A comparison of pre-emergent herbicides for the control of annual ryegrass in Scepter wheat across two trials in 2017.

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Key messages

- *All pre-emergent herbicides showed a positive $ROI when compared to the untreated control, however even the best treatments were allowing some annual ryegrass (ARG) panicles to set seed.*
- *The superior performance of the three Sakura treatments with their longer residual activity and the trifluralin + post-emergent Boxer Gold treatment (when applied under good conditions) highlighted the strength of a longer period of activity to reduce annual ryegrass numbers.*
- *Post emergent applications of Boxer Gold are highly reliant on favourable conditions, as seen when comparing results at West Buntine and Arrino. When applied to small weeds in a moist soil profile, and a follow up rainfall event occurs – this can be a successful method of weed control.*
- *Early weed control ratings (at 2-6 weeks after weed germination) are not reflective of the final number of weed seeds re-entering the seed bank.*

Background

In 2017 two trials were conducted in the northern WA Wheatbelt by Bayer Crop Science and Syngenta comparing the yield, profitability and level of weed control of different pre-emergent and early post-emergent herbicides in a wheat crop.

There are a range of pre-emergent herbicide modes of action available for use by growers to control grass weeds which all perform differently due to the varying properties of their respective active ingredients. These properties include the unique herbicidal capabilities of each product, the level of water solubility, soil/stubble binding characteristics, volatility, residual lifespan, as well as their spectrum of activity on other weeds.

Work carried out by the Australian Herbicide Resistance Initiative (AHRI) suggests a mixture of herbicides with different modes of action is a stronger long term resistance strategy. However, trials conducted by AHRI have proven that herbicide groups J & K should be considered the same in terms of resistance management despite having different modes of action. 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 also recommended to reduce weed numbers and delay the build-up of resistant weed populations. Do not rely solely on herbicides.

Trial Details

Trial ID	WF07	WE07
Location	Dodd's Property, West Buntine	Dempster's Property, Arrino
Plot size & replication	20 m x 2 m x 3 replications	20 m x 2 m x 3 replications
Soil type	Sandy loam over gravel	Grey sand
Soil pH ($CaCl_2$)	0-10 cm: 6.2 10-20 cm: 4.4 20-30 cm: 4.4	0-10 cm: 4.8 10-20 cm: 4.4 20-30 cm: 4.5
EC (dS/m)	0-10 cm: 0.058 10-20 cm : 0.021 20-30 cm: 0.025	0-10 cm: 0.041 10-20 cm : 0.018 20-30 cm: 0.021
Paddock history:	2016 wheat	2016 wheat
Sowing date	24/05/2017	18/05/2017
Sowing rate	60 kg/ha Scepter wheat treated with EverGol® Energy 260 mL/100 kg	60 kg/ha Scepter wheat treated with EverGol® Energy 260 mL/100 kg
Fertiliser	24/05/17: 100 kg/ha Gusto Gold + 50 kg/ha urea 15/08/17: 40 L/ha UAN	18/05/17: 100 kg/ha Gusto Gold + 50 kg/ha urea 20/07/17: 50 L/ha UAN
Herbicides, insecticides & fungicides	24/05/17: 100 mL/ha Talstar® + 1 L/ha Lorsban®, 2 L/ha Roundup® Ultra®MAX 24/05/17: Application A as per treatment list 11/08/17: Application B as per treatment list 15/08/17: 670 mL/ha Velocity® + 1% Hasten®	18/05/17: 100 mL/ha Talstar® + 1 L/ha Lorsban®, 1.5 L/ha Roundup® Ultra®MAX + 2 L/ha Spray.Seed® 18/05/17: Application A as per treatment list 15/06/17: Application B as per treatment list 10/08/17: 670 mL/ha Velocity® + 1% Hasten®
Growing season rainfall	112.5 mm	255 mm

Table 1: A list of treatments used in this trial, and their cost to the grower. Application costs are the price as of December 2017, and take into account price reductions for several products leading into the 2018 season.

