The effect of single disc seeding operation on herbicide crop tolerance in wheat

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Purpose:	To ascertain the crop safety of pre-emergent (IBS) herbicides when used with differing seeding systems and sowing speeds.
Location:	Cunderdin
Soil Type:	Deep sand over clay sand
Soil Results:	pH 5.4 (10cm)
Rotation:	2008 lupins
GSR:	237 mm

BACKGROUND SUMMARY

No-till farming is a practice that is widespread in Western Australia and is based on the premise that intensive tillage leads to soil degradation and loss of overall productivity. In addition to no-till (narrow knife points), zero-till which involves the use of disc seeders, is becoming more popular. This is because of their increased residue handling abilities that allow for greater residue retention and even lower soil disturbance than knife points. However, there are concerns about the efficacy of pre-emergent herbicides and crop safety in disc systems.

The performance of pre-emergent herbicides can be influenced by the amount of soil disturbance, the degree of incorporation and the position of weed seeds in the soil. When left unincorporated pre-emergent herbicides can undergo photodegradation and volatilisation and hence their bioavailability is reduced. Crop safety is also an important consideration when using any herbicide. Crop safety with pre-emergent herbicides in the no- and zero-till systems relies on the soil opener, throwing the herbicide treated soil out of the furrow. In very low disturbance disc systems the herbicide may not be adequately displaced from the furrow, causing crop damage (eg. reduced emergence).

The hypothesis for this trial is that an increase in the single disc sowing speed will improve the crop safety and weed control efficacy of the pre-emergent herbicides tested and this result will vary with the different herbicides. The basis of this hypothesis is that increased sowing speed results in greater soil throw out of the seed row, thereby incorporating/covering the herbicide and removing it from the crop row.

TRIAL DESIGN

The trial was a strip plot criss-cross design with three randomized blocks consisting of five different tillage treatments applied east-west and seven herbicide treatments north-south (Table 1). Each plot was 3.5m wide and 10m long. Natural ryegrass germinations occurred across the site and these were counted to test herbicide efficacy. The seed bed was moist at sowing.

Table 1: *Sowing and herbicide treatments used in the field trial.*

Factor 1: Sowing method	**Factor 2: Herbicide treatments**		
	Herbicide	**Trade name**	**Rate of product**
Tyne 8km/hr	Nil	N/A	N/A
Disc 4km/hr	Trifluralin 600 g ai/L	Dow Treflan 600	Trifluralin 384 g a.i./ha (0.64 L/ha)
Disc 8km/hr	Trifluralin 600 g ai/L	Dow Treflan 600	Trifluralin 720 g a.i./ha (1.2 L/ha)
Disc 12km/hr	Trifluralin 600 g ai/L	Dow Treflan 600	Trifluralin 1920 g a.i./ha (3.2 L/ha)
Disc 16km/hr	Prosulfocarb 800 g/L and S-Metolachlor 120 g/L	Boxer Gold	Prosulfocarb 2000 g ai/ha and Metolachlor 300 g a.i./ha (2.5 L/ha)
	Pyroxasulfone 850 g/kg	Sakura	Pyroxasulfone 100.3 g ai/ha (118 g/ha)
	Pyroxasulfone 850 g/kg	Sakura	Pyroxasulfone 199.75 g ai/ha (235 g/ha)

Sowing: Immediately prior to sowing the herbicide treatments were applied using a boom spray. The herbicides were applied at a water rate of 60 L/ha with a boom height of 50 cm. Spray drift was considered to be nil between the plots. The seeders were 3.5 m wide and were either a tyne machine with Ag master boots and knife points with double shoot ability or a NDF single disc seeder with a sweep angle with only single shoot ability. Both seeders were calibrated just prior to sowing to deliver 85 kg/ha wheat seed and 85 kg/ha CSBP MacroPro Extra fertiliser (Table 2). The row spacing for both seeders was 30 cm. Prior to sowing the plot was sprayed with three knockdowns to kill the weeds that had already emerged.

