Section 5

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Weeds

Barley grass management in retained stubble systems - farm demonstrations

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RESEARCH

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Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2015 Total: 333 mm
2015 GSR: 258 mm
Yield
Potential: 3.0 t/ha (W)
Actual: 1.23 t/ha
Soil Type
Red loam

Key messages

- **Weed seeds were found in narrow windrows and chaff dumps, ryegrass was more prevalent than barley grass which is more prone to shedding seed early.**
- **Burning reduced the viable ryegrass and self-sown cereal seed density by 85%, reducing the overall weed seed bank, but results for barley grass were lower at 38%.**
- **Conditions (i.e. temperature and humidity) and timing of burn were shown to strongly influence the effectiveness of this cultural management tactic.**
- **Burning windrows resulted in fewer weed seeds returning to the weed seed bank.**
- **There is a cost associated with windrow harvesting due to lower harvesting height requiring reducing the harvest speed with larger throughput of straw.**
- **A better understanding of burning and the weather conditions needed to sterilise barley grass seed is needed.**

Why do the trial?

The GRDC 'Maintaining profitable farming systems with retained stubble - upper Eyre Peninsula' project aims to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP). Weed control in stubble retained systems can be compromised where herbicide efficacy is limited due to higher stubble loads, especially for pre-emergent herbicides. Current farming practices have also changed weed behavior with later germinating barley grass genotypes now present in many paddocks on the Minnipa Agricultural Centre (MAC) (B Fleet, EPFS Summary 2011). Several MAC farm demonstrations were undertaken in 2014 to address barley grass weed issues including later germinating types and barley grass resistance to Group A herbicides.

An integrated approach to weed management aimed at lowering the weed seed bank can make use of diverse techniques such as cultivation, stubble burning, in-crop competition using higher sowing rates and possibly row orientation. The weed seed bank can be reduced within the break phase by hay making, or green or brown manuring. Other techniques used effectively in WA on ryegrass and wild radish have been narrow windrows and chaff carts. However there is limited information on the effectiveness of these tactics on barley grass in part because it is believed that most seed is shed well before harvest, limiting control.

In 2015 the monitoring of farm paddock demonstrations in low rainfall farming systems to assess control methods for grass weeds, mainly targeting barley grass, were undertaken by;

- Monitoring of narrow windrows in MAC paddocks N1 and N6W, and Bruce Heddle's paddock CE42 (windrows and chaff dumps).
- Spray topping after oat and vetch hay (MAC paddock S4) using both crop competition (high seeding rate) followed by spray topping after the hay cut.

How was it done?

Before harvest in 2014 the MAC 2366 header was fitted with a narrow windrow attachment made on farm from dimensions obtained from the GRDC website to divert chaff and straw into a 600 mm windrow. The straw chopper was disengaged. There were no issues with the windrow attachment during harvest.

Selected MAC farm paddocks were monitored for barley and ryegrass numbers and, in the 2015 season, burning temperature, seed capture and seed viability in the narrow windrows was recorded.

Research was undertaken at MAC, as well as on a local farmer's property, where Bruce Heddle modified a 60 Series John Deere harvester for weed seed capture and management using narrow windrows and a chaff cart (see EPFS Summary 2014, Barley grass in a retained stubble system – farm demonstrations, p152-154 for further detail).

The paddock CE42 has been problematic for both ryegrass and barley grass. It was sown in 2014 on 170 mm row spacing with a 100 mm row spread to maximise wheat crop competitiveness. The paddock was harvested as low as possible with the chaff fraction blown into the cart, the chopper disengaged and the windrow boards fitted to create narrow windrows. In 2014 the crop yielded approximately 3.5 t/ha with a high stubble load, presenting a challenge to burn the straw windrows and chaff piles effectively without burning the whole paddock. The paddock was lightly grazed to utilise unharvested grain for two weeks at 5 DSE/ha.

In 2015 the paddock was sown to Stingray canola at 3 kg/ha with 35 kg/ha of DAP (18:20:0:0) with knife points and press wheels at 300 mm row spacing. The chemical control applied in crop was 450 ml/ha clethodim and 500 gm/ha atrazine 900WG after early weed counts.

