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FarmLink Research Report 2019

Harvest weed seed control in the Southern High Rainfall Zone

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Introduction

Harvest weed seed control (HWSC) refers to a range of technologies and practices that capture and destroy weed seeds at harvest. It has been demonstrated to be highly effective on annual ryegrass in a range of rainfall zones of the Australian grain belt but the Southern High Rainfall Zone (HRZ) is underrepresented in these studies. As a result of the high rainfall and long growing season, 6 to 8 t/ha wheat yields are achievable and are harvested in December through January. These unique features – a high yield potential with late harvest dates – may affect the efficacy of HWSC. A series of small-plot experiments and farm-scale demonstrations were conducted as part of this GRDC-funded project to determine the efficacy of HWSC in the region.

It was shown that HWSC can make an economically viable contribution to sustainable weed control in the Southern HRZ. However, it also became apparent that HWSC will play a different role for weed control in this region. As a result of the long crop growing season, annual ryegrass typically sheds about 50% of its seed and about 20% of its seed heads have lodged before typical cereal harvest dates, limiting HWSC's efficacy. On the other hand, eliminating the remaining 30% of annual ryegrass seeds through HWSC was shown to increase long-term gross margin by maintaining moderate annual ryegrass populations and preventing greater weed competition.

Therefore, HWSC in the Southern HRZ is similar to other regions in that it makes a profitable contribution to annual ryegrass control, but it differs in that it only restricts population growth. It maintains moderate weed pressures rather reducing them drastically over time. The more a growing region resembles the high yield potentials and late harvest dates of the Southern HRZ, the more likely it is that it will resemble this model. The lower the yield potential with earlier harvest dates, the more likely it is to resemble previous findings on HWSC. Wherever HWSC may be adopted, the extra costs must be outweighed by the increase in yield through prevented weed competition, and this research has highlighted that careful attention should be paid to the extra time, fuel, wear and tear, and capital that are needed to implement a given HWSC technology.

Project Partners

SFS FarmLink RiverinePlains MFMG

Funding Partners

GRDC Grains Research & Development Corporation

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Project overview

Harvest weed seed control (HWSC) refers to a range of technologies and practices that capture and destroy weed seeds at harvest. These include chaff carts, narrow windrow burning, chaff lining, chaff tramlining (chaff decks) and weed seed impact mills. These technologies differ in the way that weed seeds are destroyed, but they are all designed to capture weed seeds via the sieves during harvest operations and eliminate them before they germinate in the following season.

HWSC has been demonstrated to be highly effective on annual ryegrass in a range of rainfall zones of the Australian grain belt. For example, it has been shown that 60-80% of annual ryegrass seeds can be captured at harvest, and that 95-99% of these seeds can be destroyed with a weed seed impact mill (Walsh *et al*. 2014; Walsh *et al*. 2017).

However, the Southern High Rainfall Zone (HRZ) is underrepresented in the studies that were conducted prior to the initiation of this project in 2015. As a result of the high rainfall and long growing season in this environment, 6 to 8 t/ha wheat yields are achievable and are harvested in December through January. These unique features – a high yield potential with late harvest dates – may affect the efficacy of HWSC.

The project was designed to address three key questions for the Southern HRZ:

1) Is HWSC effective?

2) Is HWSC practical? and

3) Is HWSC profitable?

Small-plot experiments addressed the efficacy of HWSC, on-farm demonstrations tested its practicality and the findings from these trials were entered into a model called LUSO (Lawes and Renton 2010) to address the question of profitability. The trial locations are presented in Figure 1.

HWSC is profitable (in the long-term) in the Southern HRZ

The question 'Is HWSC profitable in the Southern HRZ?' needs to be viewed in a long-term timeframe. HWSC does not increase the gross margin for the season that is being harvested; its benefits will be seen in later years. Further, the question has its complexities. Many factors affect weed survival and reproduction. To answer the question, therefore, a scenario analysis of the long-term effect of HWSC on farm profit is needed. This is provided by a version of LUSO that was modified with the project data.

The consequence of adding a weed seed impact mill (WSM) to a wheat/barley/canola rotation for farm profit was examined in LUSO under two factors: initial weed burden and herbicide efficacy (Figure 2). A low starting weed burden is represented by 100 seeds/m^2, or about 15 annual ryegrass plants/m^2 in late winter, and a high starting point is represented by 500 seeds/m^2, or about 75 ryegrass plants/m^2. Effective herbicides were modelled by a 95% kill rate, and ineffective herbicides were modelled by a 90% kill rate. The key input values are presented below in Table 2.