	Pre-emergent herbicide	**Herbicide MOA**	**Company**	**Cost $/ha (herbicide only)**	**Cost $/ha (applied)**
1	Untreated			$0.00	$0.00
2	Trifluralin 2 L/ha	D	-	$11.80	$17.80
3	Trifluralin 2 L/ha + Logran® (triasulfuron) 25 g/ha	D + B	-	$13.80	$19.80
4	Trifluralin 2 L/ha + Monza® (sulfosulfuron) 25 g/ha	D + B	-	$15.80	$21.80
5	Trifluralin 2 L/ha + Avadex® Xtra (triallate) 2 L/ha	D + J	-	$29.80	$35.80
6	Trifluralin 2 L/ha + Arcade® (prosulfocarb) 2.5 L/ha	D + J	Syngenta	$33.05	$39.05
7	Arcade 2.5 L/ha	J	Syngenta	$21.25	$27.25
8	Arcade 3 L/ha	J	Syngenta	$25.50	$31.50
9	Boxer Gold® 2.5 L/ha	J + K	Syngenta	$27.50	$33.50
10	Sakura® WG 118 g/ha	K	Bayer	$40.10	$46.10
11	Sakura SC 210 mL/ha	K	Bayer	-	-
12	Sakura WG 118 g/ha + trifluralin 1.5 L/ha	K + D	Bayer	$48.95	$54.95
13	Boxer Gold 2.5 L/ha + trifluralin 2 L/ha	J + K + D	Syngenta	$39.30	$45.30
14	Trifluralin 2 L/ha followed by post-emergent Boxer Gold 2.5 L/ha	D J + K	Syngenta	$39.30	$51.30
15	Nil followed by post-emergent Boxer Gold 2.5 L/ha	- J + K	Syngenta	$27.50	$33.50

Seasonal conditions and site comments

This annual ryegrass population at the Buntine was independently tested by Plant Science consulting following the 2016 season with no resistance detected to the MOA's in this trial. The results for the resistance status of the annual ryegrass population at the Arrino site will be available in April 2018.

The wheat stubble from the 2016 crop at both sites was burnt during the autumn. There was little to no surface organic matter present to tie up pre-emergent herbicides at application, and no stubble to intercept the post emergent application. This was in the favour of active ingredients with high stubble binding properties such as trifluralin and prosulfocarb; it can be assumed that in a scenario with stubble present that less of these active ingredients would be successfully incorporated into the root zone.

The Arrino trial was sown on the 18th of May 2017 with germinating rains totalling 20 mm received within a week of sowing (see figure 1 for rainfall distribution). This early season rain allowed all herbicide treatments to activate and a significant flush of annual ryegrass to occur. The majority of the ARG could be found in the furrow possibly due to a water harvesting effect. The post emergent treatment was applied under dry conditions on the 15th of June (28 days after sowing) due to the weed size at the time (2-3 leaf). No further significant rainfall events occurred until the 21st of June, after which a second flush of annual ryegrass was observed following 15 mm of rain over three days. Steady rainfall events occurred for the rest of the growing season.