At MAC, paddock N1 (with previous high, medium and low input zones with different fertiliser and seeding rates, refer to EPFS Summary 2012, Zone responses to four years of repeated low, medium and high input treatments at Minnipa, p86 for details) had dense barley grass in 2014 and was returned to a pasture phase in 2015. The paddock was windrowed at harvest 2014 but the windrows were not burnt in the whole paddock. The section of paddock which had been monitored for grass weeds in 2014 was burnt on 23 April, in non-ideal conditions due to 23 mm of rainfall occurring the week before.

Paddocks N1 and CE42, which had windrows and chaff dumps (CE42 only), were assessed for grass weed seed density in-crop and in the soil seed bank. The effectiveness of windrowing and chaff dumping, as affected by burning temperatures and weather conditions, was assessed by comparing burnt and unburnt sections of narrow windrows and chaff dumps.

The weed seed soil samples were germinated in an external weed seed area established in 2015. Weed seed samples were placed in 35 cm x 29 cm black germinating trays, partially filled with sterilised soil mix and the collected weed seed bank soil was spread over the top to 1-2 cm depth, with another light coating of the sterilised soil mix spread over the top. The trays were placed in a rabbit proof open area and watered as required during the season. The trays were assessed for weed germination approximately every four weeks. The counted weeds were removed from the trays. Twenty-one check plots with barley grass seed collected from MAC N1 (sprinkled into check trays) were located across the germination area to assess timing of barley grass germination.

Chaff was collected (5 samples per dump) from 4 different sides of the dump, approximately 20 cm into the dump at approximately 1 m height, and one sample from the top of the dump to determine the weed seed species being collect at harvest.

Soil weed seed bank samples were collected in February and March 2015 along a transect across the paddock comprising 10 GPS-located sampling points. The soil sampling method used was as described by Kleemann *et al*. (2014). Prior to narrow windrows being burnt a 5 m section of chaff was removed (non-burnt area) within each paddock (Figure 1). Three subsamples of very fine chaff from in the windrow were also collected and germinated on trays. Chaff was also collected and germinated from three chaff dumps to assess the weed seeds being collected at harvest.

After burning the windrows, sampling of the three areas occurred with 10 soil core samples (using a 7 to 10 cm diameter core to 10 cm depth) from each of the following three locations

1. Burnt section of windrow (10 cores)
2. Sample from within 3 m on the non-burnt section of windrow (i.e. section raked) (10 cores)
3. Sample from middle of adjacent unburnt inter-row area (10 cores)

The 10 soil core samples were pooled or bulked so a total of 3 soil samples were collected for each of the 10 GPS locations in the paddock (i.e. burnt, non-burnt, adjacent unburnt inter-row). These 3 soil samples were spread across 3 soil trays for germination.

The paddock was monitored during the season for early and late grass weed germination by doing 6 counts of 1 m x 0.5 m quadrats at 10 GPS-located sites along a transect across the paddock.

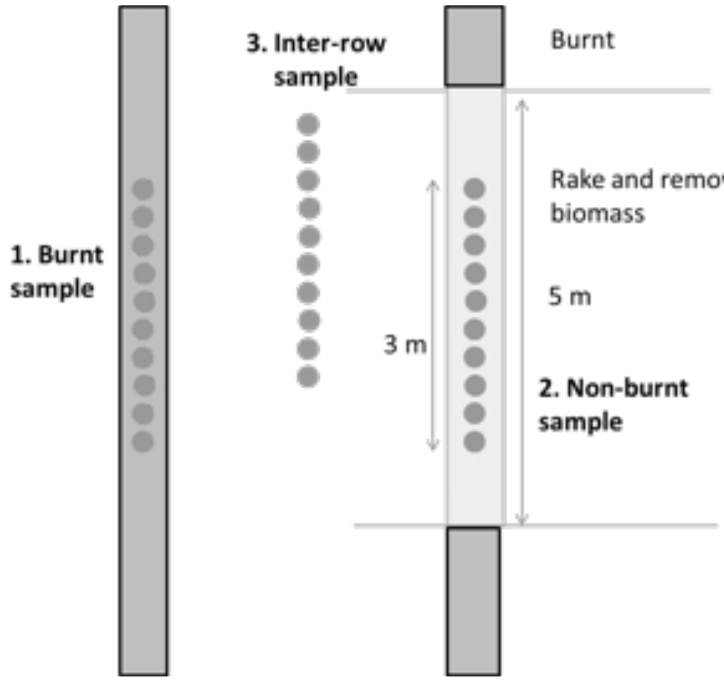

Figure 1 Sampling methodology for each of the 3 locations (1. burnt, 2. non-burnt, & 3. adjacent inter-row), (Kleemann et al. 2014). Shaded areas represent windrows.

