Harvest weed seed control - narrow windrow burning

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Key findings

- Narrow windrow burning canola can be an effective tactic against ryegrass provided weed seeds can be captured and concentrated at swathing & harvest.
- Of the ryegrass seed captured between 93-99% was controlled by burning narrow windrow canola.

Why do the trial?

The widespread evolution of multiple herbicide resistance in Australian cropping has forced the development of alternative, non-chemical weed control strategies, especially new techniques at grain harvest. Harvest weed seed control systems target weed seed during commercial grain harvest operations and act to minimise fresh seed inputs to the seed-bank. Harvest weed seed systems, include chaff carts, baling, Harrington seed destructor and narrow windrow burning.

Weed seed kill levels of 99% for both annual ryegrass and wild radish have been recorded from the narrow windrow burning of wheat, canola, and lupin chaff and straw residues (Walsh and Newman 2007). The simplicity and low cost of this narrow-windrow system has resulted in its adoption by an estimated 70% of crop producers in the major grain production state of Western Australia. In South Australia the adoption of this practice is not as high as there have been a limited number of trials able to show the reduction in weed seed number.

The aim of this study was to understand how effective narrow windrow burning is capturing annual ryegrass seeds (comparison of between row and inter-row measurements). Also to determine the reduction in ryegrass as a result of burning (comparison of burnt and unburnt sections of the row).

How was it done?

Three growers in the Mid-North who were planning to narrow windrow burn canola provided field sites for this study. Prior to narrow windrows being burnt in early 2014, an assessment of canola stubble/cutting height (cm) and biomass (t/ha) in the narrow windrow were assessed (Table 1). A 5 m section of chaff was removed in five rows to represent a non-burnt area.

After the narrow windrows were burnt, 10 soil samples (7 cm diameter core x depth 10 cm) were taken from five replicates per paddock in the following three locations:

1) Burnt section of windrow
2) Sample within 3 m on the non-burnt section
3) Inter-row

These 10 soil samples were combined to make one bulk sample per treatment. The soil samples were then transferred to shallow trays and germinating ryegrass assessed at regular intervals. Census of ryegrass was ceased when no new seedlings emerged over a 3-week period. Ryegrass seed number was determined from the total number of ryegrass seedlings to germinate, and the total area sampled (i.e. core area (πr^2) × number of cores sampled (n=10)) and converted to a unit area (i.e. seeds/m^2).

Table 1. Cutting height and stubble biomass of canola from 3 field sites across Mid-North of SA.

Field site	Stubble/cutting height (cm)	Stubble biomass (t/ha)
1	42.8	2.8
2	31.6	2.4
3	34.0	2.6


Photos: Field site one (left) measuring 5 m of canola narrow windrow to be removed prior to burning (right) inter-row area with canola and annual ryegrass stems remaining.


Photo: Burning narrow windrows 2014.

Results and discussion

The effectiveness of narrow windrow burning of canola is governed by the amount of weed seed captured and accumulated in the windrow by the swathing and harvest operation. Whilst ryegrass shows less of a tendency to shed seed relative to other grasses (i.e. wild oats, brome grass), it can be prone to lodging reducing the amount of seed collected. Furthermore, there has been some suggestion that ryegrass is more prone to lodging in canola than other crops because of a reduction in stem strength resulting from increased crop shading.

The effectiveness of seed capture and accumulation under narrow windrows was apparent at 2 of the 3 study sites, where up to 13-fold more ryegrass seed was found in the narrow windrow in comparison to the adjacent swath area (Table 2). The exception was site 1, where seed accumulation was only 2-fold higher in the narrow windrow. At this site the cutting height of canola was 10 cm higher (42.8 cm) than at sites 2 (31.6 cm) and 3 (34 cm), and much of the ryegrass had lodged according to the grower. This would have reduced the effectiveness of both the swathing and harvest operations to capture and concentrate seeds in the windrow. To improve seed capture some consideration must therefore be given to both the growth habit of ryegrass and subsequent swathing height.

