Disc seeders and pre-emergence herbicides

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Take-home messages

- Due to crop safety concerns most pre-emergence herbicides are not currently registered for use with disc seeders.
- Wheat crops can be seriously damaged by the use of trifluralin under single disc systems. In contrast, Sakura® (pyroxasulfone) which caused no damage to wheat establishment and was highly effective against annual ryegrass appears to be the most suitable pre-emergent herbicide for use with disc seeding systems.
- Disc seeding system design and settings, including operating and sowing depths and travel speed, all appear to influence behaviour of pre-emergence herbicides and can play a critical role in minimising crop damage.
- Triple disc configurations (i.e. K-Hart and Bertini fitted with rippled coulters) consistently provided greater crop safety to pre-emergence herbicides relative to single disc systems.
- The use of residue managers ahead of single disc blade openers has shown to significantly improve the level of crop safety.

Introduction

An increasing proportion of no-till farmers are making the transition to disc-based zero-till cropping. Disc seeding systems can create significantly less soil disturbance than narrow-point seeding systems, enable greater residue retention, allow faster sowing and can result in more uniform crop establishment (Desbiolles, 2011). However, due to crop safety concerns most pre-emergent herbicides are not registered for use with disc seeders. Even where herbicide labels do not specifically prohibit use with disc seeders, chemical companies will often not support their use with disc seeding equipment, due to lack of reliable results and some limited understanding of the processes involved in securing crop safety. A situation complicated further by the huge range of disc seeding system technology available which can differ enormously in both the level and type of soil disturbance they create.

Herbicide safety at sowing is often obtained by creating "positional selectivity", that is the physical separation of seed and herbicide. Under high soil disturbance, knife-point and press wheel systems, a satisfactory separation and good crop safety are typically achieved with herbicide treated surface soil thrown clear of the furrow onto the inter-row, especially under a controlled speed of sowing. However, disc seeding systems present a different challenge, with often a lack of adequate separation between the herbicide and germinating seedlings resulting in a significant risk of crop damage.

The movement of herbicide treated surface soil and the physical herbicide incorporation can vary greatly with different disc seeders and configurations, and this can also affect the efficacy of volatile pre-emergence herbicides such as trifluralin and pendimethalin. These herbicides require mechanical incorporation with soil throw at seeding to reduce losses from sunlight degradation and volatilisation. In contrast, new pre-emergence herbicides Boxer Gold® and Sakura® have low volatility and are much more stable in the soil. However, little is known of the behaviour of these new pre-emergence herbicides under disc systems.

Consequently field trials have been undertaken over the past 5 years at the University of Adelaide's Roseworthy Campus, to investigate the behaviour of pre-emergence herbicides with disc seeders. More specifically the range of trials have been designed to evaluate the effect of different seeding systems on pre-emergence herbicide control of annual ryegrass and their phytotoxicity to wheat. The systems evaluated over the period have included: KHart and Bertini triple discs, Austil (MT3500 series), John Deere (90 series), NDF (650 series) and DayBreak (Duodec) single discs, and a double shoot (DS) knife-point and press wheel system.

Single disc compared with DS knife point

In these field trials, wheat seedling establishment was consistently affected by the interaction between herbicides and seeding system (Figure 1). Trifluralin significantly reduced wheat emergence under single discs (37 to 64%), whereas little or no reduction in wheat density was recorded for the DS knife-point system (≤23%). Boxer Gold® also reduced wheat establishment with single discs, however the level of damage was far more variable and ranged between 8 to 56%. This variation in damage with Boxer Gold® was probably related to post-sowing rainfall which may have influenced the movement and concentration of this soluble herbicide in and around the crop root zone. In contrast, no crop damage was observed for Sakura®, which appears to be the safest pre-emergent option for use in wheat sown with discs.

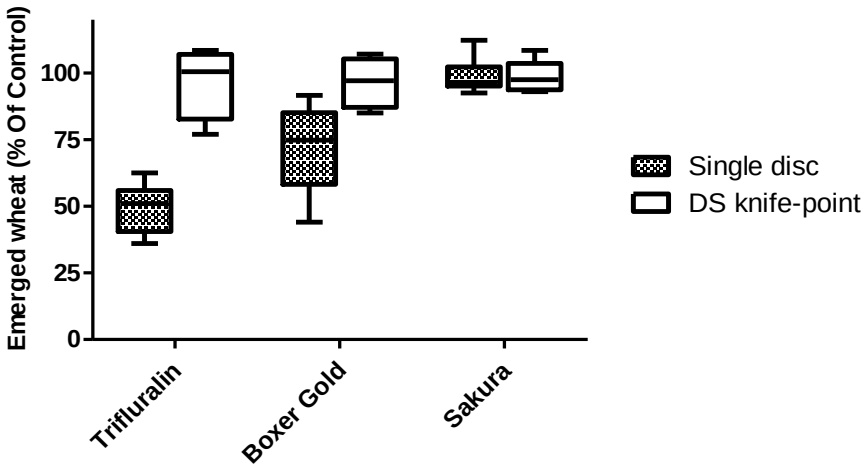

Figure 1. Box plots showing the effect of pre-emergence herbicides on wheat emergence (% Of Control) under single disc and DS knife-point and press wheel seeding systems. Data were sourced from 6 trials undertaken at Roseworthy in the years from and including 2008 to 2012.

