

## 6.6 Long Term Comparison of Stubble Management Strategies - Perth, Tas

**Location:**

"Oakdene", Perth, Tasmania

**Author:**

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**Funding:**

Grains Research and Development Corporation.

**Acknowledgements:** Bill Chilvers

**Researchers:**

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**Growing season rainfall (April-Nov):**

241mm plus approximately 130mm irrigation.

**Summary of Findings:**

Five management strategies were compared: stubble fully retained (SFR); cut and baled (SCB); incorporated with Lemkin discs (Lemkin); Burnt; and stubble digester applied with stubble incorporated. Increased ground cover resulted in large delays in establishment. This may be a direct function of poor seed soil contact as in the case of SFS plots but also through increased shading which in turn significantly reduced soil temperature.

The different stubble treatments had no significant effect on grain yield. However there was a strong trend ( $P=0.11$ ) for the SFR treatment to out-yield the Burnt treatment and the number of pods per plant was significantly higher in the SFR and SCB treatments compared with Burnt plots. This presumably relates to the higher moisture content measured in the stubble retained plots enabling greater survival of developing pods.

Some long term benefits from full retention of stubble are already evident with significant increases in earthworms and a trend towards decreased resistance to root penetration.

**Background:**

The generally greater crop yields in higher rainfall areas result in additional stubble loads compared with the major grain growing areas of Australia. Direct drilling with tyned drills into retained stubble is invariably restricted with stubbles in excess of 5 t/ha.

Burning of stubbles prior to sowing the next crop has environmental and other disadvantages, notably the loss of organic matter and some nutrients (N and S). Four trials across SE Australia (Victoria x2, Tasmania, S.A.) are being conducted to determine suitable stubble management options. This is the second season of the trial. The aim of this trial is to compare the effect of different stubble treatments on crop establishment, growth, grain yield and quality over a three year timeframe. The sustainability of the treatments will also be evaluated with comparison of soil physical, chemical and biological data.

Plots were machine harvested on 24<sup>th</sup> January 2008.

**Treatment and Methods:**

After discussion with key farmers the treatments chosen for the trial were:

- Stubble fully retained (SFR)
- SFR + microbes, nutrients (applied post harvest, incorporated)
- SFR + incorporation (post harvest with Lemkin discs)
- Stubble cut low (15cm) with windrower and removed
- Burnt in mid autumn to achieve a "cool burn"

The trial was sown on 11<sup>th</sup> July with tickbeans at 150kg/ha and 3:15:13 fertiliser at 250kg/ha using a John Deere thirty foot single disc drill with Simplicity air cart. The previous crop in the trial was Mackellar wheat. Plots were 50m long x 11m wide and there were four replicates in a randomised complete block design.

A pendimethalin/simazine mix was applied pre-emergent and a grass selective herbicide (Select). A fungicide program and the dry conditions ensured little disease pressure.

Measurements taken included: Ground cover, establishment counts (average of 20/plot), soil temperature (3 readings/plot), soil moisture content (10 samples/plot), penetrometer (5 readings /plot) and weed counts (10/plot).

For the SFR and Burnt treatments assessments of invertebrate populations were conducted - Pitfall traps (2 per plot) were constructed from plastic tubs containing ethylene glycol, inserted at ground level. Spade tests (average of 5 holes/plot) were dug to assess changes in populations of worms.

### Results:

**Plant establishment:** The low stubble load from 2006-07 resulted in minimal sowing problems but as a result of the cold dry conditions establishment in the tickbeans was slow and largely related to the difficulty in dealing with excess stubble chaff and sprayed-off Vulpia. Straw windrows created sowing problems for SFR plots with some of this material being residue from the 2005-2006 season.

▼ **Table 6.12: Effect of stubble treatments on stubble, plant residues and plant density, Perth 2007-08.**

Treatment	Plant density 25 Jul (plants/m <sup>2</sup> )	Plant density 23 Aug (plants/m <sup>2</sup> )	Difference in plants/m <sup>2</sup> (%)	Previous stubble residue (t/ha)	Ground cover 0 (none) - 10 (high)
Burnt	29.4	28.7	0.0	0.00	1.50
Lemkin	23.9	30.5	27.8	0.37	2.25
Digestor + disc	17.1	27.9	63.2	1.70	4.00
Cut + baled (SCB)	15.5	23.9	53.9	0.19	6.25
Fully retained (SFR)	10.0	19.8	97.9	2.14	9.00
<b>F prob</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>		<b>&lt;0.001</b>	<b>&lt;0.001</b>
<b>LSD (P=0.05)</b>	<b>4.16</b>	<b>2.60</b>		<b>0.419</b>	<b>1.297</b>
<b>CV%</b>	<b>14.1</b>	<b>6.5</b>		<b>30.9</b>	<b>18.3</b>

The delay in germination with poorer seed soil contact is evident from plant density counts (Table 6.12) conducted on 25 July. Plant density in Burnt plots was significantly higher than all other treatments (29 plants/m<sup>2</sup>) and SFR plots were significantly lower with only 10 plants/m<sup>2</sup>. Further plant counts were taken on 23 August by which time plant density had increased in all treatments except burnt plots which did not vary from the earlier counts ie they had all germinated by the time of the first count. Establishment counts in Burnt, Lemkin, and Digestor + disc treatments at this later date were not significantly different but were significantly higher than SCB and SFR.

