Herbicide efficacy in retained stubble systems

RESEARCH

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Searching for answers

Location
Minnipa Agricultural Centre, paddock N6E
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2017 Total: 281 mm
2017 GSR: 155 mm
Yield
Potential: 1.7 t/ha (W)
Actual: 0.43 t/ha average (early 0.37, mid 0.49, late 0.43)
Paddock History
2017: Mace wheat
2016: Compass barley
2015: Emu Rock wheat
Soil Type
Red loam
Plot Size
12 m x 2 m x 3 reps

Key messages

- **Dry seeding conditions and lack of rainfall at the start of the 2017 season resulted in challenging conditions for both establishing crops and weed control.**
- **Stubble residues reduced plant establishment and weed numbers; standing stubble in dry conditions had higher wheat germination than chained stubble.**
- **April dry sowing had lower wheat numbers than later sowings, which reduced grass weed competition during the season. Grass weed numbers were higher and set more seed in the April sowing.**
- **No pre-emergent herbicide provided total barley grass weed control and keeping the weed seed bank low through other methods is important.**
- **Under the production regimes of upper EP, stubble management is unlikely to impact negatively on performance of pre-emergence herbicides targeting grass weed control, providing adequate water rates and best practice application techniques are used.**

Why do the trial?

The GRDC project ‘Maintaining profitable farming systems with retained stubble - upper Eyre Peninsula’ aims to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP). One of the barriers to retaining stubble is the perceived reduction in pre-emergent herbicide effectiveness (efficacy) in stubbles. This component of the project is testing whether various stubble management activities impact on herbicide efficacy.

Weed control in stubble retained systems can be compromised when stubbles and other plant residues intercept the herbicide and prevent it from reaching the desired target, or the herbicide is tightly bound to organic matter. Reduced herbicide efficacy in the presence of higher stubble loads is a particular issue for pre-emergence herbicides. Current farming practices have also changed weed behavior; e.g. prolonged dormancy in barley grass has been confirmed in many paddocks on Minnipa Agricultural Centre (MAC). As a part of the stubble project this trial was undertaken to assess herbicide efficacy in different stubble management systems.

This article reports on the results of the third and final year of the trial. See EPFS Summaries 2015 and 2016 for previous trial reports.

How was it done?

The 2017 trial was located at Minnipa Agricultural Centre (MAC) in paddock N6E. The stubble management treatments imposed were; (i) Cut low and traditional spread stubble and (ii) Cut low at harvest and prickle chained (6 April).

Mace wheat @ 60 kg/ha with DAP @ 60 kg/ha was sown on:

i. dry sowing 26 April (selected treatments) (TOS 1)
ii. 30 May dry sowing before predicted rainfall front (main trial with all treatments) (TOS 2)
iii. 10 July in moist conditions (selected treatments) (TOS 3).

All spray treatments were applied at 8 km/h using a shrouded boom with a 100 L/ha water rate, pressurised canisters at 2 bar and medium size spray nozzles.

Weed germination early in the season at the site was nil, due to low rainfall with no knockdown being required before any of the sowing times. The plants in TOS 1 and TOS 2 had poor emergence and did not fully emerge until late June/early July when significant rainfall events occurred. Due to the very late start to the season another small replicated trial was sown into a moist seedbed with selected treatments.

The paddock is a red loam with alkaline pH (7.7 in $CaCl_2$), P reserves of 36 mg/kg in 0-10 cm (Colwell P), a P buffering index of 120 and reserves of 67 kg mineral N/ha in the top 100 cm of soil.

The Predicta B soil analysis predicted a high risk of Rhizoctonia disease (279 pg DNA/g soil) and Yellow leaf spot inoculum was also present. The average barley stubble load on the trial at the beginning of 2017 after a light grazing was 3.5 t/ha DM.

Measurements taken were stubble load pre-seeding, soil moistures, plant emergence counts, early (17 August) and late (16 October) dry matter, early, mid (11 September) and late grass weed counts, grain yield (17 November) and grain quality. Harvest grass weeds were counted for tillers, seed heads, head weight and 100 seed weight.

Data were analysed using Analysis of Variance in GENSTAT version 18. The least significant differences are based on F prob=0.05. There was no interaction between Stubble and Herbicide treatments, so the data is presented as the main effect of either Stubble management or Herbicide treatment.

What happened?

