Establishment of wheat as influenced by seeding systems

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Take home messages

- *The knife point plus press wheel seeding system consistently maximised wheat seedling establishment on sand and clay soils, independently of herbicide application. This translated into higher crop biomass levels at anthesis.*
- *Wheat seedling emergence in the disc seeding systems was reduced due to stubble pinning and pre-emergent herbicide damage.*
- *The largest reductions in plant establishment occurred with Triflur X while little or no reductions were observed with Boxer Gold or Sakura.*

Background

The progression from no-till to zero-till cropping systems is likely to be the next phase in the development of more conservative and sustainable farming systems for the Wimmera Mallee. The current widely adopted no-till system is a highly successful reduced tillage system based on a single cultivation at sowing with knife points and press wheels. This system has revolutionised crop production across southern Australia allowing the retention of stubbles in a reduced tillage system. In comparison with previous systems, reliant on cultivation and stubble burning, the no-till system has enabled more productive and sustainable crop production due to reduced risks of erosion and enhanced moisture conservation, However, there is some degree of soil disturbance with soil throw and stubble incorporation still occurring during sowing. Therefore, there remains an opportunity for the use of even more conservative crop seeding systems.

The advantage of zero-till discs over no-till tine sowing systems is a further reduction in soil and residue disturbance at sowing with increased capacity for stubble retention. Therefore, zero-till cropping systems will potentially lead to further reductions in erosion and increases in moisture conservation. Unfortunately, it is not just simply a case of swapping knife points and press wheels for discs. As well as new sowing equipment, a complete agronomic package – incorporating weed control, pest management, fertiliser inputs, row spacing, residue management etc – needs to be integrated.

Aim

To evaluate the interaction between seeding systems and pre-emergence herbicides on the establishment of wheat, on 2 contrasting soil types.

Method

Trial sites were established on 2 soil types, sand and clay at Nhill. The same trial design was used at both sites where combinations of 4 seeding systems and 4 pre-emergent herbicide treatments were evaluated (Table 1). Both sites were sown with Wyalkatchem wheat at 53kg/ha into a grazed wheat stubble (2t/ha). To account for the variable row spacings the plots were sown on a 10° angle to the direction of wheat stubble rows.

The seeding systems used were: a knife point press wheel (control) at 7.5km/h, a K-Hart triple disc at 10.5km/h and a John Deere 90 series/Excel EI853 single disc system at 10.5km/h. The targeted seeding depth for all treatments was 2.5 – 4cm. The row spacing was 278mm for all systems, and additionally 179mm for the single disc system.

The following pre-emergent herbicide treatments were applied immediately prior to sowing. None (control), Triflur X 2.5L/Ha (Triflur X 480g/L), Boxer Gold 2.5L/Ha (prosulfocarb 800g/L+ s-mtolachlor 120g/L) and Sakura 120g/Ha (pyroxasulfone 800g/kg).

Location:	Nhill (sand and clay sites)
Replicates:	4 (NB: plot size: 1.65m x 20m)
Sowing date:	5 – 7 May 2009
Seeding density:	150 plants/m²
Crop type/s:	Wyalkatchem wheat

Results

Control plots (no herbicides):

Crop emergence in the control plots was best under the tine sowing system and was reduced under all disc seeding system treatments. At both sites, the single disc seeding system established better under narrow row spacing. Relative to the tine system, the narrow (179mm) and wide (278mm) row single disc seeding systems reduced wheat emergence by 15% and 35% respectively at the sand site and by 8% and 19% respectively at the clay site (Figure 1). The triple disc seeding system performed similarly to the single disc system at narrow spacing, with 18% and 12% lower plant establishment measured on the sand and clay soils respectively. Observations were that the reduction in wheat emergence under discs was primarily due to the pinning of moist stubble beneath the seed during the sowing operation.