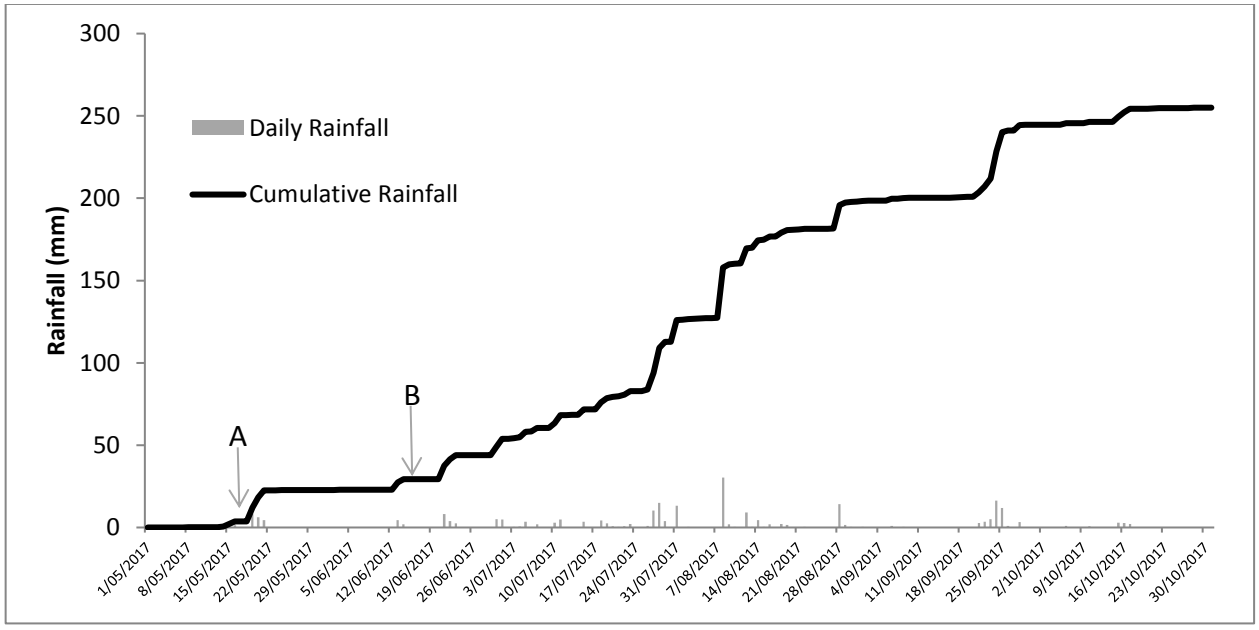

Figure 1: Cumulative rainfall at the Mingenew-Irwin Group 2017 trial site near Arrino. Application A represents the timing of the pre-emergent treatments. Application B represents the timing of the post-emergent treatment.

The Buntine trial was sown on the 24th of May 2017, following approximately 3 mm of rain over the previous 24 hours. Despite this, no weed emergence or crop germination occurred (see figure 2 for rainfall distribution). The next rainfall event was not for another 41 days, on the 3rd of July; 8 mm of rain fell over the course of a week, resulting in an evenly emerged crop. The first substantial rains of the growing season were not received until the 28th of July (65 days after sowing), where 21 mm fell over four days: this was enough to germinate a large stand of annual ryegrass. The majority of the ryegrass could be found in the furrow possibly due to a water harvesting effect. The post emergent Boxer Gold application was applied on the 11th of August (79 days after sowing) three days after a 17 mm rainfall event. The target weed (annual ryegrass) was mostly at the 2-3 leaf growth stage and the crop at Z14,21 (early tillering). 23 mm of follow-up rain was received on the 12th of August.

Grain quality was only determined from replicate 2 at these sites.