Rainfall

Good summer and autumn rainfall occurred with an average of 95 mm stored soil moisture in the profile below 30 cm in April. A 6 mm rainfall event occurred on 30 May, 6.4 mm on 29 June and 15 mm over 3 days between 7-9 July resulting in poorly established crops. The 2017 season was a decile 1 which resulted in poor growth and low yields.

Time of sowing

Plant establishment was lower with April sowing, averaging only 70 plants/m^2 compared to 113 plants/m^2 in TOS 2 and TOS 3 (Table 1). Trifluralin (2 L/ha) also reduced plant establishment compared to the control in the TOS 3 sowing when the topsoil was moist (Table 6).

TOS 2 (30 May) resulted in reasonable plant establishment, greater dry matter and higher yield. TOS 1 had higher barley grass numbers throughout the season with higher seed set, and TOS 3 had the lowest grass weed numbers in crop (Table 2).

Stubble management

Standing stubble had better plant establishment than chained stubble (Table 1). April chained stubble had higher grain yields (Table 1), lower grass weed numbers and grass weed seed set (data not presented).

Table 1. Effect of stubble treatments and time of sowing on plant establishment and wheat yield at MAC 2017.

Stubble treatment	Wheat plant establishment (plants/m^2)			Grain yield (t/ha)		
	TOS 1 26 April	TOS 2 30 May	TOS 3 10 July	TOS 1 26 April	TOS 2 30 May	TOS 3 10 July
Chained	65.2	108.6	-	0.45	0.52	
Standing stubble	75.3	116.5	113.4	0.28	0.46	0.43
LSD (P=0.05)	*9.7*	*6.2*	-	*0.03*	*0.02*	-

Table 2. Time of sowing effects at MAC 2017.

Sowing Date	Late wheat dry matter (t/ha)	Barley grass plants/m^2 Sept	Barley grass plants/m^2 Oct	*Total number of Barley grass seed/m^2 Oct
TOS 1 26 April	1.01	28.1	24.2	2353
TOS 2 30 May	1.23	14.9	13.7	776
TOS 3 10 July	1.04	5.0	1.6	64
LSD (P=0.05)	*0.10*	*13.5*	*10.4*	*674*

** calculated from weight of barley grass heads and average barley grass 100 seed weight.*

Table 3. Stubble management and plant measurements in dry sown TOS 1 (26 April) and TOS 2 (30 May) trials, MAC 2017.

Time of sowing	Stubble management	Barley grass plants/m² Aug	Late wheat dry matter (t/ha)	Barley grass plants/m² Sept	Barley grass plants/m² Oct	Barley grass height Oct (cm)	Total number of Barley grass seed/m² Oct
26 April TOS 1	Chained	8.4	1.16	9.1	6.1	16.1	235
	Standing stubble	42.7	0.85	47.2	42.3	13.8	4470
LSD (P=0.05)		*18.3*	*0.11*	*19.4*	*13.6*	*2.1*	*1176*
30 May TOS 2	Chained	4.3	1.28	4.8	6.9	13.6	276
	Standing stubble	23.2	1.19	25	20.5	15.6	1276
LSD (P=0.05)		*6.6*	*0.08*	*7.2*	*5.8*	*1.9*	*258*

Weeds and herbicide treatments

Plant establishment was not affected by any herbicide treatment in TOS 1 and TOS 2 (Table 4 and 5) in drier conditions. In colder moister soil conditions (TOS 3) Trifluralin (2 L/ha) reduced plant numbers compared to the control, which may have been due to the Trifluralin being more active at the rate of 2 L/ha or less physical separation of the seed and herbicide (Table 6).

Barley grass numbers were generally low in the 2017 season with an average of 13 plants/m² across the whole trial site in August, regardless of treatments. The stubble management showed differences in barley grass germination, with the standing stubble block (23 plants/m²) having greater grass weed numbers than the chained stubble (4 plants/m²). The chained stubble block may have had lower barley grass weed seed germination due to; very small rainfall events and less moisture reaching the soil and grass weed seeds, and the wheat germination was also lower in TOS 1 and TOS 2 with chained stubble; generally soil disturbance does not increase barley grass weed seed germination, unlike ryegrass (B Fleet, per comm.) so this may have resulted in lower barley grass germination; and some variation in background weed seed populations.