Table 2: *Agronomic details of the field trial.*

Date	**Operation**	**Timing**	**Treatment**	**Rate**
April 09	Spray	Knockdown	Glyphosate 450	3 L/ha
May 09	Spray	Knockdown Double knock	Glyphosate 450 Sprayseed (7 days after)	3 L/ha 1.5L/ha
3 June 09	Treatment IBS	Up to 4 hour prior to seeding	IBS treatments	Specified rate in Table 1
3 June 09	Seed	Sowing	Wheat (Magenta)	85kg/ha
3 June 09	Fertiliser	Sowing	Macropro Extra Urea (46% N)	85kg/ha 50kg/ha
May 09	Fertiliser	28 Days after sowing	Urea (46% N)	80kg/ha

RESULTS

Wheat seed placement and herbicide incorporation: The sowing depth was significantly affected by the tillage treatment with the disc at 4 km/h being the sown the deepest and depth decreasing as speed increased (Table 3). The tyne had the shallowest seeding depth being almost 1.5 cm shallower than the disc at 4 km/h.

The variation in horizontal seed placement (seed spread) was also observed to increase significantly ($p < 0.001$) with increasing sowing speed in the disc treatments and was the greatest with the tyne sown treatment plots (Table 3).

Table 3: *Effect of seeding method on sowing depth (cm) and horizontal spread (cm).*

Seeding method	**Sowing depth**		**Horizontal spread**	
	Average	**SE**	**Average**	**SE**
Tyne	4.5	0.2	2.9	0.1
Disc 4 km/h	5.9	0.2	1.7	0.1
Disc 8 km/h	5.7	0.2	2.0	0.1
Disc 12 km/h	5.4	0.2	2.2	0.1
Disc 16 km/h	5.0	0.2	2.2	0.1

The percentage of dye incorporation was significantly affected by the sowing method ($p = 0.002$). The percentage incorporation was the highest in the tyne treatments at 93% which is significantly higher than all disc treatments (Table 4). In the disc seeder operated at 4 km/h had the lowest level of incorporation with only 17% of the dye being incorporated and this was significantly less than the higher speeds.

Table 4: *Effect of seeding method on dye incorporation to resemble pre-emergent herbicide incorporation.*

Seeding method	Average depth of dye incorporation (mm)	Depth of furrow (mm)	% Dye incorporation
Tyne	38	73	93
Disc 4 km/h	2	37	17
Disc 8 km/h	5	50	54
Disc 12 km/h	5	40	61
Disc 16 km/h	6	42	59

Crop Growth: There was a significant (p = 0.02) interaction between the sowing method and herbicide for shoot dry mass. Overall, the tyne had a significantly higher dry mass than the disc treatments. The greatest dry mass occurred in the trifluralin 1920g ai/ha followed by trifluralin at 720 g a.i./ha, both with the tyne. There was little difference between the other herbicides in the tyne treatments. It was found that there was no consistent difference in dry mass between any of the disc speeds and herbicide treatment (Table 5). Tiller counts were also completed but there were no significant differences between the seeding system or herbicide treatment, with plants having an average of two tillers.

Table 5: *The shoot dry weight, in grams per m^2, of the wheat plants across the different plots.*

Herbicide	***Seeder* Tyne 8 km/h**	**Disc 4 km/h**	**Disc 8 km/h**	**Disc 12 km/h**	**Disc 16 km/h**	***Herbicide mean***
Nil	223	197	189	190	215	*203*
Trifluralin 600 0.64L/ha	236	163	210	162	186	*191*
Trifluralin 600 1.2L/ha	270	187	172	190	205	*205*
Trifluralin 600 3.2L/ha	296	173	205	184	191	*210*
Boxer Gold 2.5L/ha	247	187	209	224	206	*215*
Pyroxasulfone 118 g/ha	229	191	197	211	188	*203*
Pyroxasulfone 235 g/ha	245	189	179	150	195	*191*
Seeder mean	*249*	*184*	*194*	*187*	*198*	
Tyne mean	*249*		***Disc mean***		*190.75*	