The higher soil disturbance knife-point system has been shown to create enough soil throw to remove herbicide treated surface soil out of the furrow (Solhjou et al, 2012) and this is the likely

reason for the observed low or no phytotoxicity to the wheat crop. Conversely, the single disc systems appear to leave herbicide treated surface soil in the furrow where it is in close proximity to crop seeds. The greater herbicide phytotoxicity observed under single discs was not the result of shallower seed placement as measurements determined the wheat seeds had been placed at a similar depth to the comparative knife-point system (data not presented). Movement of herbicide treated surface soil into the furrow slot from entrainment by the disc blade and/or gathering by the closing furrow wheel appears to exacerbate crop damage under single disc systems.

Shallow disc operating depth compared with deep disc operating depth

Preliminary results from trials undertaken last year showed that disc seeding system setup also has a critical role in the level of wheat crop damage from pre-emergence herbicides. Disc seeding system design and setting up, including operating and sowing depth, travel speed and whether or not residue managers are used all appear to influence the behaviour of pre-emergence herbicides in disc systems. For example, a comparatively aggressive soil throw arising from the seed banding boot deflector of the DayBreak Duodec disc seeding system resulted in significantly better crop safety than that achieved with other single disc configurations, likely due to a more effective herbicide separation process.

Disc seeders are often operated at fast travel speeds (i.e. in a 2007 disc seeder survey, 50% of 31 SA farmers surveyed operated between 11-13 kph, with reported speeds of up to 16 kph), with research and industry evidence showing that higher speeds reduce seed placement uniformity. Variable or shallow seed placement can often increase the risk of herbicide damage where furrow surface soil has not been cleared and limited vertical separation may not secure the required positional selectivity. In the 2012 trials, increasing sowing depth minimised herbicide damage when a double shoot version of NDF 650 disc seeding system was used which created greater soil disturbance and achieved deeper seeding depth, and thus increased the likely separation between the herbicide and germinating seed (Figure 2). A shallow sown seed is more likely to be closer to herbicide on the soil surface and less rain is required to move soluble chemicals (i.e. Boxer Gold ®) from the surface down to the seed.

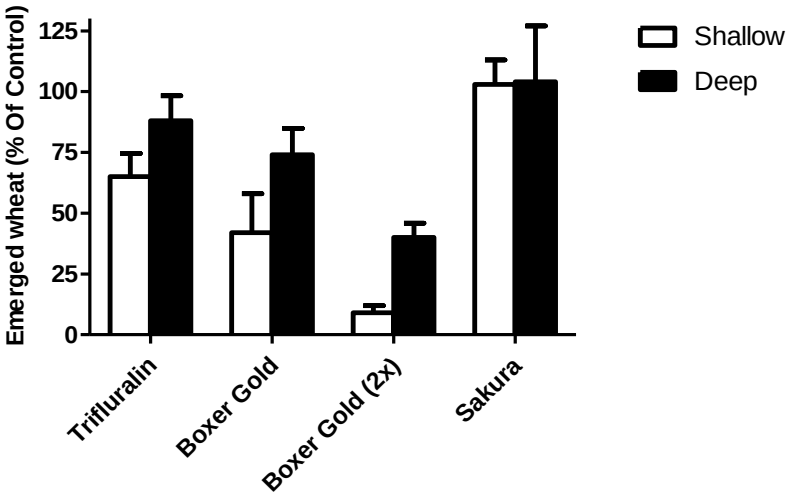

Figure 2. Influence of disc operating depth (shallow vs. deep) on wheat emergence (% Of Control) with different pre-emergence herbicides. The single disc seeding systems used were NDF 650 (single

vs double shoot). Mean shallow and deep sowing depths were 25.2 and 40.5 mm respectively. Control wheat emergence = 168 plants m^{-2} (shallow) and 159 plants m^{-2}, (deep). Bars represent SE of mean.

Wheat emergence with and without residue managers

Herbicide damage was especially reduced by the use of residue managers on single disc seeding systems in the 2012 trial (i.e. John Deere 90 series + Aricks wheel - data in Figure 3 - and NDF 650 + Ndf wheel - data not shown). The residue managers were set to clear a 3 to 4 cm band of surface residue and herbicide ahead of the disc opener, limiting the interaction between treated soil and the germinating crop.

