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Comparison of pre-emergent herbicides for annual ryegrass control in wheat at four locations across Western Australia in 2016

Rick Horbury, Customer Advisory Representative, Bayer Crop Science

PURPOSE:

1. Compare the efficacy of commercial pre-emergent herbicides and mixtures for ARG control across multiple soil types using grower machinery for seeding and ongoing management consistent with the grower's practice.
2. Determine yield and $ return on investment to the grower from current standard pre-emergent herbicides Sakura®, trifluralin, Avadex® Xtra and Boxer® Gold® with new options such as standalone prosulfocarb, the main component of Boxer Gold. Prosulfocarb (e.g. Arcade®) must be incorporated within 7 days of application.

BACKGROUND SUMMARY

- Sakura, like other root uptake herbicides i.e. propyzamide works best when incorporated within a moist soil profile prior to or as weeds germinate.
- Sakura is not volatile, is UV stable, and can be applied up to 3 days ahead of incorporation adding flexibility to the sowing operation. Trifluralin and Avadex Xtra both require incorporation within 24 hours of application. Boxer Gold has an incorporation requirement of up to 7 days after application.
- 2016 was a season with a longer wetter spring than the recent seasons resulting in late weed emergence which was an issue for many growers where pre-emergent herbicides did not have sufficient residual activity to cover multiple annual ryegrass germinations in a long season.

Pre-emergent herbicides and rotation of chemical mode of action groups should form part of a fully Integrated Weed Management program with harvest weed seed management practices strongly recommended to reduce weed numbers and delay the onset of herbicide resistance.

SEASONAL CONDITIONS AND SITE COMMENTS

Conditions at sowing were generally favorable with a reasonable soil moisture profile at all sites. As a result, there was a strong early pre-sowing germination of weeds. All trials received an effective double knockdown, while Waddy Forest received a triple knockdown program consisting of glyphosate (Group M) followed by glufosinate-ammonium (Group N) and finally paraquat (Group L) applied at sowing, utilising the full range of available non-selective knockdown herbicide modes of action.

Despite the excellent pre-sowing weed control achieved at all locations weed numbers were high to very high in all four sites underlining the importance of long term management of weed seed banks to reduce ARG numbers.

The full moisture profile in the trials resulted in the pre-emergent herbicides being well activated at sowing. The good soil moisture also meant that there was a further strong initial flush of ryegrass in all sites due to the soil disturbance by sowing, requiring immediate herbicide activity to keep the ARG under control. Without this strong initial activation of the herbicides at sowing weed control could have been below commercially acceptable levels. In the trials at Waddy Forest, Cunderdin and Nugadong there was almost two weeks before significant follow up rainfall occurred which could have resulted in reduced efficacy had this scenario occurred on a more limited soil moisture profile.
With average, or higher than average rainfall through winter at all locations weeds continued to emerge through the later part of July as some of the herbicides ran out of efficacy before the crop had commenced stem elongation and shaded the soil on the inter-row resulting in further germinations of ryegrass competing with the crop.

TRIAL DETAILS

Trial ID	WE05	WE06	WE07	WE32
Location	Waddy Forest	Pithara	Cunderdin	Nugadong
Rotation last 2 years	wheat, wheat	canola, wheat	lupin, wheat	canola, wheat
Plot size & replication	2 m x 36 m x 3 replicates	2 m x 30 m x 3 replicates	2 m x 36 m x 3 replicates	2 m x 10 m x 3 replicates
Soil type	Loam	Gravelly loam	Sandy duplex	Grey sand
pH 0-10 cm($CaCl_2$)	Mid 5	5.5	Mid 5	5.9
Stubble cover	10% (burnt)	35% weeds & stubble	~25% (range 10-60%)	Not recorded
Variety	Mace	Mace	Trojan	Mace
Seeding rate/ ha	60 kg + Raxil 1 L/t	80 kg + Raxil® 1 L/t	70 kg/ha + Vibrance® 3.6 L/t,	55 kg + Raxil 1 L/t
Application:	Applied by Bayer Application Trailer 80 L/ha at 12 km/h using DG110002 nozzles with a medium droplet spectrum at 3 bar			Applied by Michael Macpherson
Sowing date	27/5/16	19/5/16	6/5/16	7/5/16
Hours to incorporation	~12 hours	≤2 hours	≤2 hours	~25 hours
Seeder type	knife points	Bourgault 8800 with Maxi knife points	JD with Conserva Pak Knife points	knife points
Press wheels	Yes	Yes	Yes	Yes
Row spacing	25.43 cm	20.3 cm	25..43 cm	25..43 cm
Sowing speed	8 km/h	8.5 km/h	9 km/h	Not recorded
Soil moisture	Moist, cloddy	Slight dry top, moist at depth, cloddy	Slight dry top, moist at depth,	Moist
Rainfall notes	9 mm that day 5 mm in next 14 days with 20 mm after that	12.5 mm that night 40 mm in first 7 days	Nil for 11 days 21 mm on 7/6/16	5 mm that day No significant rain till 15 mm on 20/5/16

