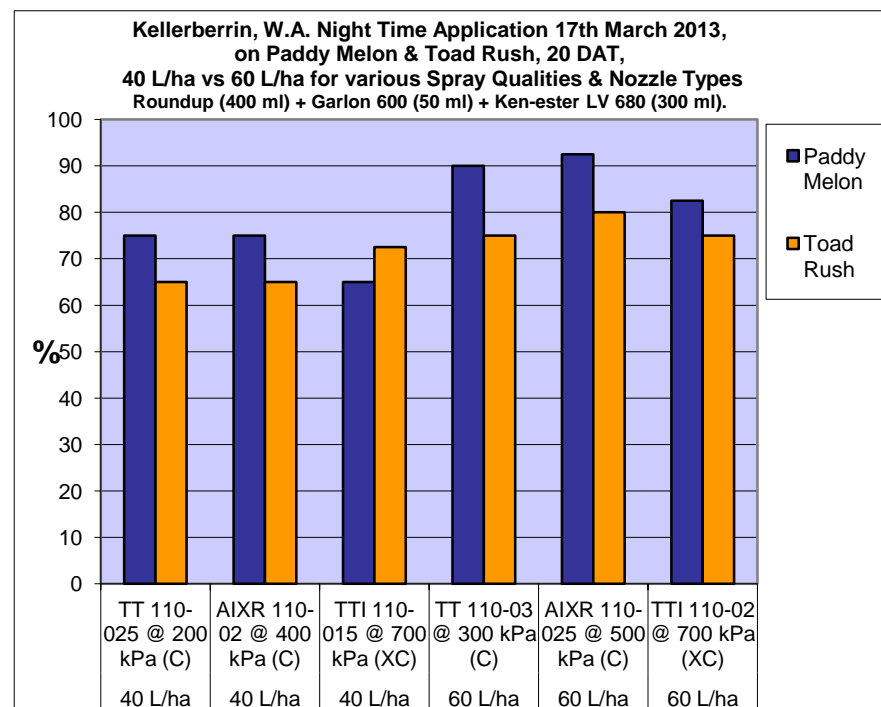
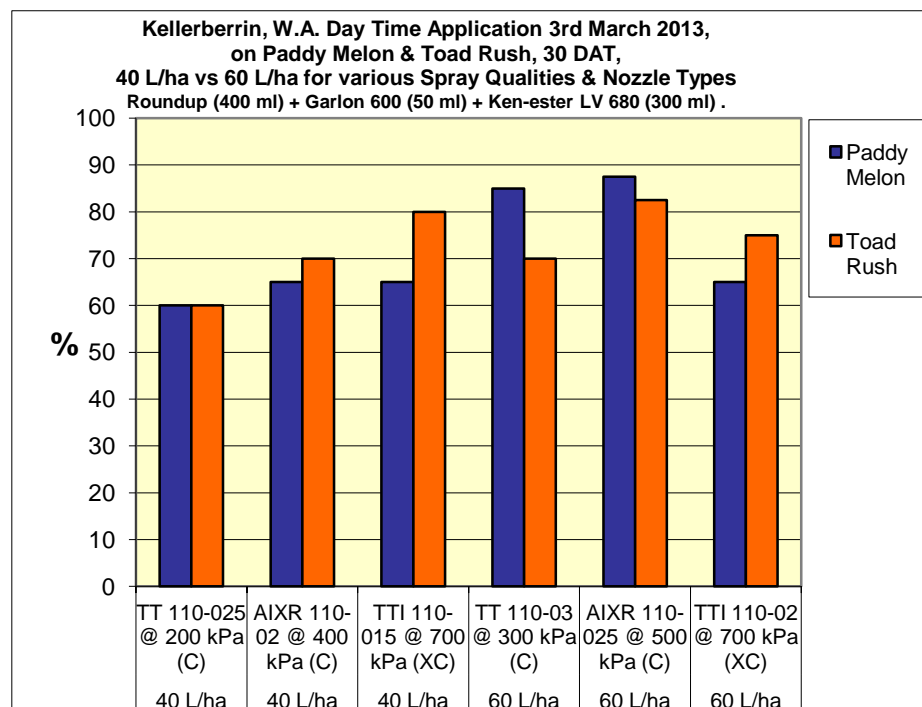
14 DAT, for three weed species,

40 L/ha vs 60 L/ha for various Spray Qualities & Nozzle

Types. Roundup (700 ml) + Garlon 600 (70 ml) + Ken-ester LV  
680 (480 ml)