In 2017, an on-farm demonstration was conducted at Wolesley, South Australia, comparing two New Holland CR8090 headers – one with an integrated Harrington Seed Destructor (iHSD) and one without. Wheat that yielded 6 t/ha was harvested at 15 cm and the extra cost of running the WSM was estimated at $34/ha, primarily to increased fuel use and reduced harvest speed. This is comparable to the value estimated by the Kondinin Group for a crop of this size (White, Guimelli and Saunders 2018). It is, however, likely to be an overestimate of the cost of newer models of weed seed impact mills.

Figure 1. The location of small-plot experiments (blue) and on-farm trials (red) that were part of the research project.

Table 2. Values used in LUSO for the economic analysis of a WSM in a 12-year wheat/barley/canola rotation.

Enterprise	Yield potential (t/ha)	Grain price ($/t)	Variable cost ($/ha)	N required (kg/ha)
Wheat + WSM	8	300	635	180
Wheat	8	300	600	180
Feed barley + WSM	8	260	585	150
Feed barley	8	260	550	150
Canola + WSM	3	580	635	100
Canola	3	580	600	100

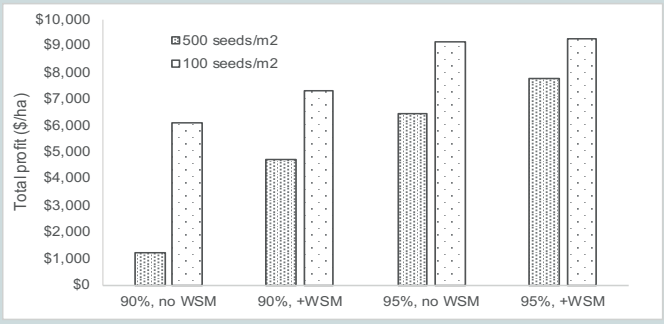

Figure 2. Total profit after 12 years of a wheat/barley/canola rotation starting at 100 seeds/m² or 500 seeds/m². "90%" or "95%" refers to the proportion of weeds killed before harvest. "WSM" refers to a weed seed impact mill.

Total profit after 12 years of a wheat/barley/canola rotation was reduced when 90 per cent of weeds survived until seed set and no WSM was used under both starting weed burden scenarios. Adding a WSM increased profit, but having effective herbicides increased profit even more. It was always profitable to include a WSM when the starting weed seedbank was 500 seeds/m², but if the starting seedbank was 100 seeds/m² a breakdown in herbicide efficacy was needed to justify the extra cost of a WSM.

This shows that even more expensive HWSC technologies such as WSM's have a place in the farming systems of the Southern HRZ. This assumes at harvest of the first season using a WSM either the paddock already had more than 15 plants/m² in mid-winter or more than 95% of the weeds typically survive until harvest. If this is not the case, the extra costs of using a HWSC technology should be much less than $34/ha to be justified. Given continued improvements in the WSM technology this is likely to be achievable with current models or upcoming ones, furthermore WSM's are the most expensive of the available HWSC technologies.

HWSC is less effective in the Southern HRZ

Although HWSC can be profitable in the Southern HRZ, it should not be expected to behave in a similar way to reports from other growing regions of Australia. Rather than capturing around 70% of annual ryegrass seeds, small-plot experimental data suggests that capturing around 30% is more likely in the Southern HRZ. Figure 3 below illustrates the effect of a 30% weed seed destruction rate on a weed seedbank using the same scenarios as the economic analysis above.

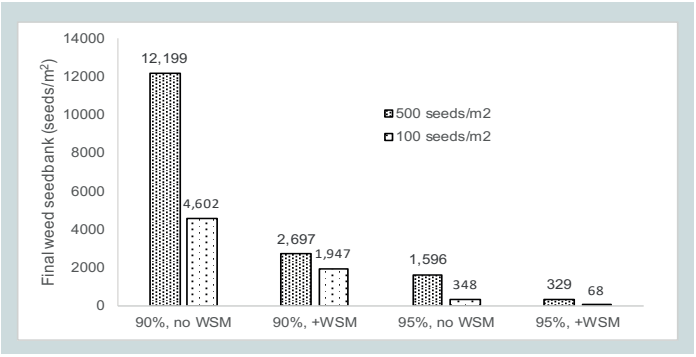

Figure 3. Final seedbank after 12 years of a wheat/barley/canola roation with 90% of 95% of weeds killed by herbicides and with/without a weed seed impact mill (WSM), starting at 100 seeds/m² or 500 seeds/m².