In the TOS 1 trial all treatments had lower barley grass weed numbers than the control (Table 4). However, by the end of the season barley grass numbers had increased resulting in higher weed seed set compared to the control except in the Sakura and the Trifluralin (2 L/ha) + Avadex (1.6 L/ha) + 900diuron (500 g/ha) treatments. Some herbicides showed suppression with decreased height of grass (Table 4 and 5), fewer tillers and smaller heads (data not presented). There were no differences in TOS 1 in early or late dry matter of wheat between treatments, or barley grass and ryegrass weed numbers late in the season. There were no differences in grain quality with protein averaging 13.2%, screenings averaging 10.9% and a test weight of 74.3 kg/hL.

Table 4. Herbicide effects on barley grass and wheat establishment and yields in dry sown TOS 1 trial (26 April).

Treatment	Establishment (plants/m²)	Barley grass (plants/m²) Aug	Barley Grass (plants/m²) Sept	Barley grass height Oct (cm)	Total number of barley grass seed/m²	Grain yield (t/ha)
Control	80.7	51.5	52.0	16.0	3726 b	0.37
Trifluralin (2 L/ha)	69.1	31.5	36	16.2	3807 b	0.33
Sakura (pre-emergent)	75.1	5.3	4.7	12.8	609 a	0.40
Boxer Gold (pre-emergent)	66.9	32.1	40.7	14.5	2060 ab	0.38
Trifluralin (2 L/ha) + Avadex (1.6 L/ha) + 900diuron (500 g/ha)	59.3	7.4	7.3	15.3	1562 a	0.34
LSD (P=0.05)	*ns*	*13.8*	*30.6*	*ns*	*1858*	*ns*

Table 5. Herbicide effects on barley grass and wheat establishment and yields in dry sown TOS 2 trial (30 May).

Herbicide treatment	Group	Herbicide cost ($/ha)	Establishment (plants/m²)	Barley grass plants/m² Oct	Barley grass height Oct (cm)	Total number of seed/m² **	Yield (t/ha)
Control Untreated		-	116.9	24.6 b	16.2	1008 defg	0.47
Trifluralin (1.5 L/ha)	D	9	114.6	22.9 b	16.5	1177 efg	0.47
Trifluralin (2 L/ha)	D	12	109.6	23.8 b	17.3	1265 fg	0.48
Trifluralin (1.5 L/ha) + Lexone (metribuzin) 180 g (post)*	D+C	15	104.2	5.6 a	15.7	543 abcde	0.47
Trifluralin (1.5 L/ha) + Diuron 900 (400 g/ha = 360 ga/ha)*(pre-emergent)	D+C	14	105.2	13.8 ab	16.3	658 abcdef	0.49
Trifluralin (1.5 L/ha) + Diuron 900 (high rate)* (pre-emergent)	D+C	19	121.5	14.0 ab	18.3	1603 g	0.50
Trifluralin (1.5 L/ha) + Avadex (Tri-allate) (1.6 L/ha) (pre-emergent)	D+J	25	113.1	11.1 ab	16.0	725 bcdef	0.52
Trifluralin (2 L/ha) + Avadex (1.6 L/ha) + 900diuron (500 g/ha)* (pre-emergent)	D+J+C	28	115.8	12.9 ab	15.3	1043 defg	0.47
Trifluralin (1.5 L/ha) (pre) + Monza (sulfosulfuron) (25 g/ha) (post)	D+B	35	108.4	18.2 ab	10.6	753 bcdef	0.50
Monza (sulfosulfuron) 25 g (pre-emergent)	B	26	117.3	4.2 a	9.2	222 abc	0.50
Sakura (118 g) (pre-emergent)	K	40	112.6	7.6 a	14.2	525 abcd	0.51
Monza (sulfosulfuron) (25 g) + Sakura (118 g) (pre-emergent)	B+K	66	113.3	4.7 a	11.2	105 ab	0.49
Sakura (118 g)+ Avadex (Tri-allate) 3 L (pre-emergent)	K+J	70	111.9	5.6 a	8.0	402 abcd	0.49
Boxer Gold (2.5 L/ha) (pre-emergent)	K+J	37	105.7	10.4 ab	16.3	777 cdef	0.49
Boxer Gold (2.5 L/ha) (post)	K+J	37	117.0	24.0 b	16.2	1304 fg	0.44
Sakura (118g)+ Avadex (Tri-allate) 3 L/ha (pre-emergent) + Boxer Gold 2.5 L/ha (post)	K+J	107	109.1	5.1 a	14.7	68 a	0.52
LSD (P=0.05)			*ns*	*14.5*	*4.7*	*652*	*ns*