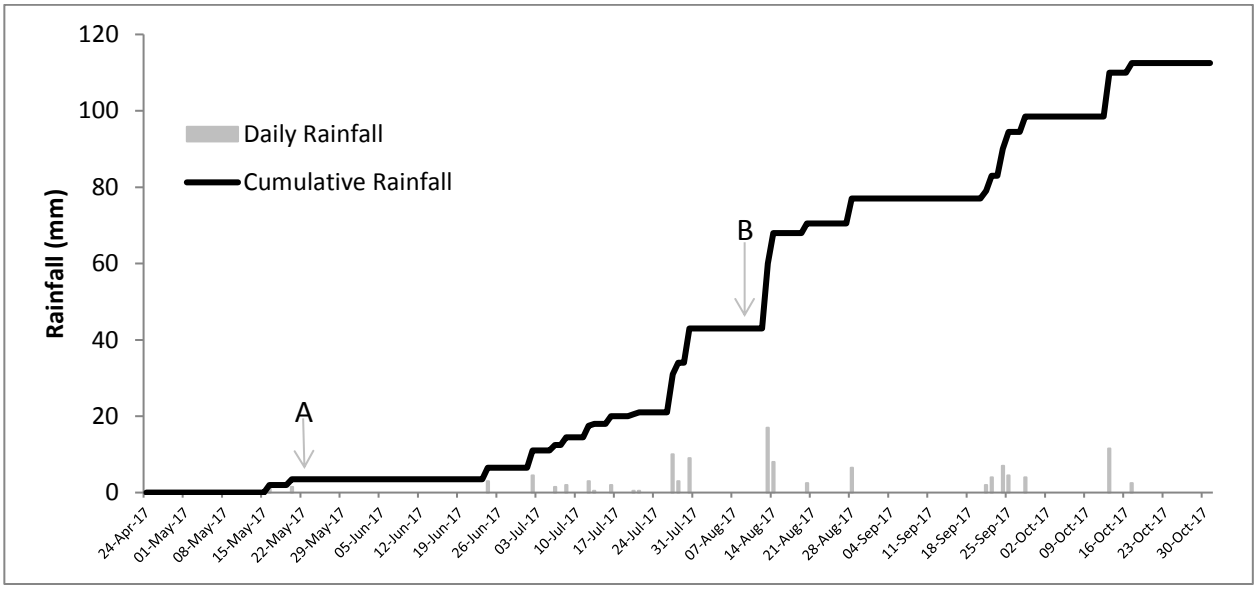

Figure 2: Cumulative rainfall at the Liebe Group 2017 trial site near West Buntine. Application A represents the timing of the pre-emergent treatments. Application B represents the timing of the post-emergent treatment.

Results – Weed Control

Early weed control is important for removing competition for moisture and nutrition for an early developing crop to help set up the best possible final yield. It is important to note however, that early weed control in June or July does not necessarily equate to final ARG control at the end of the growing season. The best measure of treatment performance in relation to weed seed bank management is a count of panicles prior to harvest.

Due to the dry start to the season at the Buntine site there was no germination of ARG until July. The complete lack of early moisture meant that the herbicide treatments did not activate immediately. During the first weed control rating at Buntine (see table 3) in August it was observed that the best level of control was observed in the three Sakura treatments (90-94% rating), Boxer Gold + trifluralin (88%) and the split trifluralin followed by Boxer Gold post emergent also recorded good control. The two standalone Arcade treatments recorded reduced control compared to Boxer Gold highlighting the improved control from the S-metolachlor.

The highest level of ARG control from the second assessment during the Liebe Group Field Day in September was recorded for the trifluralin + post emergent Boxer Gold treatment (91%). The three Sakura treatments (85-86% control rating) recorded the next best control.

Final panicle counts (see table 3) on the 11th October showed that the highest level of ARG control was recorded from trifluralin + post emergent Boxer Gold (84%) and Sakura SC (84%). Sakura WG and Sakura WG + trifluralin treatments recorded slightly lower control based on counts although earlier ratings recorded similar performance, with the addition of trifluralin improving control. Trifluralin + Avadex Xtra and Boxer Gold + trifluralin provided a reduction in panicle numbers in the range of 63-67%. All other treatments provided a reduction of less than 60% of panicle numbers.

Table 3: Level of annual ryegrass control in Scepter wheat at trials at Arrino and Buntine. Arrino trial ARG control rating assessed on 27th June (40 DAA, 12 DAB) and 3rd August (77 DAA, 49 DAB), panicle count assessed on 12th October (147 DAA, 119 DAB). Buntine trial ARG control rating assessed on 17th August (85 DAA, 6 DAB) and 14th September (113 DAA, 34 DAB), panicle count assessed on 11th October (140 DAA, 61 DAB).