# Waiting for weeds to freshen up?



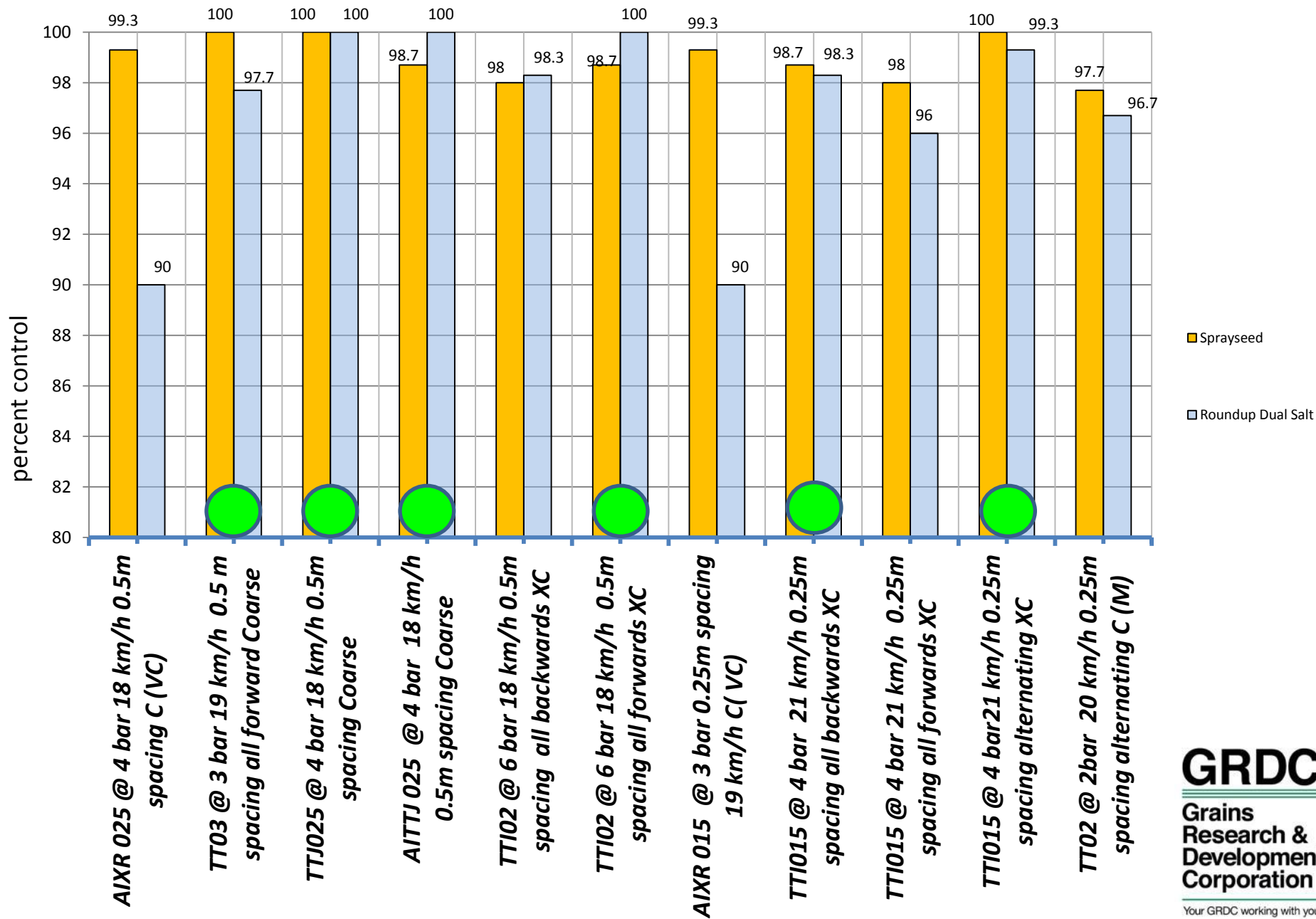
# Control (% desiccation or stunting) of heliotrope Glyphosate/Phenoxy Mix vs. Sprayseed®, 60 L/ha vs. 90 L/ha using a range of nozzle types.

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	<b>0.0</b>	0.0	<b>0.0</b>
	TurboTeejet TT11002-VP (forward)	M	87.5	<b>92.5a</b>	27.5	<b>72.5ab</b>
	TeeJet AIXR11002VP	C	88.8	<b>98.0a</b>	30.0	<b>78.8a</b>
	TurboTwinJet TTJ60-11002VP	C	88.8	<b>94.0a</b>	30.0	<b>68.8ab</b>
	TeeJet AITTJ60-11002VP	C	92.5	<b>93.8a</b>	27.5	<b>70.0ab</b>
	TurboTeejet Induction TTI11002-VP (alternating forward and backward)	XC	72.5	<b>82.5b</b>	25.0	<b>63.8b</b>
90 L/ha	Untreated Control		0.0	<b>0.0</b>	0.0	<b>0.0</b>
	TurboTeejet TT110-025-VP (forward)	M	92.0	<b>94.5a</b>	23.8	<b>63.8b</b>
	TeeJet AIXR110025-VP	C	89.5	<b>95.5a</b>	25.0	<b>68.8ab</b>
	TurboTwinJet TTJ60-110025VP	C	85.0	<b>95.5a</b>	38.8	<b>72.5ab</b>
	Teejet AITTJ60-11002VP	C	94.8	<b>96.8a</b>	18.8	<b>61.2b</b>
	TurboTeejet Induction TTI1102-VP (alternating forward and backward)	XC	86.0	<b>92.3a</b>	21.2	<b>66.2b</b>
LSD (0.05)			8.6	<b>5.9</b>	8.3	<b>11.5</b>