What happened?

Bruce Heddle burnt the windrows and chaff dumps on 24 March 2015 in the late afternoon with a temperature of 22°C, the wind speed was average of 1 km/h and maximum of 8 km/h, direction was south/south easterly (swung to Minnipa direction which caused some community issues), humidity 25%, stubble height 17.5-18 cm. Using a handheld thermometer the temperature of the burning narrow windrow peaked at 620°C within 43 seconds of ignition and was maintained at between 600 and 300°C for up to 240 seconds (Figure 2). The sudden spikes in temperature appeared to be related to wind gusts while burning. These temperatures easily exceeded the 400°C required for 10 seconds required to kill weed seeds (Walsh and Newman, 2007).

In Bruce's farming system he has different strategies for chaff piles, depending on the paddock rotation for the next year:

- Wheat stubble to be cropped with canola - piles are grazed to the point they can be sown through and driven over with the sprayer without any inconvenience. If this can't be achieved, they are burnt.
- Canola stubbles to be cropped with wheat - piles are grazed to the point they can be sown through (even with 170 mm row spacings) and driven over with the sprayer without any inconvenience. Canola chaff is far too valuable as sheep feed to burn.
- Wheat stubbles to be returned to medic pasture – paddocks are conserved for lambing ewes and winter grazing with the piles left in place. Grazing over the pasture phase will see them largely degrade and gone by the time the paddock returns to wheat.
- Chaff piles in paddocks being sown to grain legumes are burnt.

Bruce's opinion is burning of chaff piles is still successful after the opening rain as long as they are ungrazed and shed the water to ensure they stay dry. Grazed and disturbed piles need to be burnt earlier to ensure they are dry and the burning is successful. Narrow windrows are not grazed and are burnt quite early in the season to ensure a hot and effective fire. The windrow and chaff dump burning was very successful and majority of straw between rows was unburnt with the paddock left well protected from wind erosion (Figure 4).

The canola windrows in MAC paddock N6W were burnt on the 14 April before a 23 mm rainfall event with a temperature of 29.5°C, the wind speed averaged 28 km/h with a maximum of 39 km/h, direction was west north westerly.

The MAC N1 paddock was burnt on 23 April in cool weather conditions after the 23 mm rainfall event on 17 April. The weather conditions were 17.5°C, humidity 56%, and wind 11 km/h in a south westerly direction. The windrows remained damp following the rain the week before, and after 6 minutes of burning the damp stubble beneath the row reached a maximum temperature of 50°C. These temperatures fall well short of the required 400°C, with most weed seeds expected to remain viable. Given the amount of residue concentrated into narrow windrows it's unlikely that they can effectively dry down after significant rainfall, limiting the effectiveness of the tactic and creating stubble handling issues at sowing from unburnt residue.