			Arrino site					Buntine site				
	Pre-emergent treatment	Herbicide Modes of Action	% ARG control 12 DAB	% ARG control 49 DAB	ARG panicles /m²		Panicles % UTC	% ARG control 6 DAB	% ARG control 34 DAB	ARG panicles /m²		Panicles % UTC
1	Untreated	-	0	0	**554**	a	**0**	0	0	**765**	a	**0**
2	Trifluralin 2 L/ha	D	76	73	283	b-e	**49**	80	73	367	b	**52**
3	Trifluralin 2 L/ha + Logran® 25 g/ha	D + B	77	73	266	cde	**52**	-	-	-	-	**-**
4	Trifluralin 2 L/ha + Monza® 25 g/ha	D + B	-	-	-		**-**	82	81	316	bcd	**59**
5	Trifluralin 2 L/ha + Avadex® Xtra 2 L/ha	D + J	78	73	251	cde	**55**	83	75	249	b-e	**67**
6	Trifluralin 2 L/ha + Arcade® 2.5 L/ha	D + J	78	70	329	bc	**41**	85	73	332	bc	**57**
7	Arcade 2.5 L/ha	J	78	72	277	cde	**50**	75	55	419	b	**45**
8	Arcade 3.0 L/ha	J	-	-	-		**-**	78	70	415	b	**46**
9	Boxer Gold® 2.5 L/ha	J + K	80	72	298	bcd	**46**	84	75	316	bcd	**59**
10	Sakura® WG 118 g/ha	K	89	87	161	de	**71**	90	85	176	cde	**77**
11	Sakura SC 210 mL/ha	K	91	84	153	de	**72**	93	86	130	e	**83**
12	Sakura WG 118 g/ha + trifluralin 1.5 L/ha	K + D	93	90	124	e	**78**	94	86	146	de	**81**
13	Boxer Gold 2.5 L/ha + trifluralin 2 L/ha	J+K+D	-	-	-		**-**	88	79	263	b-e	**66**
14	Trifluralin 2 L/ha followed by post emergent Boxer Gold 2.5 L/ha	J+K+D	83	76	251	cde	**55**	88	91	126	e	**84**
15	Nil followed by post emergent Boxer Gold 2.5 L/ha	J + K	75	68	438	ab	**21**	-	-	-	-	**-**
				LSD P=Various	143.2				LSD P=Various	150.9		
				St Dev	84.6				St Dev	90.3		
				CV	29.98				CV	29.49		

Means followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

Early weed control ratings at Arrino (see table 3) showed the highest levels (84-93%) of ARG control from the Sakura treatments across both assessment timings, and initially from the trifluralin followed by post-emergent Boxer Gold treatment (83% control 12 DAB).

Conditions at the Arrino site were different to the Buntine site due to the germinating rain in the week after sowing. This early season rain allowed all herbicide treatments to activate

and a significant flush of annual ryegrass to occur. However, a proportion of the ARG did not germinate until the next significant rain in late June. As a result the Arrino trial is a good comparison of residual weed control with reduced ARG panicle reduction (≤55%) from trifluralin, prosulfocarb and triallate treatments due to this later germination of ARG. Sakura treatments with their longer residual activity recorded improved ARG panicle reduction (71-78%) although the extended dry conditions reduced overall efficacy.

Results – Yield

There was a significant increase in yield between the Sakura treatments and the other treatments. The yield of the wheat in the trifluralin treatment was 1.71 t/ha, whereas it increased to 1.97 t/ha when treated with Sakura instead. The addition of trifluralin to Sakura resulted in a yield of 2.06 t/ha. There also appears to be a trend between the level of weed control and the yield of the wheat (see figure 3).