**Level of Control Across 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.**

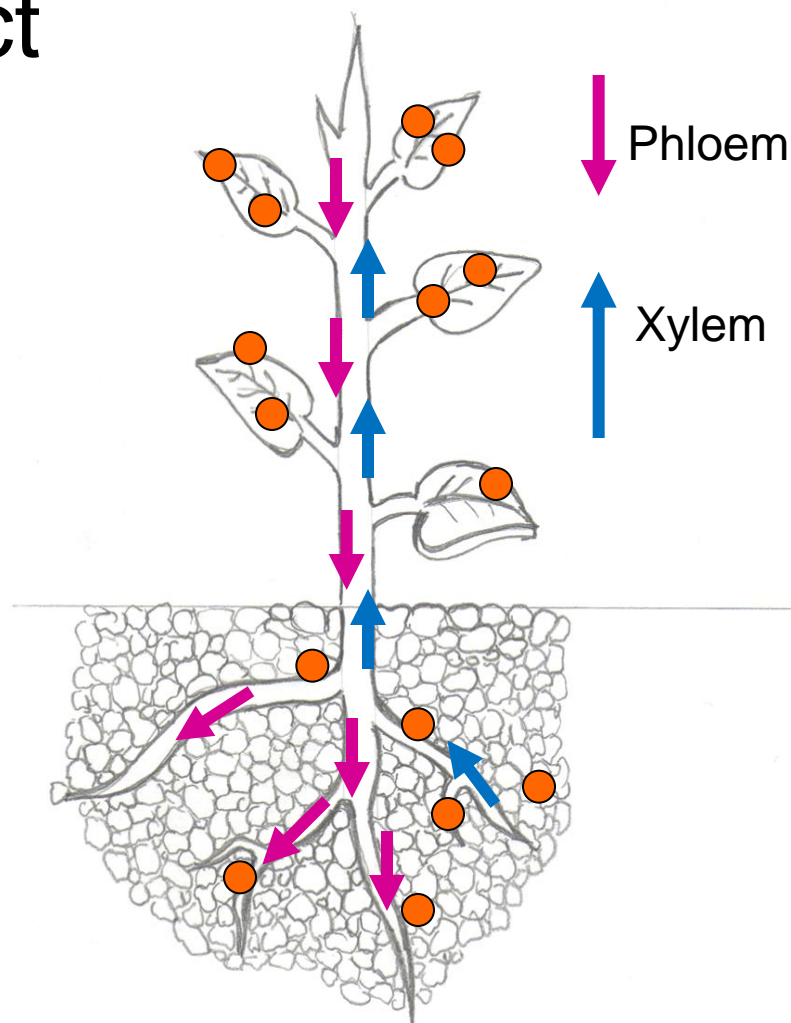


Things we should consider to  
maximise summer fallow  
spraying results



# What does the product do when it hits the target ?

- Uptake and translocation of the product will dictate the coverage requirements
- The size and type target, and the amount of standing stubble, should influence the application volume and spray quality



# Modes of Action & Translocation

Group	Examples	Uptake	Translocation	Site of Action	Mixing	Notes
<b>A</b> (Fops)	Topik® Hoegrass® Verdict®	Slow	Slow	ACCCase-grass meristem	Not with Group I	Adjuvants required, Coverage is important, selects for resistance rapidly
<b>A</b> (Dims)	Achieve® Select® Sertin®	Slow	Slow	ACCCase-grass meristem	Not with Group B	Adjuvants required, degrades rapidly in sunlight, water quality, selects for resistance rapidly
<b>B</b> Imidazolinones	Raptor® Spinnaker®	Moderate	Phloem/xylem	Acetolactate synthase- meristem	Not with Group A (Dims)	Very reliable, selects for resistance rapidly, soil pH important for residues (increase with low pH)
<b>B</b> Sulphonamides	Broadstrike® Crusader® Eclipse®	Moderate	Phloem/xylem	Acetolactate synthase- meristem	Mixable	Very reliable, selects for resistance rapidly, limited soil residual
<b>B</b> sulfonylureas	Ally® Glean® Hussar® Logran®	Moderate	Phloem/xylem	Acetolactate synthase- meristem	Caution with Group I	Very reliable, selects for resistance rapidly, soil pH important for residues (increase with high pH)
<b>C</b> triazines	Atrazine, simazine	Soil and foliar	Xylem	Photo-system II	Not with Group A	Requires sunshine for good foliar activity, organic matter and moisture determines soil activity

# Modes of Action & Translocation

Group	Examples	Uptake	Translocation	Site of Action	Mixing	Notes
D	Pendimethalin, Trifluralin	Soil only	Almost none	Cell division	Regularly mixed with Group L & M	Efficacy is reliant on even soil incorporation soon after application; volatile - gas loss an issue
F	Brodal®	Foliar/soil	Limited	Carotenoid bio-synthesis	Mixable	Good coverage is important
G	Blazer® Goal® Affinity®	Foliar	Limited	Chlorophyll/ Photosystem II	MCPA, Group M	Works better under warm conditions
I	2,4-D, MCPA, Dicamba, Comet®, Starane®, Lontrel®	Foliar and some soil	Phloem/xylem	Growing points	Mixable with Group A (Dims)	Reliable in most environments, do not mix well with Group A (Fops),
L	Paraquat	Foliar only	Limited	Photosystem II	Often mixed with soil active products e.g. Group C & D	Coverage required, poor control of large weeds