Effect of herbicides and seeding systems:

The combination of single disc seeding systems and Triflur X at a robust rate (2.5 L/ha) led to large (50 – 70%) reductions in wheat crop establishment on both sand and clay soil types (Figure 1). The narrow row disc seeding system plus Triflur X produced the largest reductions in wheat emergence with 74% and 52% on the clay and sand soils respectively. There was considerably more soil throw out of the furrow created by the triple disc sowing system which substantially reduced the detrimental effect of Triflur X on wheat establishment. Sakura and Boxer Gold pre-emergent herbicide treatments less consistently affected wheat seedling emergence under the disc seeding treatments with interactions also observed between soil type and row spacing (Figure 1).

The knife point plus press wheel seeding system consistently established higher wheat plant numbers than the 3 disc seeding treatments. Across all herbicide treatments, higher numbers of wheat seedlings emerged with this seeding system on both sand and clay soil types, confirming a high level of herbicide safety. The furrow opening and controlled soil throw characteristics of the knife point plus press wheel seeding system together with a lower speed (7.5km/h) makes this system highly suited to the use of these pre-emergent herbicides at the robust rates used in this study.

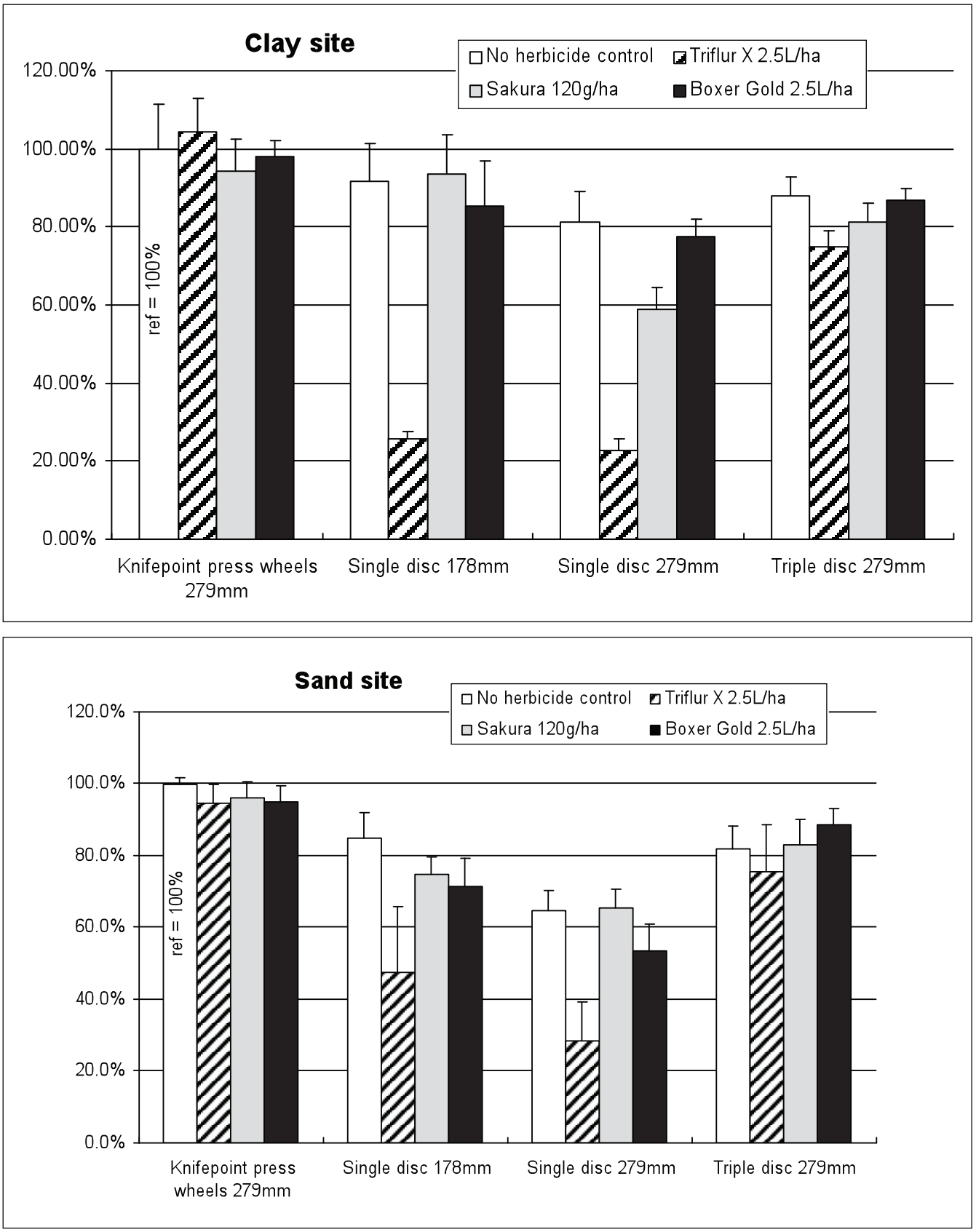

Figure 1. Effect of seeding systems on the emergence of wheat sown on a) clay and b) sand soils, Nhill 2009. Capped bars represent standard error values showing variation around the mean of 4 replicates.