- *Herbicide x Sowing System interaction p = 0.02 (*), LSD (p = 0.05) 49.9*
- *Main effect of herbicide p = 0.401 (NS), LSD (p = 0.05) 25.08*
- *Main effect of sowing system p = 0.016 (*), LSD (p = 0.05) 35.85*
- *CV% = 11.4*

The plant count was not significantly affected by any of the treatments, however, contrasts revealed that trifluralin at 1920 gai/ha was significantly lower (p 0.014) than all other herbicide treatments (Figure 1).

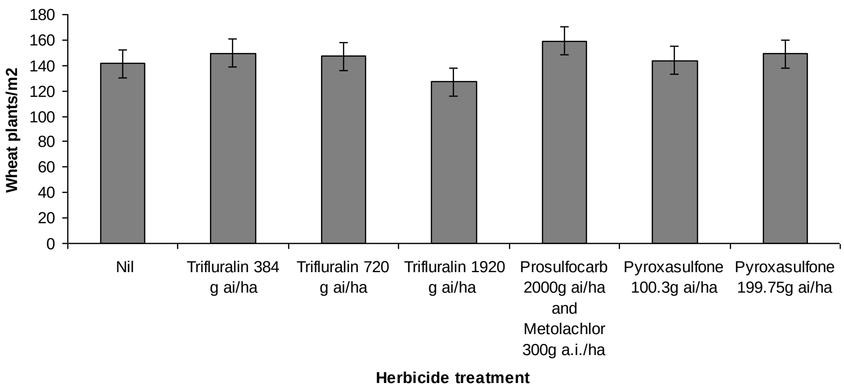

Figure 1: Number of wheat plants per m^2 for the different herbicide treatments. Error bars indicate LSD at p = 0.05.

Weeds: There was no significant interaction between sowing method and herbicide for the number of ryegrass plants or the visual weed assessment. However, the main effects of herbicide and sowing method were significant for both weed assessment methods (Figures 2A and 1B). The main effect of herbicide was significant for the count and for the visual assessment. The visual assessment made almost one month after the counts showed relatively good weed control (e.g. over 80% for pyroxasulfone); whereas the early ryegrass count had relatively large ryegrass numbers in excess of 200 plants/m^2. Sukura at 253g/ha had the lowest ryegrass numbers controlling 65% of the weeds (calculated as a percentage of the control) in the initial count and 84% in the later visual assessment within the disc treatment. This, however, was not significantly different to the lower rate of pyroxasulfone, prosulfocarb/metolachlor or the high rate of trifluralin.