# 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)
<u>Lower range</u> <b>50 -60 L/ha</b> (Low stubble load) to <b>70-80 L/ha</b> (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 <b>NIGHT SPRAYING</b>
<u>Higher range</u> <b>70-80 L/ha</b> (Low stubble load) to <b>100 + L/ha</b> (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 <b>NIGHT SPRAYING</b>



# What are the effects of higher travel speeds and larger droplets on deposition ?

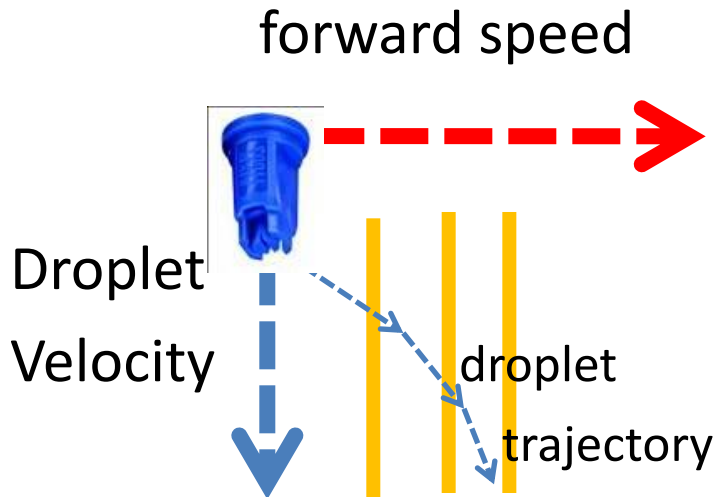


Photo by Simon Rogers (sprayed @ 33 km/h C/VC)

- increased interception by one side of the plants.
- increased shadowing behind standing stubble
- increased dust and wheel track issues
- increased losses to the environment



**Which job was done by a trailing rig?  
Which job was done by a Self Propelled?**



# **Effects of Speed, Volume and Droplet Size on deposition at various points around the sprayer**



Sprayer: Rogator  
1386

Nozzle 101C 025

8

Date Tested 18/12/12

Speed (km/h) 22

Volume (L/Ha) 60


Pressure Bar 4 bar

Spray Quality C (m)

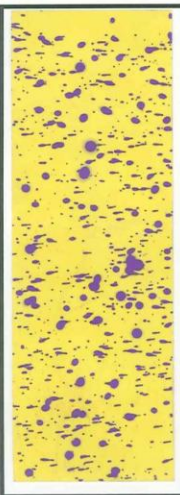
Temp(C) 22

Rel. Hum % 35

Wind Speed (km/h) 9-12

Wind Dir. Relative to sprayer travel.  


Left Boom



Between stubble line

Outside Left Wheel



Between stubble line

Inside Left Wheel



Between stubble line

Centre



Between stubble line

Inside Right Wheel



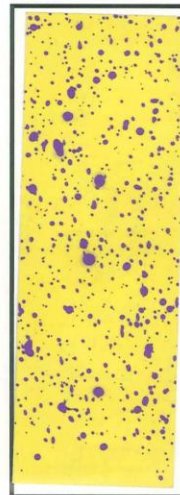
Between stubble line

Outside Right Wheel



Between stubble line

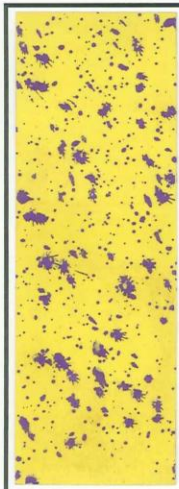
Right Boom



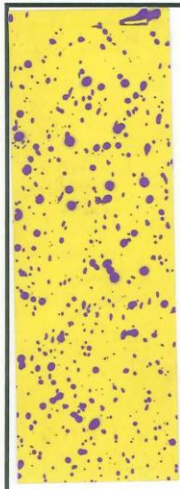
Between stubble line



Behind stubble



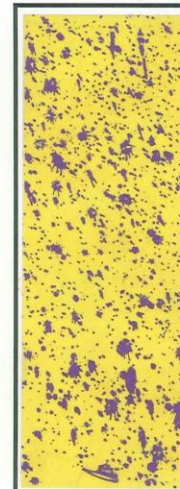
Behind stubble



Behind stubble



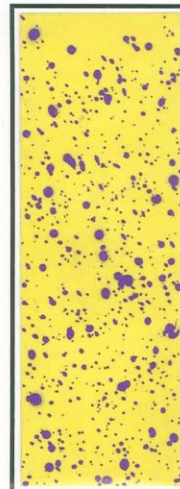
Behind stubble



Behind stubble



Behind stubble



Behind stubble



Sprayer: Rogator 1386

Nozzle 1DK 03

5:50 Date 19/12/12  
p.m. Tested

Speed (km/h) 30

114 Volume (L/Ha) 60

Pressure Bar 5

Spray Quality M

Temp(C) 34

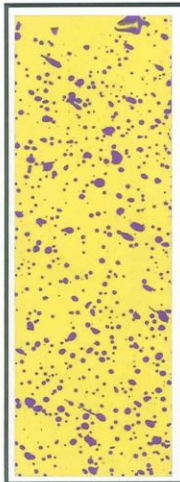
Rel. Hum %

Wind Speed (km/h) 7-10

Wind Dir. Relative to sprayer travel.