**use with caution in light soil types, and heavy rainfall events post sowing can cause leaching and crop damage. Note some treatments in the trial are for research purposes only.*

***calculated from weight of barley grass heads and average barley grass 100 seed weight*

There were no differences in wheat establishment, early or late dry matter or grain yield in TOS 2 (Table 5). However, grain quality was slightly higher with standing stubble with 13.0% protein compared to 12.7% chained, and 9.8% screenings in standing stubble compared to 8.2% in chained. There were no differences due to the herbicide treatments in early and mid-season barley grass weed counts (data not presented). Sakura/mixes and Monza had better late weed control and lower weed seed set (Table 6). The expensive mixes of Sakura (118 g)+ Avadex (Tri-allate) 3 L (pre-emergent) + Boxer Gold 2.5 L (post), Monza (sulfosulfuron) 25 g (pre-emergent) or Monza (sulfosulfuron) (25 g) + Sakura (118 g) (pre-emergent) were the only herbicide treatments to lower barley grass weed seed set in very dry conditions compared to the control. Monza has longer persistence and will reduce medic plant numbers so may only be an option in first year of cereal crops in rotation.

TOS 3 had very low grass weed numbers compared to the other trials (Table 6) however, this did not result in better yield due to the later seeding. In TOS 3 there were no differences in grain quality with protein averaging 14.1%, screenings 6.5% and test weight 76.0 kg/hL.

Spray coverage

There were no differences in spray coverage due to stubble management in the preceding 3.5 t/ha barley crop using spray cards on selected treatments in TOS 2 trial (Figure 1).

Table 6. Herbicide treatments and plant and weed measurements in TOS 3 trial (10 July).

Treatment	Plant establishment (plants/m²)	Early barley grass (plants/m²) Aug	Early dry matter (t/ha)	Late barley grass (plants/m²) Oct	Barley grass height (cm)	Grain yield (t/ha)
Control	121.5	0	0.31	1.8	18.3	0.44
Trifluralin 2 L/ha (pre-emergent)	91.1	14.8	0.25	1.8	5.3	0.42
Sakura (pre-emergent)	112.2	2.5	0.27	0.9	11.0	0.42
Boxer Gold (pre-emergent)	128.9	1.2	0.30	1.8	7.0	0.45
LSD (P=0.05)	*12.3*	*ns*	*ns*	*ns*	*ns*	*ns*