The reduced wheat plant establishment generally resulted in lower wheat plant biomass levels at flowering. At both the sand and the clay sites the anthesis biomass levels for the narrow row single disc treatment were almost always lower than those of the knife point plus press wheel treatments (Tables 1 and 2).

Table 1. Effect of seeding systems on the dry matter and grain yield of wheat established on a clay loam soil, Nhill 2009.

Seeding system and row spacing	Herbicide	Brome grass (plants/m^2)	Dry matter (t/ha)	Yield (t/ha)
Knife point and press wheels 279mm	Unsprayed	15	4.0	2.23
Single disc 178mm	Unsprayed	14	3.3	2.26
Single disc 279mm	Unsprayed	12	4.3	2.18
Triple disc 279mm	Unsprayed	17	4.7	2.00
LSD (P=0.05)		**NS**	**0.6**	**0.24**
Knife point and press wheels 279mm	Triflur X 2.5L/ha	9	4.2	1.99
Single disc 178mm	Triflur X 2.5L/ha	16	3.4	1.97
Single disc 279mm	Triflur X 2.5L/ha	8	3.1	2.07
Triple disc 279mm	Triflur X 2.5L/ha	11	4.3	2.02
LSD (P=0.05)		**NS**	**0.8**	**NS**
Knife point and press wheels 279mm	Boxer gold 2.5L/ha	15	4.3	2.19
Single disc 178mm	Boxer gold 2.5L/ha	12	3.7	2.02
Single disc 279mm	Boxer gold 2.5L/ha	10	4.6	1.97
Triple disc 279mm	Boxer gold 2.5L/ha	16	3.8	2.18
LSD (P=0.05)		**NS**	**0.6**	**NS**
Knife point and press wheels 279mm	Sakura 120 g/ha	17	3.5	2.17
Single disc 178mm	Sakura 120 g/ha	12	3.2	2.09
Single disc 279mm	Sakura 120 g/ha	12	4.4	2.15
Triple disc 279mm	Sakura 120 g/ha	20	3.8	2.03
LSD (P=0.05)		**NS**	**0.6**	**NS**

The dry finish to the season meant that differences in anthesis biomass due to seeding system effects did not result in grain yield differences. Wheat grain yields were not significantly affected by herbicide treatments, however there was a trend for lower grain yield in the Triflur X treatments.

Table 2. Effect of seeding systems on the dry matter and grain yield of wheat established on a sand soil, Nhill 2009.