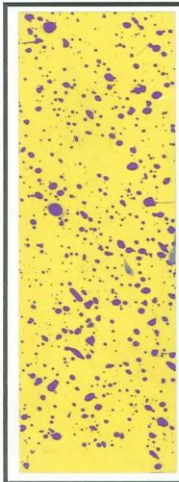


Left Boom



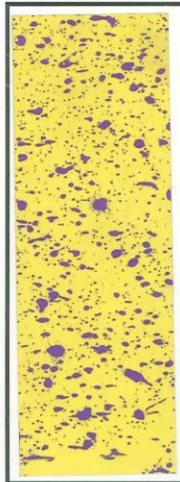
Between stubble line

Outside Left Wheel



Between stubble line

Inside Left Wheel



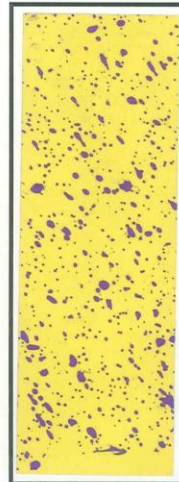
Between stubble line

Centre



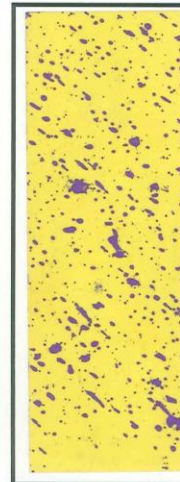
Between stubble line

Inside Right Wheel



Between stubble line

Outside Right Wheel



Between stubble line

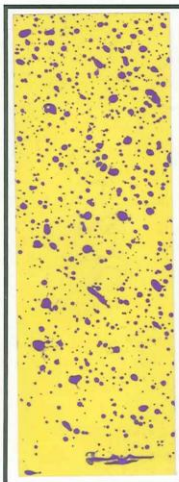
Right Boom



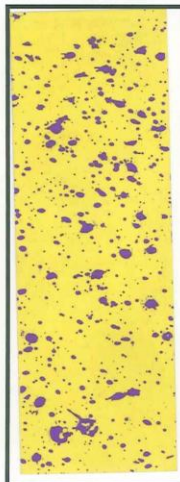
Between stubble line



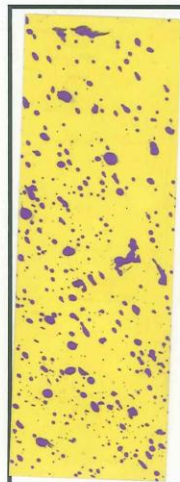
Behind stubble



Behind stubble



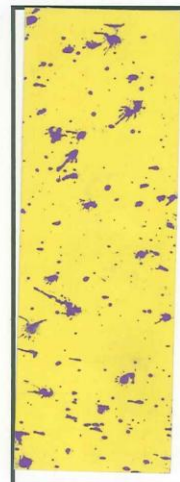
Behind stubble



Behind stubble



Behind stubble



Behind stubble



Behind stubble



Sprayer: Rogator 1386

Nozzle 10k 025 @ 25cm

Date Tested 18/12/12

Speed (km/h) 26

Volume (L/Ha) 80


Pressure Bar 2.5 bar

Spray Quality VC

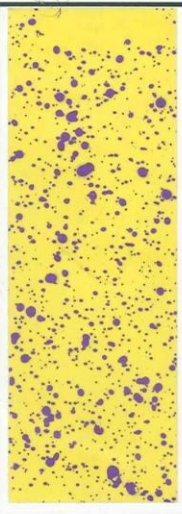
Temp(C) 21

Rel. Hum % 37

Wind Speed (km/h) 9-12

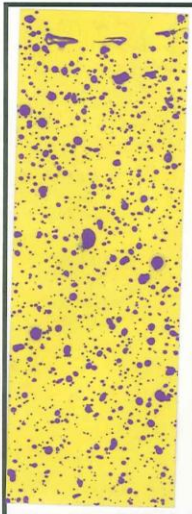
Wind Dir. Relative to sprayer travel. 