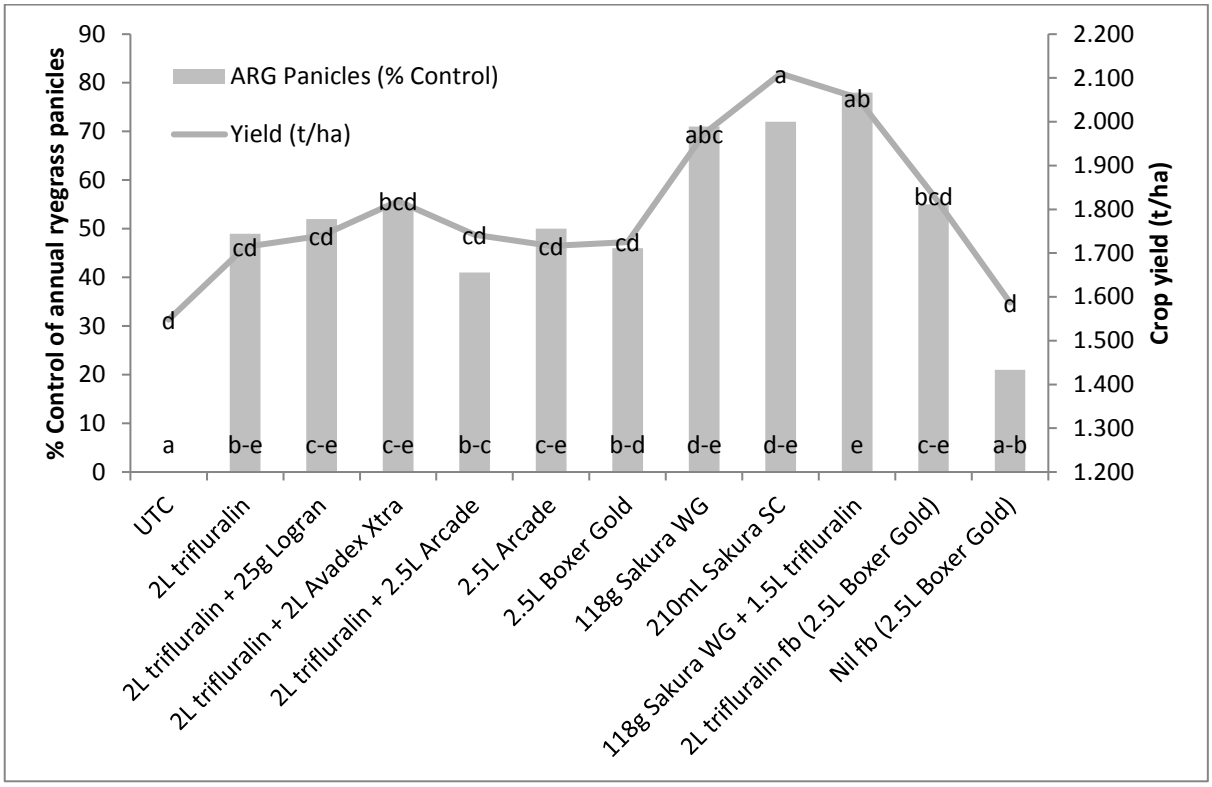

Figure 3: Annual ryegrass panicle control and crop yield results comparing different pre-emergent herbicide treatments in a Scepter wheat crop at Arrino. Data points followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

Although there was no statistical difference in the yield between the treatments at the Buntine site, there was a trend observed (see figure 4) toward increased yield for treatments with higher control of annual ryegrass panicles.