TRIAL MANAGEMENT

Trial ID	WE05	WE06	WE07	WE32
Location	Waddy Forest	Pithara	Cunderdin	Nugadong
Fertiliser	100 kg/ha Agras®	100 kg/ha Agras	Agras 50 kg/ha + Flexi-N® 40 L/ha in-furrow	7/5/16: Agstar® Extra 40 kg/ha, + Urea 60 kg/ha 7/6/16: ZincMate® 500 mL/ha

				15/6/16: Flexi N 60 L/ha
Herbicides - knockdown	1/5/16: 2 L/ha glyphosate 13/5/16 3 L/ha Basta® (glufosinate-ammonium)	28/4/16: 1.1 kg/ha Ken-Up® dry 680 + 100 mL/ha oxyfluorfen	21/4/16 - Roundup® Ultra® 1 L/ha + Estercide® 680 300 mL/ha + SOA + LI700	glyphosate rate and date not recorded
Herbicides: knockdown with pre-emergent treatments	27/5/16 3 L/ha paraquat	19/5/16 3 L/ha paraquat	6/5/16 – Roundup® Attack 2 L/ha	7/5/16 Eradicator® 450 2 L/ha
Herbicides and fungicides post-emergent	Not recorded	670 mL/ha Velocity® + Uptake® 0.5 % v/v	Jaguar® 700 mL/ha + Flexi-N 40 L/ha	07/06/2016: Jaguar 1 L/ha + MCPA LVE 450 mL/ha + 150 mL/ha tebuconazole 430
Growing Season Rainfall	299 mm	236 mm	248 mm	236 mm

RESULTS

Location	WE05 Waddy Forest (1831 panicles/ m^2)			WE06 Pithara (843 panicles/ m^2)			WE07 Cunderdin (1033 panicles/ m^2)			WE32 Nugadong (493 panicles/m^2)					
Treatments applied	27/05/2016			19/05/2016			06/05/2016			06/05/2016					
Soil type/ rainfall 24 hrs	Loam, nil			Gravel loam, 15 mm			Sandy loam, 12 mm			Sandy, nil					
Assessment Date	22/06	27/07	20/09	23/06	26/07	21/09	16/06	11/08	23/09	16/06	11/08	23/09	**Average ARG % control all sites**		
Treatment	Early - 26 DAA	Mid - 61 DAA	Final - 116 DAA	Early - 35 DAA	Mid - 68 DAA	Final - 125 DAA	Early - 41DAA	Mid - 97 DAA	Final - 140 DAA	Early - 26 DAA	Mid - 45 DAA	Final - 137 DAA	**Early (26-41 DAA)**	**Mid (45-97 DAA)**	**Final panicle (116-140 DAA)**
Sakura WG 118 g/ha + trifluralin 1.5 L/ha	92	95	97	97	95	96	90	90	90	92	91	98	**93**	**93**	**95**
Sakura 118 g/ha	89	94	93	97	95	95	90	90	92	84	85	92	**90**	**91**	**93**
Boxer Gold 2.5 L/ha + trifluralin 2 L/ha	90	76	69	93	89	87	90	82	79	81	73	80	**88**	**80**	**79**
Boxer Gold 2.5 L/ha	88	79	75	91	77	75	88	83	70	82	67	78	**87**	**76**	**75**
Prosulfocarb 3 L/ha	84	84	76	96	87	83	87	80	72	70	56	67	**84**	**77**	**74**

Prosulfocarb 2.5 L/ha	85	80	73	93	76	77	84	72	61	69	52	67	**83**	**70**	**69**
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha	87	70	62	89	82	66	70	60	53	76	72	68	**81**	**71**	**62**
Avadex Xtra 3 L/ha	83	65	58	82	73	63	68	62	53	-	-	-	**78**	**67**	**58**
Trifluralin 2 L/ha	73	58	48	82	73	58	53	37	35	64	67	68	**68**	**59**	**52**

Figure 1. Average pre-emergent ARG control ratings at early and mid-season with final panicle counts by herbicide across four WA locations in 2016

Weed control ratings comments

It is important to note that early weed control in June or July does not equate to final ARG control at the end of the growing season which is what really counts for seed bank management. The best assessment of a treatments performance is the final panicle counts highlighted in grey.