In field trials over the period, triple disc configurations consistently provided greater crop safety relative to single disc systems and showed comparative wheat establishment to the DS knife-point system. Controlled soil throw with leading rippled coulters fitted ahead of Bertini and K-Hart double disc openers ensures that herbicide treated soil is thrown out of the furrow and concentrated on the inter-row, which provided excellent crop safety in the 2012 trials. Risk of herbicide damage is normally minimised by operating the furrow opening coulters side by side on the same rank to control furrow ridging and minimise residue pinning by rear rank coulters which could operate in looser soil when set at narrow row spacing. Illustrating this soil throw benefit in a different way, some significant herbicide damage resulted from both trifluralin and Boxer Gold ® when coulter skids were fitted to Bertini leading coulters. These skids are 'soil throw controllers' designed to limit the amount of soil movement out of the furrow by preventing soil from riding up the coulter and thus keeping herbicide treated soil close to the furrow, increasing the risk of herbicide damage.

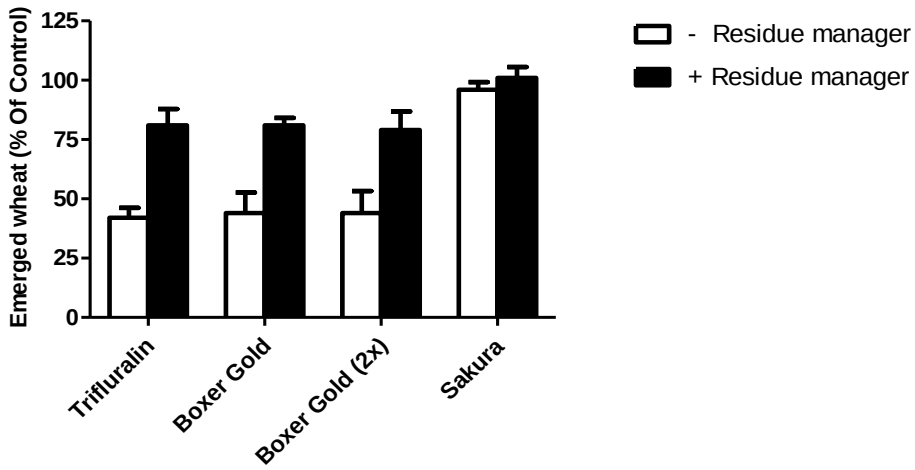

Figure 3. Effect of pre-emergence herbicides on wheat emergence (% Of Control) under John De ere (90 series) single disc opener with and without Aricks wheel residue manager. Control wheat emergence = 203 plants m^{-2} (+ residue manager) and 211 plants m^{-2} (- residue manager). Bars represent SE of mean.

Annual ryegrass control with pre emergence herbicides and disc incorporation

At several field trials, annual ryegrass control was shown to differ between pre-emergence herbicides following disc incorporation (Figure 4). Even though most of the ryegrass seedbank was

near or on the soil surface at these sites, control with trifluralin was on average consistently lower (39%) than both Boxer Gold® (82%) and Sakura® (84%). The low level of ryegrass control provided by trifluralin was likely a result of poor incorporation as well as herbicide resistance. Boxer Gold® and Sakura® are much more stable and show longer persistence in the soil than trifluralin and can be applied well before incorporation without considerable loss in efficacy. Use of trifluralin under single disc seeding systems, where weed control failed due to poor incorporation and crop density declined due to phytotoxicity, often resulted in massive seed set by ryegrass (data not presented). Such high levels of ryegrass seed production would be expected to have serious effects on productivity of subsequent crops in the rotation.

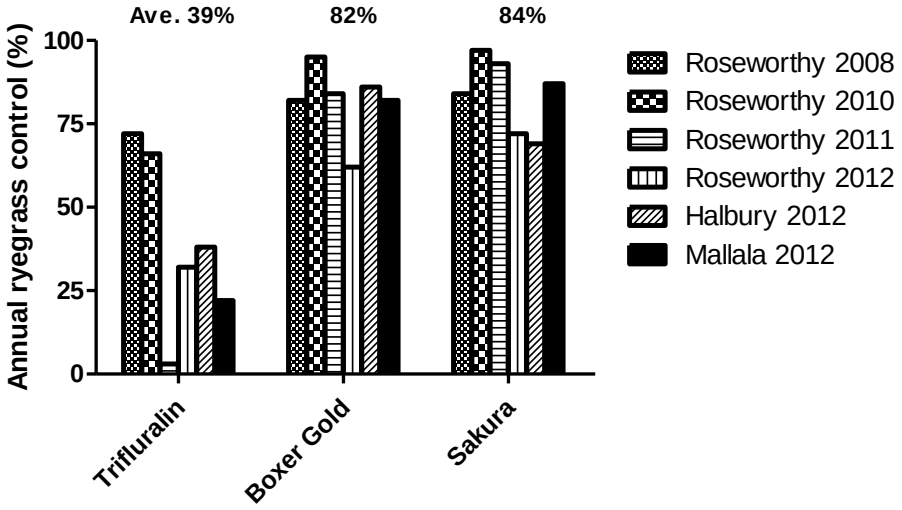

Figure 4. Performance of pre-emergent herbicides on annual ryegrass control (%) at 5 field trials sown with single disc seeding systems. It should be noted that inability of trifluralin to control ryegrass at Roseworthy in 2011 was most likely due to herbicide resistance rather than poor incorporation. Weed control is expressed as reduction in annual ryegrass plant density.

References

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