Often cutting height of canola varies with the height and biomass of the crop at maturity and subsequently the cultivar grown. Not surprisingly hybrid-cultivars, which have tendency to grow taller, are usually swathed higher than their shorter TT-relatives. Consequently ryegrass is less likely to be captured under taller hybrids than TT-cultivars unless swathing height is adjusted accordingly.

Table 2. Effect of swathing and harvest on ryegrass (seeds m^{-2}) accumulation in narrow windrows at 3 field sites across the Mid-North of SA. Values in parenthesis represent SE (±) around the mean of five replicates.

Site	Narrow windrow	*Between windrow	Increase in ryegrass seed accumulation in narrow windrows
	ryegrass seed (no./m^2)		
1	8210 (1357)	3829 (820)	2.14-fold
2	8563 (789)	644 (231)	13.3-fold
3	10600 (979)	805 (271)	13.2-fold

**Expected accumulation based on 10 m swath into 0.75 m narrow windrow = 13.3.*

When canola and ryegrass were concentrated in narrow windrows, soil surface temperatures during burning were hot enough and their duration sufficient to kill >93% of ryegrass seed (Table 3). At site 3, the control was as high as 99%, with less than 52 viable seeds remaining in the burnt versus a possible 10600 seeds/m^2 in the unburnt windrow, respectively.

Pervious research from WA (Walsh & Newman 2007) showed that given sufficient canola residue had been concentrated burn temperatures exceeding 600°C were possible and well in excess of the 400°C required for at least 10 seconds to guarantee the death of ryegrass seeds. Their research concluded that higher biomass levels in narrow windrows increased mortality of ryegrass by increasing both burning temperatures and duration of these higher temperatures. They also found that wind speeds (higher better than low) were important by maintaining more consistent burning temperatures, improving the ability of the windrow to burn to the soil surface.

There are, however, some noteworthy disadvantages to burning narrow windrows which include summer rain reducing burning temperatures, associated unburnt residue heaps and trash flow issues at sowing, risk of burning entire field leading to increased erosion (less of problem with narrow than conventional windrows), redistribution of nutrients such as potassium in windrow area, and loss of important nutrients such as nitrogen and sulphur lost in smoke.

Table 3. Ryegrass (seeds m^{-2}) following burning of canola stubble concentrated into narrow windrows at 3 field sites across the Mid-North of SA. Values in parenthesis represent SE (±) around the mean of five replicates.

	Windrow treatment			
Site	Burnt	Unburnt	Ryegrass control	*P-value* Burnt Vs. unburnt
	ryegrass seed (no./m^2)		(%)	
1	540 (236)	8210 (1357)	93	***
2	88 (18)	8563 (789)	99	***
3	52 (15)	10600 (979)	99	***

**** P < 0.001.*

Summary / implications

Narrow windrow burning canola appears to be an effective tactic for late seed set control of ryegrass provided weed seeds can be captured and concentrated into narrow windrow at swathing and harvest. To improve seed capture some consideration must be given to both the growth habit of ryegrass (lodged vs. erect) and subsequent swathing height (i.e. lodged ryegrass will require lower swathing height). Although not covered in this study, timing of swathing will also influence seed capture with earlier timing improving likelihood of capture as less ryegrass will have shed seed.

In canola, concentration of stubble residues into a narrow windrow using a simple chute mounted to the rear of the harvester is critical to obtain the fuel loads to achieve a longer, more reliable burn to the soil surface. A minimum of 400°C is required for at least 10 seconds to kill ryegrass seed (Walsh & Newman 2007); canola in narrow windrows can produce temperatures in excess of 600°C.

Our study showed that of the ryegrass seed captured, between 93 and 99% was controlled following burning of canola stubble concentrated into narrow windrows. This provides growers an excellent opportunity for late seed set control, particularly in situations where grass selective herbicides (i.e. Select®) have failed due to resistance and sizeable seedbank replenishment would undoubtedly cause production problems in the next crops of the rotation.

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References

Walsh, M. and Newman, P. (2007) Burning narrow windrows for weed seed destruction. Field Crop Research 104, 24-30.