Left Boom



Between stubble line

Outside Left Wheel



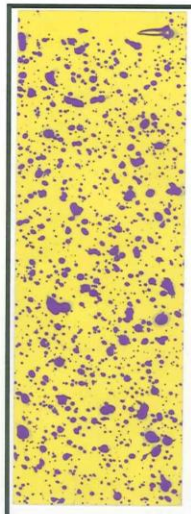
Between stubble line

Inside Left Wheel



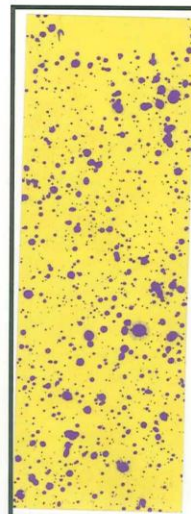
Between stubble line

Centre



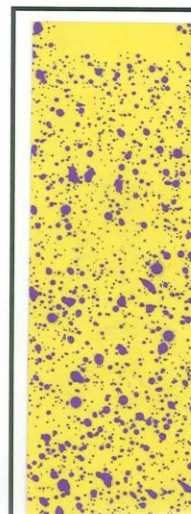
Between stubble line

Inside Right Wheel



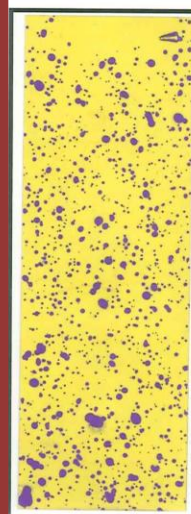
Between stubble line

Outside Right Wheel

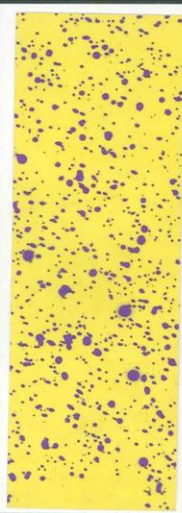


Between stubble line

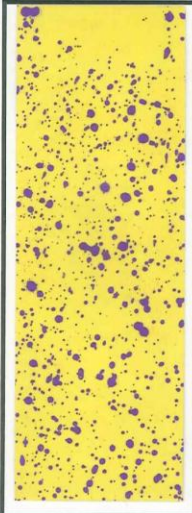
Right Boom



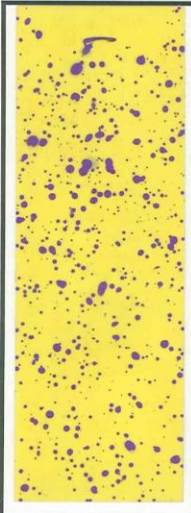
Between stubble line



Behind stubble



Behind stubble



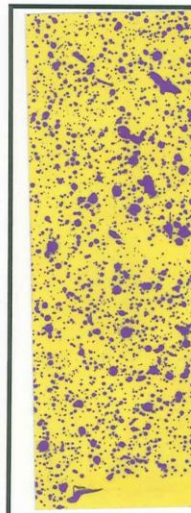
Behind stubble



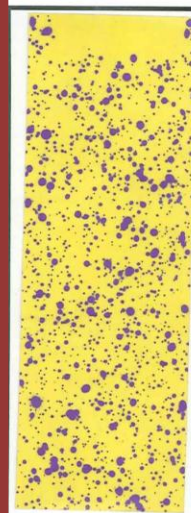
Behind stubble



Behind stubble

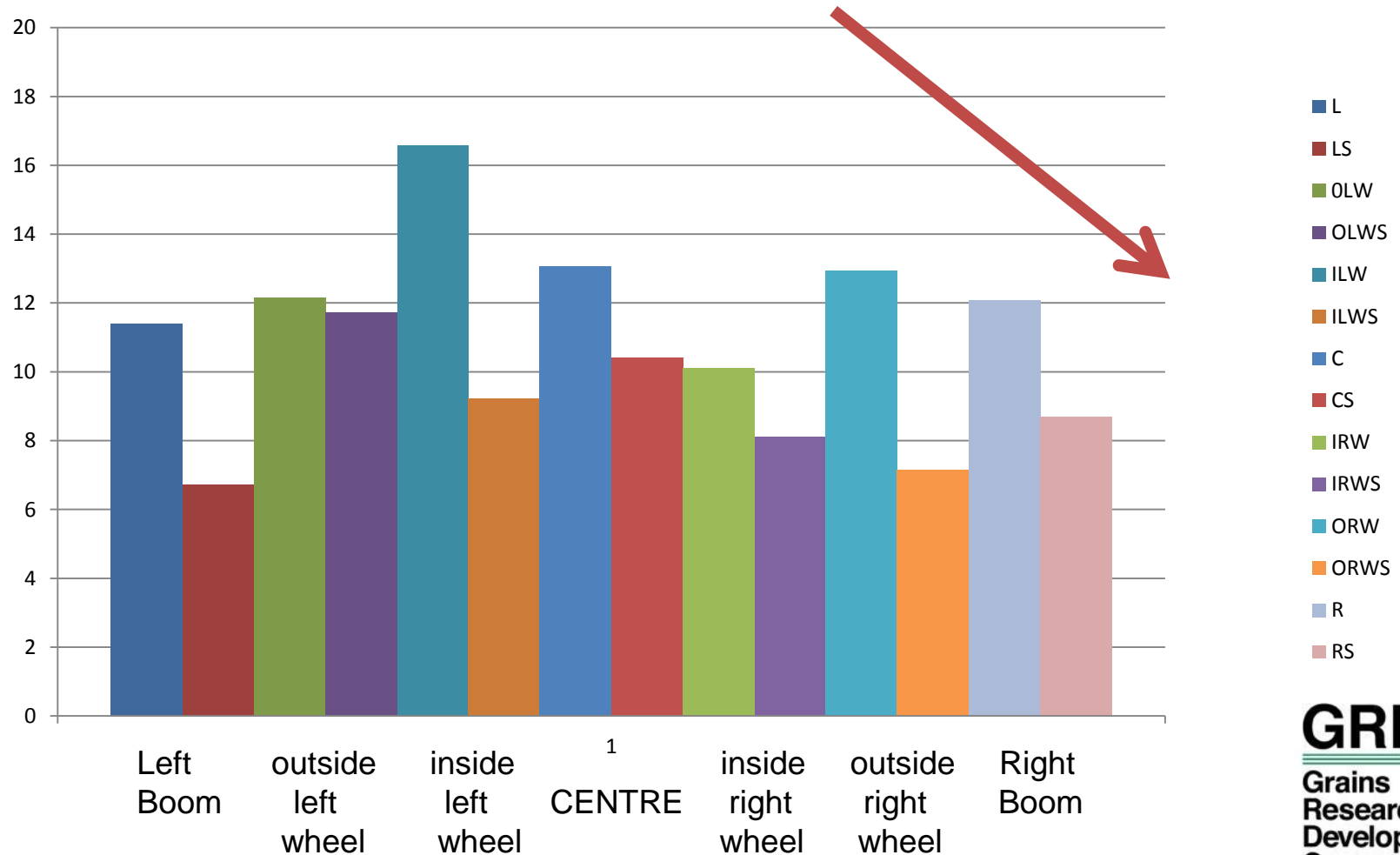


Behind stubble

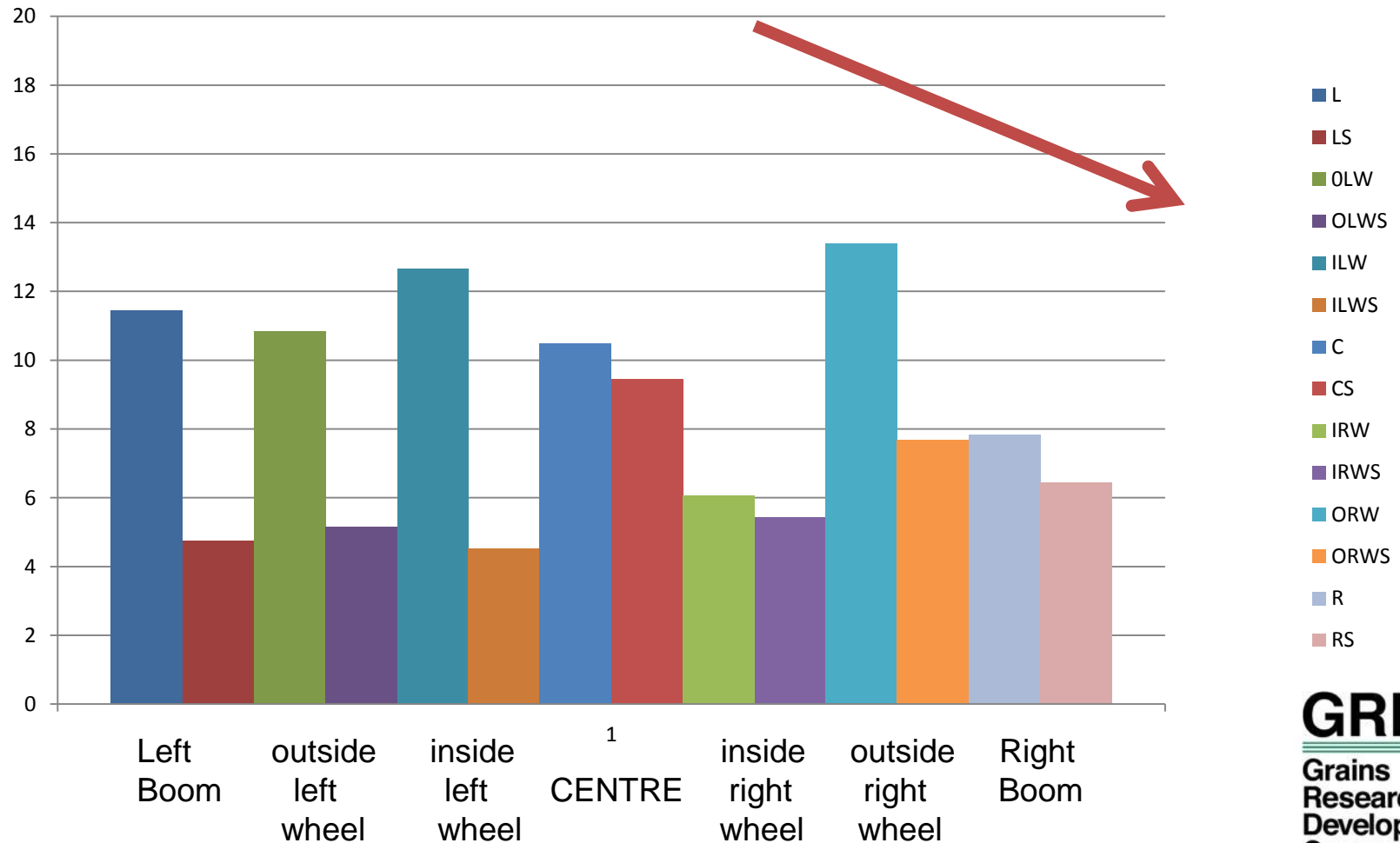


Behind stubble

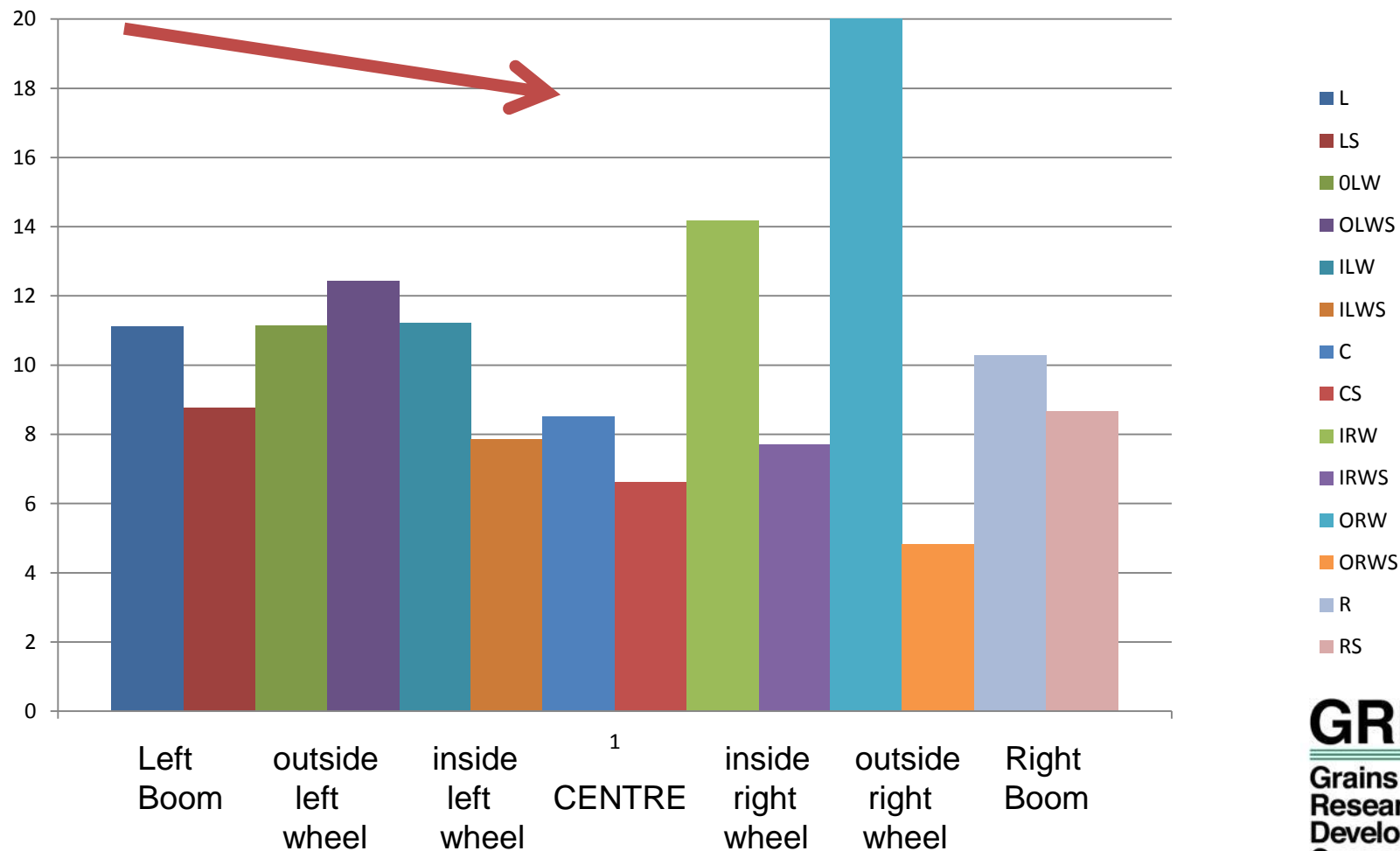