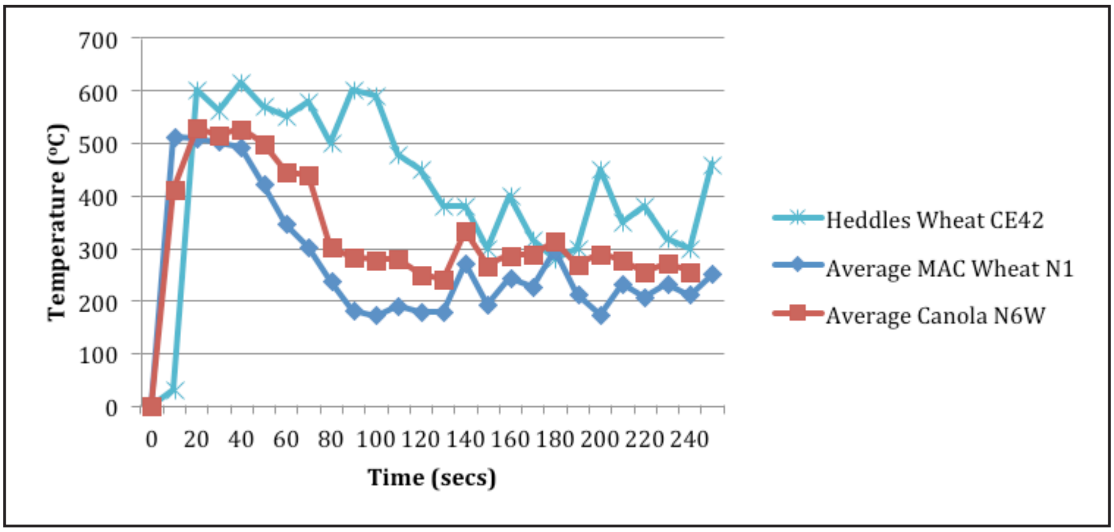

Figure 2 Burning temperatures (°C) over time (seconds) of windrows (wheat and canola) prior to seeding 2015.

Table 1 Average weed density (plants per m²) in weed seed soil banks for windrow burning, Heddle's paddock CE42 in 2015.

Treatment (refer to Figure 1)	Barley grass	Rye grass	Self-sown cereal	Canola	Medic/other broadleaved weeds
3. Inter row (before burning)	95.6	109.9	11.9	0.0	107.5
2. In row non burnt (straw removed from 5 m row - soil collected after burning)	38.2	265.2	262.8	2.4	160.1
1. In row burnt (In row soil collected after burning)	19.1	78.8	43.0	0.0	76.5
reduction in seed bank by windrow burning	50%	70%	84%	100%	52%

Table 2 Average weed density (plants per m²) in chaff (5 trays with average 57 g chaff per tray) collected from chaff dumps, Heddle's paddock CE42 2015.

Treatment	Barley grass	Rye grass	Self-sown cereal	Canola	Medic/other broadleaved weeds
Dump 1 (5 trays)	1	2022	19.0	0	2.0
Dump 2 (5 trays)	30	28	1.3	0	1.0
Dump 3 (5 trays)	17	16	4.0	0	1.0
Average of chaff dumps	16	689	8.1	0	1.3

While barley grass was the primary target in paddock CE42, ryegrass was also present with high weed infestation in the flats of the paddock. Assessments showed that there were much greater numbers of barley grass in the inter row compared to within the windrow (Table 1). It is commonly thought barley grass has a tendency to shed seed early, limiting seed capture and resulting in lower numbers in the windrow. Even though only a small number of seeds accumulated in the windrow, 50% were destroyed upon burning. Weed seed capture and control from burning was better for ryegrass, self-sown cereals and other weed species. Despite burning temperatures exceeding the recommended 400°C for 10 seconds required to kill ryegrass seed, a small proportion of seed remained viable. Chaff was sampled from chaff dumps to assess effectiveness of weed seed collection at harvest (Table 2). Results were highly variable between chaff dumps with very high collection of ryegrass in dump 1 (~2000 seeds), but considerably lower collection in dumps 2 and 3 (16-28 seeds), respectively (Table 2). Collection was much lower for barley grass (~16 seeds).

Paddock CE42 was sown to canola in 2015 and there were grass weeds present in crop early but chemical control reduced the weeds to very low numbers (Table 3).

Table 3 In-crop plant and grass weed density (plants per m²) in Heddle's paddock CE42, 2015.

	Early weed densities (plants/m²)	Late weed densities (plants/m²)
Canola	59.6	54.0
Barley grass	16.2	0.1
Rye grass	36.4	0.2

Table 4 Soil weed seed density (plants per m²), windrow burning, paddock N1.