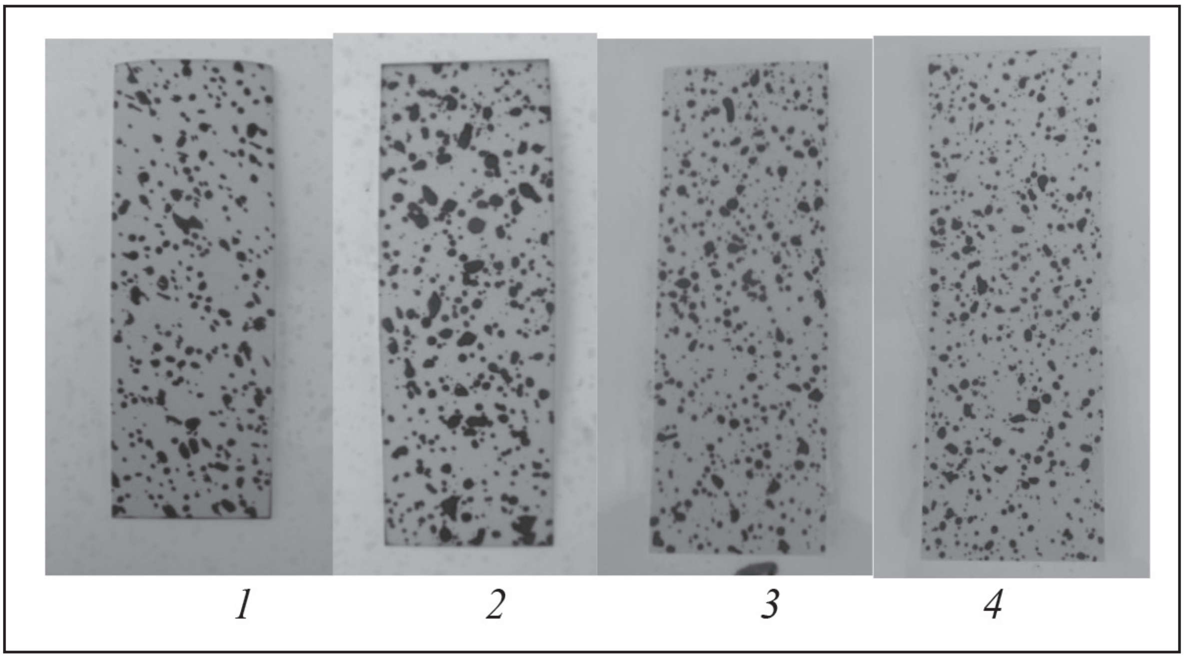

Figure 1. 2017 spray cards (1) 1.5 L Trifluralin in chained stubble (2) 1.5 L Trifluralin in standing stubble (3) Sakura (118 g) pre-emergent in chained stubble, and (4) Sakura (118 g) pre-emergent in standing stubble.

What does this mean?

The dry seeding conditions and lack of rainfall at the start of the 2017 season resulted in challenging conditions for both establishing crops and weed control. Early dry sowing (26 April) had poor plant establishment resulting in low crop competition, increased barley grass seed set and a lower yield.

Barley grass generally all germinates in the following season after shedding, however in drier conditions germination is lower as the seed does not have enough moisture to imbibe and germinate, so increased viable seed carry over can be expected in 2018. Also the weed seed produced in cool mild conditions like the 2016 spring have been shown to generally have higher seed dormancy, which would be the majority of the 2017 weed seed bank. There was little herbicide activity, especially for those more reliant on soil moisture for activation and movement into the soil.

In the dry 2017 seasonal conditions stubble management by chaining in April had lower grass weed numbers resulting in higher grain yield. Barley grass prefers less disturbance or no tillage to increase germination, unlike ryegrass (B Fleet, per comm), so the lower germination may have been due to the tillage effect or less moisture reaching the seed compared to standing stubble, hence lowering the germination. The wheat germination with standing stubble was higher than the chained stubble, so soil moisture and germination may have been a factor. Sowing late into adequate moisture (TOS 3) resulted in low grass weed numbers, as the seed dormancy may have broken and tillage at sowing lowered the grass weed numbers resulting in low weed seed set, however there was a yield penalty for sowing late.

2017 has not placed the herbicide packages "under pressure" because the grass weed populations were low. Under low populations of barley grass, weaker herbicide options may perform adequately compared to high weed population situations. Sakura still provided the best option for managing barley grass weeds and reducing weed seed set, with Monza also performing well in the dry conditions, however be aware of residual carry over which may impact on medic pasture regeneration in the following season. Caution must be taken with some of the herbicides, especially in lighter soil types and with rainfall events after seeding as they may wash into the crop root zone.

This research suggests that under the production regimes of upper EP, stubble management is unlikely to impact negatively on performance of pre-emergence herbicides targeting grass weed control, with adequate water rates.

Due to the prolonged seed dormancy in barley grass at MAC, early grass control with pre-emergence herbicides is very limited. Reducing the weed seed bank is pivotal in managing all grass weeds, so effective two year breaks during the pasture/ break crop phase is very important in paddocks with high grass weed numbers to adequately reduce the barley grass weed seed bank. If you have a dormant/later germinating population, and aim to reduce the seed bank, you may be better investing in some of the more expensive herbicides for longer residual grass control. Extra crop competition by using narrower row spacings and/or increasing seeding rates have also been effective tools to reduce weed numbers and weed seed set.

If herbicide resistance in barley grass is an issue or a concern, the first step is to test the population to know exactly what you are dealing with. While barley grass resistance is not widespread, as most seed germinates the following season, it is essential to control any potentially resistant survivors as they may quickly become the greater proportion of the weed seedbank. To ensure Group A resistance is kept in check, make sure any suspected resistant plants are dealt with within pasture systems by following up with a knock down herbicide as early as possible to prevent any seed set. Always have a follow up option to control any survivors and to preserve group A herbicides. Another option may be to use other chemical groups like propyzamide (in moist conditions) to reduce the barley grass population before using a group A herbicide. Using alternative chemical groups by including canola or Clearfield systems as a different rotational break may also be an option. The Group As are easily the cheapest and most effective way to control barley grass within current farming systems so we need to ensure this herbicide group remains a cheap and viable option.

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EPARF Eyre Peninsula Agricultural Research Foundation Inc.

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