# 18 km/h, 60 L/ha, 50cm spacing AIXR 02 @ 4 bar



# 26 km/h, 60 L/ha, 25cm spacing AIXR 015 and 02 @ 2.5bar



# 31 km/h, 60 L/ha, 25cm spacing AIXR 015 and 02 @ 4 bar



# 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

# Take Home Messages

- Night Spraying is high risk for spray drift
- Efficacy will be affected by target condition (stress), rate of product and application volume ***more than time of application*** (if conditions are OK)
- Application volume and spray quality must match the products mode of action, the target & stubble load.
- High spraying speeds cause new problems (not just wheel tracks).

Nozzle Types	Images	Main Uses	Examples & Pressure Ranges	Drift Control:
<b>Pre-orifice</b>		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 <b>best above 2 bar</b>	<b>Poor to Moderate.</b>
<b>Low Pressure Air Induction</b>		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, <b>best above 3 bar</b>	<b>Moderate to Good</b>
<b>High Pressure Air Induction</b>		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, <b>best above 5 bar, never below 3 bar</b>	<b>Good to Very Good</b>
<b>Extended Range Flat Fans</b>		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	<b>VERY POOR</b>

			speed (km/h)											
nozzle size	pressure	flowrate	8	10	12	14	16	18	20	22	24	26	28	30
	(bar)	(L/min/nozzle)												
O1	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

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

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	

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 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

Hardi ISO Minidrft	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

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

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