After 12 years, a similar pattern in annual ryegrass control was observed between the starting weed population scenarios. Adding a WSM reduced ryegrass seeds dramatically after 12 years, but the gain was greater again when herbicides were more effective. Combined, a WSM with effective herbicides reduced weed seed numbers by about 30% over 12 years. This is less than would be predicted from a weed seed destruction rate of 70%.

The findings from the small-plot experiments help explain this result. A high degree of shedding was observed in all small-plot trials. At Yarrawonga, the furthest north trial site, 1,500 to 2,000 annual ryegrass seeds per square meter were shed before harvest in 2016 and 2017. The trials were harvested on 11 December 2016 and 10 December 2017. When the data from all small-plot trials was pooled it became apparent that there was a large variation in shedding rates but the most common value was about 50% (see Figure 4).

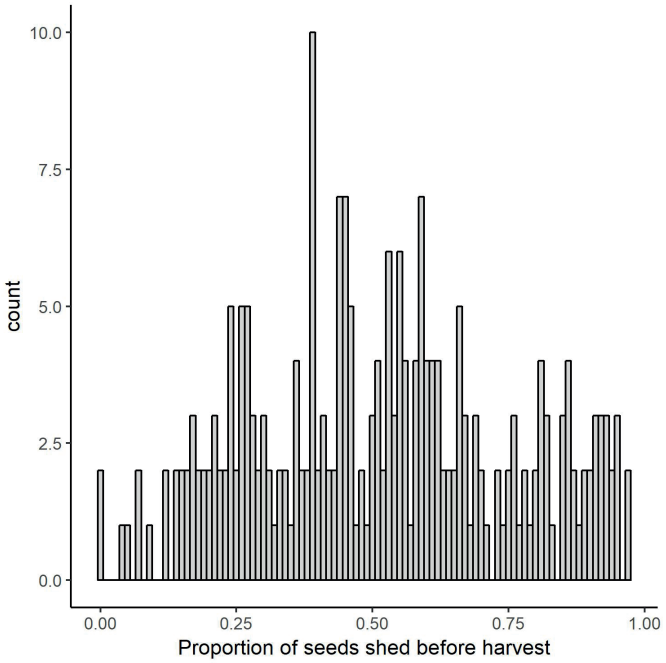

Figure 4. The distribution of seed shedding rates in small-plot experiments in the Southern HRZ.

Ryegrass seed heads also lodged or snapped off the stalk before harvest, falling to the soil surface. As a result, a harvest cut height of 15 cm or 30 cm did not make a difference to weed pressure after two consecutive years of HWSC (Table 3).

Table 3. Annual ryegrass emergence in 2018 after two years of HWSC at two cut heights in a small-plot trial at Yarrawonga.

Cut height	ARG emerged 22 May, 2018
15 cm	103 n.s.
30 cm	113 n.s.
P-value	0.14

The reason that HWSC is profitable in the Southern HRZ, despite the reduced efficacy, is that it has a higher yield potential. The small-plot data showed that the yield penalty caused by annual ryegrass in the Southern HRZ is the same as lower rainfall zones. If there are 50 annual ryegrass plants/m^2 they will cause a yield penalty of about 10% to the yield potential. If the yield potential is 3 t/ha, this penalty is 0.3 t/ha, but if the yield potential is 6 t/ha, this penalty is 0.6 t/ha. Therefore, because of the high yield potential, the southern HRZ has more to gain in yield and income per weed controlled, and this drives the profitability of a 30% HWSC destruction rate.

Implications

HWSC can make a profitable contribution to weed control across Australia, but the specific dynamics of that contribution will differ between environments.

Due to the high yield potential, HWSC makes a profitable contribution to weed control in the Southern HRZ but should not be expected to drastically change weed numbers. With only 30% of annual ryegrass seeds available for capture, HWSC can support IWM packages by decelerating population growth.

Given that expensive HWSC options ($34/ha) do not contribute to farm profitability when weeds are already under control, a strategic approach to HWSC may be needed.

Given that a harvest cut height of 15 cm did not improve HWSC in the high yielding crops of the Southern HRZ, a 30 cm cut height may suffice and would reduce harvest operation costs.

Recommendations

Consider adding HWSC to IWM packages for the Southern HRZ.

In the Southern HRZ, pay more careful attention to the extra costs associated with HWSC before investing. Estimate extra fuel useage, extra wear-and-tear costs and depreciation. A decrease in harvest speed required by a HWSC technology can be very expensive.

Take a strategic approach to HWSC. Find ways to reduce operating costs, and target HWSC to problem paddocks.

In a high yielding paddock, weigh up the effect of harvest cut height between the cost of harvest operations and the effect of stubble height on seeders in the following year. Typically, a 30 cm cut height is no less effective than a 15 cm cut height in the Southern HRZ.

References

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