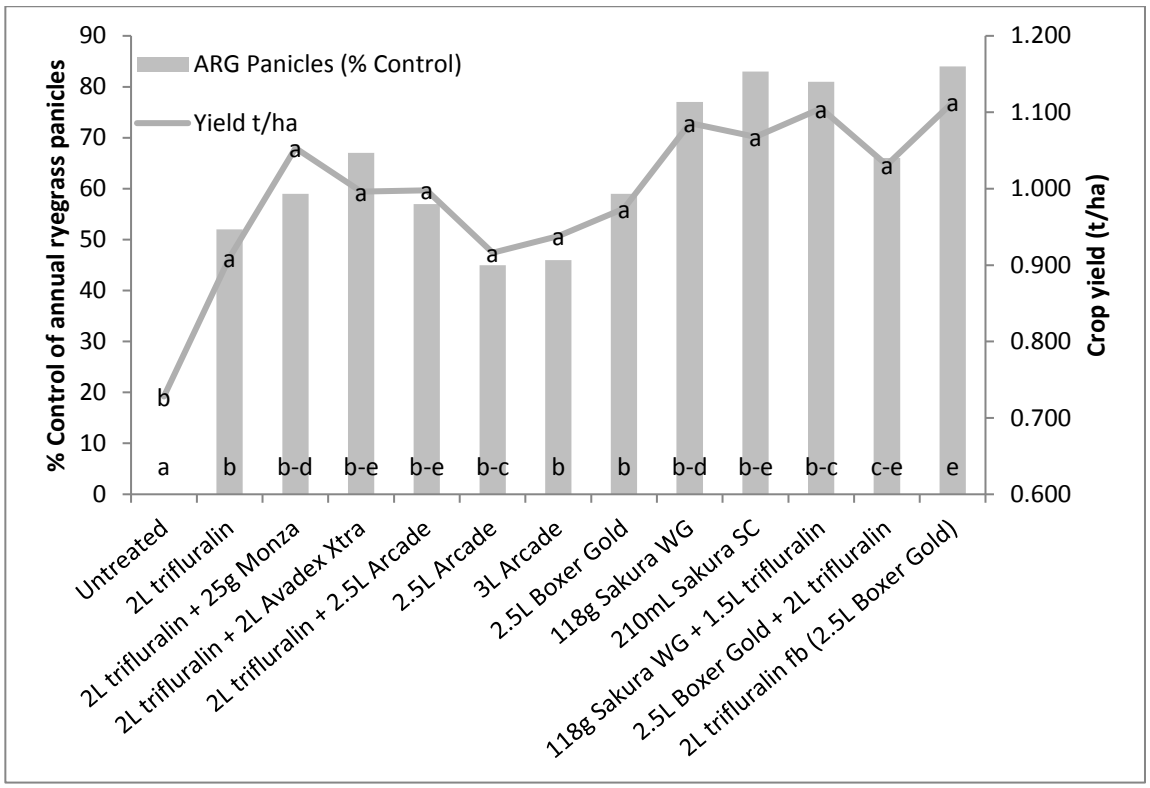

Figure 4: Annual ryegrass panicle control and crop yield results comparing different pre-emergent herbicide treatments in a Scepter wheat crop at West Buntine. Data points followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

Results – Return on Investment

Table 4: Yield (t/ha), gross margin ($/ha) and $ return on investment ($ROI/ha) in Scepter wheat at Arrino. Note that $ROI for treatment 9 is not available due to it not having a retail price at the time of publication.

	Treatment	Cost $/ha	Grade	Protein %	HL weight (kg/hL)	Screenings %	Yield t/ha		% UTC	Gross $/ha	$ROI/ ha
1	Untreated	$0.00	ASW1	8.1	77.55	3.30	1.55	d	100	$396.29	-
2	Trifluralin 2 L/ha	$11.80	ASW1	8.7	77.62	3.69	1.71	cd	111	$438.78	**$24.70**
3	Trifluralin 2 L/ha + Logran 25 g/ha	$13.80	ASW1	8.7	78.22	4.26	1.74	cd	112	$445.44	**$29.35**
4	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha	$29.80	ASW1	8.8	78.95	3.50	1.82	bcd	118	$465.66	**$33.58**
5	Trifluralin 2 L/ha + Arcade 2.5 L/ha	$33.05	ASW1	8.7	77.10	4.09	1.74	cd	113	$445.95	**$10.61**
6	Arcade 2.5 L/ha	$21.25	ASW1	8.9	79.17	3.29	1.72	cd	111	$439.30	**$15.76**
7	Boxer Gold 2.5 L/ha	$27.50	ASW1	8.9	77.76	3.70	1.73	cd	111	$441.60	**$11.81**
8	Sakura WG 118 g/ha	$40.10	ASW1	8.9	78.44	3.57	1.97	abc	127	$505.09	**$62.70**
9	Sakura SC 210 mL/ha	-	ASW1	8.9	78.17	3.55	2.11	a	136	$540.16	-
10	Sakura WG 118 g/ha + trifluralin 1.5 L/ha	$48.95	ASW1	8.8	78.63	3.13	2.06	ab	133	$526.08	**$74.84**
11	Trifluralin 2 L/ha fb (Boxer Gold 2.5 L/ha)	$39.30	ASW1	8.9	76.86	3.87	1.83	bcd	118	$468.74	**$21.15**
12	Nil fb (Boxer Gold 2.5 L/ha)	$27.50	ASW1	8.7	76.21	3.55	1.59	d	103	$406.27	**-$23.52**
						LSD P=Various	0.202				
	Application Cost:	$6.00				St Dev	0.119				
	ASW1 delivered Geraldton	$256.00				CV	6.62				

Means followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

At the Arrino trial (see table 4) Sakura recorded $62.70 $ROI/ha and the addition of trifluralin resulted in improved weed control and an ROI of $74.84/ha. No other treatment returned an ROI above $33.58.

Gross margin calculations at Buntine (see table 5) highlighted the benefits of weed control in a low yielding year. The trifluralin + Monza treatment, with an improvement of $63.68/ha when compared to the untreated control recorded the highest $ROI, with trifluralin + post emergent Boxer Gold and Sakura WG treatments returning +$49.96/ha and +$48.05/ha respectively. Other treatments recorded +$34.39 or less.

Table 5: Yield (t/ha), gross margin ($/ha) and $ return on investment ($ROI/ha) in Scepter wheat at West Buntine. Note that $ROI for treatment 11 is not available due to it not having a retail price at the time of publication.