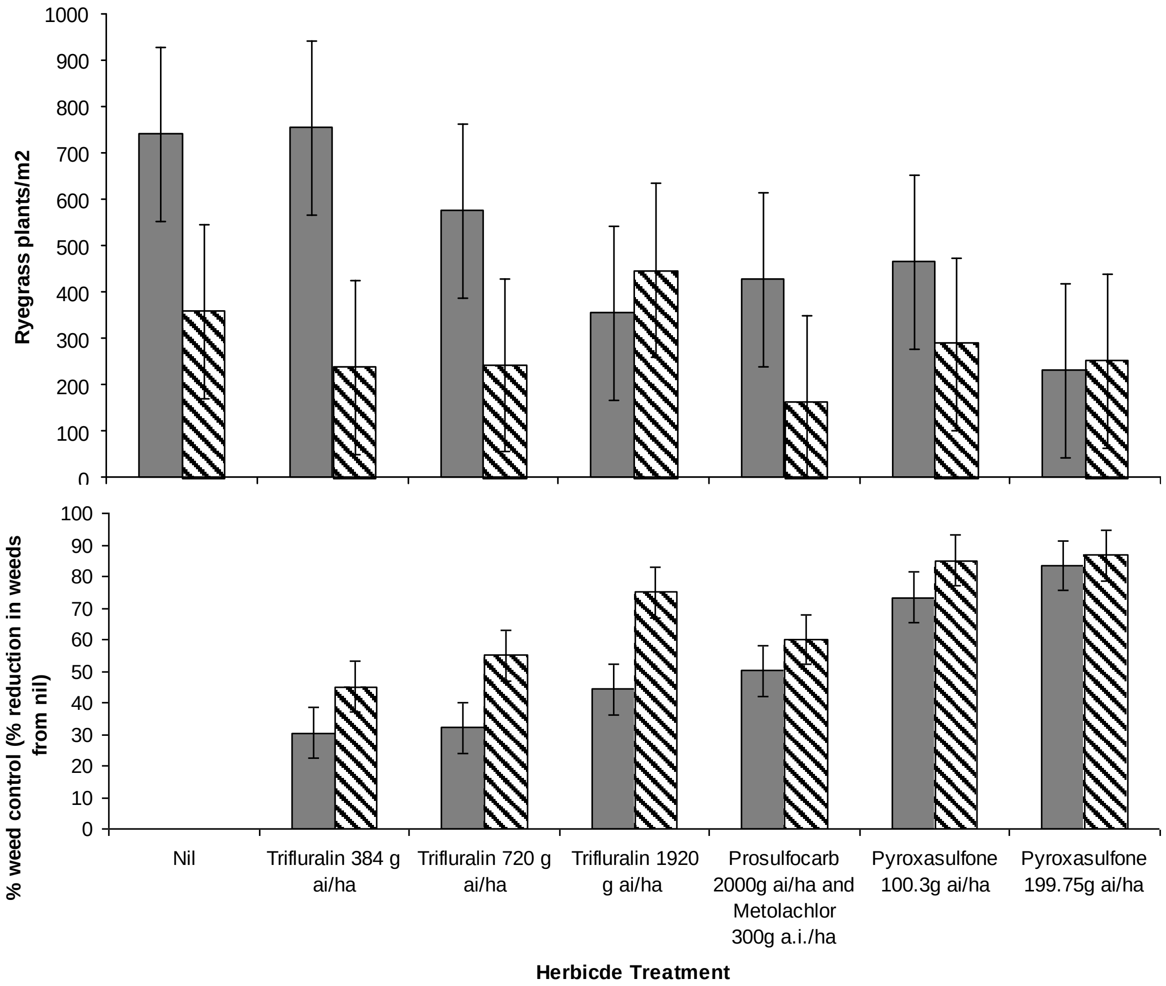

Figure 2: *A) Ryegrass counts (14th July 2009) and B) visual percentage reduction of weeds compared to the adjacent control (12th August 2009) for either the disc (average of all speeds) ▩ or the tyne ▧. Error bars indicate LSD at p = 0.05. See appendix 3 for complete results.*

Wheat yield: The yield showed that there was no statistically significant difference between seeing systems but tyne treatments out yielded all disc sown treatments (Table 6). There was a significant difference within the herbicide means where the Nil and 0.64L/ha of trifluralin 600 yielded less than the highest rate of trifluralin and the Sukura treatments.

Table 6: *Wheat yields (t/ha) calculated from harvest cuts through the centre of the plots.*

Herbicide	***Seeder*** **Tyne 8 km/h**	**Disc 4 km/h**	**Disc 8 km/h**	**Disc 12 km/h**	**Disc 16 km/h**	***Herbicide mean***
Nil	2.06	2.07	1.95	1.64	2.02	*2.02*
Trifluralin 384g ai/ha	2.35	1.69	1.99	1.57	2.16	*1.95*
Trifluralin 720g ai/ha	2.82	2.51	2.27	2.07	2.17	*2.36*
Trifluralin 1920g ai/ha	3.00	2.37	2.45	2.22	2.16	*2.44*
Prosulfocarb 2000g ai/ha and Metolachlor 300g a.i./ha	2.45	2.43	2.44	2.21	2.37	*2.38*
Pyroxasulfone 100.3g ai/ha	2.74	2.34	2.66	2.24	2.37	*2.46*
Pyroxasulfone 199.75g ai/ha	2.65	2.65	2.68	2.48	2.74	*2.64*
Seeder mean	*2.63*	*2.29*	*2.34*	*2.06*	*2.28*	
Tyne mean	*2.64*		***Disc mean***		*2.24*	