Early season assessment 26-41 days after application (DAA)
Based on ratings Sakura treatments recorded the highest control of ARG across the four sites. Boxer Gold with or without trifluralin was comparable to Sakura stand alone. Prosulfocarb treatments s recorded slightly lower control with trifluralin and Avadex treatments lower again. The Cunderdin site in particular is suspected of having trifluralin resistance (Group D).

Mid-season assessment 45-97 DAA
Sakura treatments continued to record ARG control consistent with early season ratings. Most other treatments recorded lower levels of control than in the first assessment indicating that activity had reduced with new ARG germinations occurring.

Final panicle control – What is going back into my seed bank?
Panicle counts are the most reflective measure of the effectiveness of a herbicide program's impact on how much weed seed is being set and being contributed to the seed bank of the paddock for future crop rotations.

Based on final panicle ratings only the two Sakura treatments recorded commercially acceptable control of ARG due to Sakura's long residual activity. The tank mixture of Sakura with trifluralin, a shoot uptake and volatile herbicide, recorded an increase in control (4-6%) on the two sites with sandier soil types Cunderdin and Nugadong. On the heavier soil types at Pithara and Waddy Forest there was no significant weed control benefit from the addition of trifluralin to Sakura.

Reduced weed competition from an effective herbicide like Sakura with its long residual activity can improve the water and nutrient efficiency of the crop to maintain yield potential.

Based on the four site average Boxer Gold (75%) and prosulfocarb 3 L/ha (74%) recorded comparable final ARG panicle control with a rate response from the lower prosulfocarb rate of 2.5 L/ha (69%). The tank mixture of trifluralin + Avadex (62%) performed slightly ahead of Avadex 3 L/ha (58%) in two of the three sites the straight Avadex was present in. Trifluralin at 2 L/ha recorded the lowest average level of control (52%) influenced by poor results at the Waddy Forest and Cunderdin trial sites.

With the long soft conditions throughout spring surviving ryegrass was able to produce high numbers of panicles and therefore seed. Growers with this scenario need to consider the implications of this seed set for following seasons and implement measures to control weed numbers with herbicides, rotations and harvest weed seed management techniques.

Figure 4. Yield (t/ha), gross margin ($/ha) and $return on investment ($ROI/ha) from Waddy Forest and Pithara in Mace wheat

Trial Location and weed density		16WE05 – Waddy Forest (1831 panicles/ m^2)				16WE06 - Pithara (843 panicles/ m^2)				
Treatment	**Cost $/ha**	**Yield t/ha**		**Gross $/ha**	**$ROI/ ha**	**Yield t/ha**		**Grade**	**Gross $/ha**	**$ROI/ ha**
Untreated	*$0.00*	1.57	a	$329.70		2.30	b	ASW1	$510.60	
Sakura WG 118 g/ha + trifluralin 1.5 L/ha	$51.90	2.60	a	$546.00	$158.40	2.82	a	ASW1	$626.04	$57.54
Sakura 118 g/ha	$40.10	2.31	a	$485.10	$109.30	2.81	a	ASW1	$623.82	$67.12
Prosulfocarb 2.5 L/ha	$29.75	2.31	a	$485.10	$119.65	2.65	ab	ASW1	$588.30	$41.95
Avadex Xtra 3 L/ha	$29.75	1.85	a	$388.50	$23.05	2.41	ab	ASW1	$535.02	-$11.33
Prosulfocarb 3 L/ha	$35.70	1.91	a	$401.10	$29.70	2.70	ab	AGP1	$567.00	$14.70
Boxer Gold 2.5 L/ha	$38.28	2.14	a	$449.40	$75.42	2.40	ab	ASW1	$532.80	-$22.08
Trifluralin 2 L/ha	$11.80	1.87	a	$392.70	$45.20	2.35	ab	ASW1	$521.70	-$6.70
Boxer Gold 2.5 L/ha + trifluralin 2 L/ha	$50.08	2.22	a	$466.20	$80.42	2.28	b	AGP1	$478.80	-$87.88
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha	$31.63	1.75	a	$367.50	$0.17	2.43	ab	AGP1	$510.30	-$37.93
Application cost $6/ha	**LSD**	0.665				0.285				
Kwinana ASW1 9/11 $222	**St. Dev**	0.388				0.166				
Kwinana AGP1 9/11 $210	***CV***	18.66				6.58				

Means followed by same letter do not significantly differ (P ≥5%), Duncan's New Multiple Range. Note: All treatments met AGP1 grade at Waddy Forest, Cunderdin and Nugadong. Pithara grades noted.