Treatment (refer to Figure 1)	Barley grass	Rye grass	Self-sown cereal	Canola	Medic/other broadleaved weeds
3. Inter row (before burning)	262.8	15.9	0.0	0.0	31.9
2. In row non burnt (straw removed from 5 m row - soil collected after burning)	593.3	19.9	83.6	0.0	75.7
1. In row burnt (In row soil collected after burning)	430.1	0.0	11.9	0.0	171.2
reduction in seed bank by windrow burning	27%	100%	86%		

MAC N1 had high levels of barley grass in 2014 and was returned to a pasture phase in 2015. The paddock was windrowed at harvest 2014 but not all windrows were successfully burnt. The section of paddock which had been monitored for grass weeds was burnt under less than ideal conditions on 23 April, with windrows damp following 23 mm of rainfall the week before (Table 4). As a consequence, windrow burning was ineffective with many seeds remaining viable after burning (Table 4). The temperatures reached were not sufficient to kill ryegrass seed (Figure 2).

Canola windrows in paddock N6W were effectively burnt, reaching temperatures above 400°C for approximately 80 seconds. Burning canola has excellent fit within farming systems as the burn can be more easily contained to the windrow. Barley grass (6 plants/m²), ryegrass (2 plants/m²) and wild oats (2 plants/m²) were generally less prevalent, however some seed shed was evident for barley grass reducing the effectiveness of burning. This paddock will continue to be monitored in 2016.

Spray topping oats and vetch hay (paddock S4)

In 2015 a hay mix of oats and vetch was sown as a strategy to reduce barley grass in S4 by increasing crop competition by sowing at high rates. Plant counts taken on 25 June showed good crop establishment (77 vetch plants/m²; 154 oats plants/m²) with relatively few weeds present (4 barley grass plants/m²; and 3 ryegrass plants/m²).

Leaf Area Index (LAI) measurements were taken on 18 September using an AccuPAR PAR/LAI Ceptometer (model LP-80), taking the average of 5 readings per plot placed at an angle across the crop rows as per the manufacturer's instruction manual. The measurements were taken at Zadoks growth stage Z49-51, aiming for maximum crop canopy. The LAI showed that the hay crop was providing high level of light interception (105 umols) and shading of weeds. Measurements from nearby trial assessing influence of row spacing and seed rate on crop competition had considerably lower LAI readings (66-67 umols). Even though readings were lower for high seed rate x narrow row spacing treatments, there appeared to be some benefit on suppressing weed growth and competitiveness. A dense and competitive oaten hay could be a useful option against barley grass and ryegrass, which also provides the option of spray-topping for late weed seed set control (i.e. hay freeze).

The influence of farming management strategies on barley grass will be ongoing in these demonstration paddocks in 2016.

Figure 3 Weed seed bank germination trays at Minnipa Agricultural Centre, 2015.

Figure 4 Windows and chaff dump burning at Bruce Heddle's, March 2015.

Figure 5 (left to right) Ungrazed chaff dump, chaff dump grazed for 1 week and 2014 grazed chaff dump in pasture paddock.

What does this mean?

Weed seeds were found in narrow windrow and chaff dumps in CE42, however seed capture was more effective for ryegrass and self-sown cereals, with much of the barley grass seed shed prior to harvest. Also, late germinating barley grass plants were visually shorter and were consequently less likely to be captured at harvest. Burning of narrow windrows had some success at reducing weed seed numbers, with the burn more easily contained in canola than wheat. However, in paddock N1, where narrow windrows were damp due to significant rainfall, temperatures required to kill weed seeds were unobtainable at the time of burning and consequently control was poor. This management tactic must be undertaken under optimal conditions for reducing the overall weed seed bank using no chemical methods. Like all farm operations, windrow burning requires timeliness and ideal conditions to maximise benefit. Windrow harvesting does have a cost at harvest, as harvesting lower increases fuel use or reduces speed of harvest (or both).

In 2016 ongoing paddock monitoring of alternative methods to chemical control options to manage grass weed numbers, especially barley grass, will occur in paddocks on MAC (S3N, Airport, N6W) and Bruce Heddle's for further information to be collated for upper EP farming systems.

A better understanding of burning time/temperature requirements and environmental conditions required to sterilise barley grass seed is needed, with this research planned for the coming season in conjunction with the University of Adelaide researchers.

References

Kleemann, S., Noack, S., Hooper, P., Preston, C. & Gill, G. (2014). *Harvest weed seed control – narrow windrow burning.* Hart Annual Trial Results. p69-72.

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