	Treatment	Cost $/ha	Grade	Protein %	HL weight (kg/hL)	Screenings %	Yield t/ha		% UTC	Gross $/ha	$ROI/ ha
1	Untreated	$0.00	APW2	10.0	78.82	4.28	0.728	b	100	$191.46	-
2	Trifluralin 2 L/ha	$11.80	APW2	10.2	79.85	3.15	0.910	a	125	$239.33	**$30.07**
4	Trifluralin 2 L/ha + Monza 25 g/ha	$15.80	APW2	10.1	82.31	2.95	1.053	a	145	$276.94	**$63.68**
5	Trifluralin 2 L/ha + Avadex Xtra 2 L/ha	$29.80	ASW1	9.8	80.50	3.00	0.996	a	137	$249.00	**$21.74**
6	Trifluralin 2 L/ha + Arcade 2.5 L/ha	$33.05	ASW1	9.9	79.83	3.58	0.998	a	137	$249.50	**$18.99**
7	Arcade 2.5 L/ha	$21.25	ASW1	9.8	79.32	4.06	0.916	a	126	$229.00	**$10.29**
8	Arcade 3 L/ha	$25.50	APW2	10.1	79.20	3.51	0.938	a	129	$246.69	**$23.73**
9	Boxer Gold 2.5 L/ha	$27.50	ASW1	9.9	80.15	4.25	0.974	a	134	$243.50	**$18.54**
10	Sakura WG 118 g/ha	$40.10	APW2	10.1	81.42	4.06	1.086	a	149	$285.62	**$48.05**
11	Sakura SC 210 mL/ha	-	ASW1	9.8	81.75	2.58	1.068	a	147	$280.88	-
12	Sakura WG 118 g/ha + trifluralin 1.5 L/ha	$48.95	ASW1	9.7	80.50	3.00	1.105	a	152	$276.25	**$29.84**
13	Trifluralin 2 L/ha + Boxer Gold 2.5 L/ha	$39.30	APW2	10.0	80.55	3.80	1.031	a	142	$271.15	**$34.39**
14	Trifluralin 2 L/ha fb (Boxer Gold 2.5 L/ha)	$39.30	APW2	10.1	81.47	2.89	1.113	a	153	$292.72	**$49.96**

Application Cost:	$6.00	LSD P=Various	0.121
APW2 delivered Geraldton	$263	Standard Dev	0.072
ASW1 delivered Geraldton	$250	CV	7.3
AGP1 delivered Geraldton	$238		

Means followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

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Discussion

All pre-emergent herbicides showed a positive $ROI when compared to the untreated control. However, the need for integrated weed management (IWM) strategies such as harvest weed seed control was emphasized, as even the best treatment across the two trials was still allowing 124/m^2 annual ryegrass panicles to survive.

Early weed control ratings (at 2-6 weeks after weed germination) are not reflective of the final number of weed seeds re-entering the seed bank. Commercially acceptable levels of control ~85% were recorded from some treatments in August, only for final panicle counts in October to decline to ≤60% control.

The three Sakura treatments with their longer residual activity and the trifluralin + post-emergent Boxer Gold treatment (when applied under good conditions) highlighted the strength of a longer period of activity to reduce annual ryegrass numbers. Post emergent applications of Boxer Gold are highly reliant on favourable conditions, as seen when comparing results at West Buntine and Arrino. When applied to small weeds in a moist soil profile, and a follow up rainfall event is observed – this can be a successful method of weed control.

It is important to note the difference in performance between the trifluralin + post emergent Boxer Gold treatments in the West Buntine and Arrino trials. Excellent weed control (85%) was observed in the West Buntine trial, while the level of control at Arrino (55%) was no better than trifluralin 2 L/ha only. This can be attributed to the conditions at the time of application. At West Arrino there was a moist soil profile at this timing, and 23 mm of rain fell over the following 24 hours to encourage activation and uptake of the product. The Arrino site had a dry soil profile at the post-emergent application timing with no significant rainfall over the following seven days. This supports Syngenta's label recommendation that post emergent applications of Boxer Gold be only undertaken when weeds are small (1-3 leaf), the soil profile is moist, and a follow up rain occur over the next 14 days.

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