Treatments that failed to make ASW1 at Pithara were due to the grain samples exceeding the 0.6% allowable level of small foreign seeds in this case annual ryegrass.

Figure 5. Yield (t/ha), gross margin ($/ha) and $ROI/ha from Cunderdin (Trojan) and Nugadong (Mace)with average gross margin ($/ha) and average $ROI/ha across 4 trials

Trial Location and weed density		16WE07 - Cunderdin (1033 panicles/ m^2)			Liebe - Nugadong (493 panicles/m^2)			Average of all four sites	
Treatment	**Cost $/ha**	**Yield t/ha**	**Gross $/ha**	**$ROI/ ha**	**Yield t/ha**	**Gross $/ha**	**$ROI/ ha**	**Average Gross $/ha**	**Average $ROI/ ha**
Untreated	*$0.00*	1.50	$315.00		1.23	$257.32		$353.16	
Sakura WG 118 g/ha + trifluralin 1.5 L/ha	$51.90	1.81	$434.40	$61.50	1.68	$351.77	$36.55	$489.55	$78.50
Sakura 118 g/ha	$40.10	1.95	$468.00	$106.90	1.50	$314.01	$10.59	$472.73	$73.48
prosulfocarb 2.5 L/ha	$29.75	1.66	$348.60	-$2.15	1.57	$329.06	$35.99	$437.76	$48.86
Avadex Xtra 3 L/ha	$29.75	1.75	$420.00	$69.25	-	-	-	$447.84	$26.99
prosulfocarb 3 L/ha	$35.70	1.65	$396.00	$39.30	1.40	$294.53	-$4.49	$414.66	$19.80
Boxer Gold 2.5 L/ha	$38.28	1.67	$350.70	-$8.58	1.57	$330.44	$28.84	$415.84	$18.40
Trifluralin 2 L/ha	$11.80	1.31	$314.40	-$18.40	1.35	$283.82	$8.70	$378.15	$7.20
Boxer Gold 2.5 L/ha + trifluralin 2 L/ha	$50.08	1.69	$354.90	-$16.18	1.66	$348.82	$35.42	$412.18	$2.94
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha	$31.63	1.50	$315.00	-$37.63	1.42	$297.21	$2.26	$372.50	-$18.28
Application cost $6/ha	**LSD**	NS			NS				
Kwinana ASW1 9/11 $222	**St. Dev**	0.3			0.3				
Kwinana AGP1 9/11 $210	***CV***	16			18				

Note: All treatments met AGP1 grade at Waddy Forest, Cunderdin and Nugadong. Pithara grades noted.

Yield discussion - four trial average
Over all four trials both Sakura treatments maintained a positive $ROI/ha with Sakura + trifluralin ($78.50) slightly ahead on average $ROI/ha to the standalone Sakura ($73.48)

Sakura 118 g/ha recorded a $55.08 increase in $ROI/ha over Boxer Gold across the four trials. Boxer Gold $ROI was generally in line with that of the prosulfocarb treatments in three of the sites, except from Waddy Forest where prosulfocarb 2.5 L/ha recorded a higher yield. Why this occurred is not clear as results were cross checked back with the contractor to ensure there was not a transcription error.

Trifluralin, due to its poor weed control, especially at Cunderdin, returned a slight positive $ROI/ha ($7.20) across the four trials.
All four sites to some extent were affected by frost which may have affected yield outcomes.

Getting weed control right is the key to ensuring the longevity of any herbicide but it also allows the crop it's best possible chance of achieving its yield potential. Using a program of effective knockdowns and a product with a long residual activity like Sakura can deliver higher yields and returns across a variety of soil types and locations as seen across the four trials conducted during the 2016 season.

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PAPER REVIEWED BY
David Gregor – Regulatory Affairs Manager.

CONTACT
Rick Horbury
E: rick.horbury@bayer.com
Ph: 0429 055 154
Twitter: @HorburyRick