Seeding system and row spacing	Herbicide	Brome grass (plants/m^2)	Dry matter (t/ha)	Yield (t/ha)
Knife point and press wheels 279mm	Unsprayed	30	3.3	2.31
Single disc 178mm	Unsprayed	20	2.3	2.57
Single disc 279mm	Unsprayed	35	3.2	2.26
Triple disc 279mm	Unsprayed	47	3.0	2.29
LSD (P=0.05)		**NS**	**0.8**	**NS**
Knife point and press wheels 279mm	Triflur X 2.5L/ha	10	2.6	2.18
Single disc 178mm	Triflur X 2.5L/ha	19	2.4	2.26
Single disc 279mm	Triflur X 2.5L/ha	17	2.6	2.33
Triple disc 279mm	Triflur X 2.5L/ha	21	3.1	2.31
LSD (P=0.05)		**11**	**NS**	**NS**
Knife point and press wheels 279mm	Boxer gold 2.5L/ha	29	2.9	2.58
Single disc 178mm	Boxer gold 2.5L/ha	37	2.2	2.42
Single disc 279mm	Boxer gold 2.5L/ha	30	3.2	2.50
Triple disc 279mm	Boxer gold 2.5L/ha	36	3.2	2.57
LSD (P=0.05)		**NS**	**0.8**	**NS**
Knife point and press wheels 279mm	Sakura 120 g/ha	17	3.5	2.59
Single disc 178mm	Sakura 120 g/ha	13	2.2	2.37
Single disc 279mm	Sakura 120 g/ha	24	3.1	2.59
Triple disc 279mm	Sakura 120 g/ha	38	2.6	2.28
LSD (P=0.05)		**24**	**0.5**	**NS**

Sakura and Triflur X pre-emergence herbicide treatments reduced brome grass levels at the sand site only – below levels of the untreated control treatment. However, the effect of Triflur X and Sakura was not consistent across all sowing systems. The efficacy of these herbicides was generally greater when applied as part of the knife point plus press wheels system.

Interpretation

The knife point plus press wheels seeding system operated at low speed consistently established higher wheat seedling numbers at both sites compared with the single and triple disc seeding systems. The reduced emergence in the disc seeding treatments was likely due to the effects of observed stubble pinning during seeding – which also increased the sensitivity to herbicides such as Triflur X. Overall, the soil throw and furrow formation that are an integral part of the knife point plus press wheels system allowed for the safer application of robust levels of pre-emergent herbicides.

The triple disc system, including a wavy coulter, provided greater soil throw which reduced the impact of the pre-emergent herbicides on wheat seedling emergence. In contrast the single disc seeding systems had no soil throw and subsequently resulted in the greatest levels of crop damage. To minimise herbicide effects on wheat seedling emergence lower rates of pre-emergent herbicides may need to be used to minimise crop damage levels. This no doubt may compromise the weed control efficacy of these treatments.

Overall, these results highlight that under the experimental conditions:

i) Triflur X presented the highest risk to crop safety, particularly in the single disc seeding system, while Boxer Gold and Sakura overall showed little or no crop safety risks.

ii) Herbicide safety was best maintained with the tine plus press wheel system operated at low speed

iii) Crop establishment was significantly poorer with all disc systems.

iv) The type of disc seeding system also influenced herbicide crop safety with the triple disc system being safer than the single disc systems.

v) At harvest, there were no residual herbicide effects on yield.

The advantage of disc seeders in a no-till context is intrinsically tied to optimum stubble management including achieving a uniform spread of residue and chaff at harvest. Increased soil disturbance reduces the impact of pre-emergent herbicides, particularly Triflur X on the establishment of wheat plants. The knife point plus press wheel system – with the highest levels of soil throw – was the safest in reducing the pre-emergent herbicide damage. The triple disc system incorporating independent deep working leading coulters also satisfactorily achieved the movement of herbicide treated soil away from the crop furrow.

In comparison, low disturbance single disc systems are particularly effective at minimising seedbed moisture loss and weed seed germination. However, they vary in their ability to control crop damage from pre-emergent herbicides. To this end, the recent evolution in technology and practices has seen the use of soil shifting row-cleaners fitted ahead of single disc openers (eg Tobin disc drills, WA), a seed boot shield design with built-in soil deflector (eg Daybreak) and a reversible and adjustable disc closers (Ndf-Ag design). These technologies are designed to achieve herbicide incorporation while also providing potential benefits for reduced or controlled crop damage. Safer practices often also include deeper sowing depth. Further research is required to demonstrate which factors are best able to drive the crop safety aspects with single disc technology.

Acknowledgments

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