- *Herbicide x Sowing System interaction p = 0.27 (ns)*
- *Main effect of herbicide p = 0.029 (*), LSD (p = 0.05) 0.40*
- *Main effect of sowing system p = 0.198 (ns)*

DISCUSSION

- The disc machine had much less variation in seed placement than the tyne.
- The depth of incorporation with the single disc seeder increased slightly with speed, although speed of sowing did not significantly improve weed control.
- Crop growth was not affected by the speed of sowing with discs as hypothesized but there was a significant difference between the tyne and disc seeded treatments. The limited vigour of the wheat seedling sown by the disc seeder is probably the reason for generally lower yields than tyne sown plots. It is not clear whether reduced vigour was due to weed competition or herbicide toxicity as these factors weren't tested separately in this trial.
- The disc seeder provided less weed control than the tyne machine under the high weed burdens (eg. mean of approximately 700plants/m2 for Nil), although weed control was good for Sakura incorporated by the disc seeder.
- Pre-emergent herbicides requiring less incorporation for effective weed control (eg. Sakura) need further investigation. In the meantime it is suggested that farmers using disc systems be careful applying pre-emergent herbicides. Although not seen here this is likely to be especially important when high rates are used.

Wheat seed placement and herbicide incorporation: The variation in the horizontal seed placement was greatest in the tyne system however this did not appear to be a major cause of phytotoxicity. The most likely reason for this is that the tyne created a relatively large herbicide free zone and thus despite the horizontal variation in seed placement the crop growth was not influenced by this.

Crop Growth: Crop growth was not affected by the speed of sowing with discs as we hypothesized but there was a significant difference between the tyne and disc seeded treatments. The disc treatment had smaller and less vigorous plants than the tyne plots. The effects of herbicide toxicity and weed competition on wheat crop growth are confounded and it is difficult to separate them because there was no nil herbicide/nil weed control plot established in the trial. This is evident in the results where we see poor crop growth with a high weed burden, and in some instances poor crop growth with good weed control, likely due to phytotoxicity. The disc machine trialed in this study is a low disturbance seeding system which threw less soil, and hence less herbicide, out of the furrow compared to the tyne. It also only gave a very narrow herbicide free area compared to the tyne which in turn increases the chance of herbicide damage.

The emergence of the plants was unaffected by the treatments in the field trial. This suggests that whilst there was a reduction in biomass from some herbicides and the use of the disc seeder, the level of herbicide that caused this reduction was not high enough to lead to wheat plant mortality.

Weeds: Weed control was significantly influenced by the sowing method. This was primarily due to the tyne treatments producing better weed control than the disc treatments, especially with trifluralin. This is because of the significant difference in incorporation depth where there was 38 mm of incorporation with tynes and only between 2 to 6 mm of incorporation with the discs. Although at disc speeds of 8 km/h and above the level of herbicide incorporation more than double that seen at 4 km/h.

Regardless, the speed of sowing with discs did not significantly influence the weed control by the herbicides; perhaps because the differences in the depth of incorporation were minimal compared to the tyne. The increase in the percentage incorporation seen from 4 km/h to 8 km/h may also not have been enough to significantly affect the weed numbers. In addition to this the experimental variability was too large to detect small differences in weed control between incorporation levels of the disc treatments.

Wheat yield: There was a significant difference within the herbicide means where the Nil and 0.64L/ha of trifluralin 600 yielded less than the highest rate of trifluralin and the Sukura treatments. This reduction in yield is highly likely to be due to increased plant competition from weeds.

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