Increases in density between the two counts ranged from no difference for Burnt plots to over 100% for SFR treatments, clearly showing the delay caused by poor seed soil contact and shading. These differences were largely overcome by maturity - SFR plots tended to be lower but there were no significant differences between treatments.

Of interest to those growers incorporating stubble was the more rapid establishment, through better stubble incorporation, with the Lemkin compare with offset discs.

**Stubble residues/Ground cover:** The quantity of stubble residue remaining above the soil surface after harvest and prior to sowing was significantly higher for SFR plots but also shows the poorer incorporation of the offset discs compared with the Lemkin. The poor establishment in SCB plots with relatively little stubble residue relates to a greater cover of sprayed-off Vulpia present in these plots and SFR plots. Poor germination in the SCB treatment may also be a function of allelopathic effects from Vulpia. Ground cover scores of stubble residue, Vulpia and chaff cover prior to sowing correlate well with the delay in plant establishment.

**Soil temperature:** Plant establishment and ground cover scores also broadly correlate with soil temperature and reflect the degree of shading. Measurements (average of 3 readings) were conducted at 5cm on 10<sup>th</sup> July (Temp1), 25<sup>th</sup> July (Temp2) and 8<sup>th</sup> October (Temp3). Additional readings were taken at 10cm on 10<sup>th</sup> July but only in one replicate. (Table 6.13)

The treatment with the highest cover (SFR) resulted in significantly lower soil temperatures compared with other treatments except SCB, from establishment through the growing season to at least early October. Removal of stubble through burning and to a lesser degree burying with the Lemkin resulted in significantly higher soil temperatures at 5cm depth at establishment but by mid October the only significantly lower temperature was with the SFR treatment.

▼ **Table 6.13: Effect different stubble treatments on soil temperature at 3 dates (10 July, 25 July, and 8 Oct), soil moisture content and penetrometer depth, Perth 2007-08.**

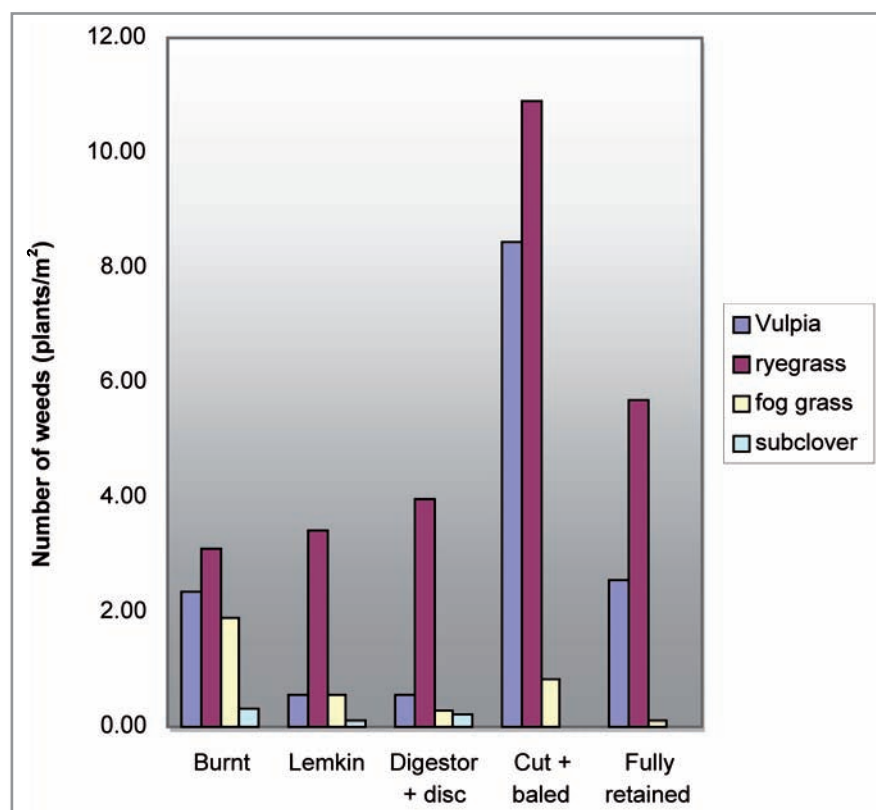
Treatment	Temp1 (10/7) at 5cm (°C)	Temp1 (10/7) at 10cm (°C)	Temp2 (25/7) at 5cm (°C)	Temp3 (08/10) at 5cm (°C)	Soil moisture (%)	Penetrom eter depth (mm)
Burnt	8.60	6.2	11.9	12.79	28.75	159.5
Lemkin	8.08	5.9		12.97	29.33	178.3
Digestor + disc	7.23	5.9		12.71	30.82	202.5
Cut + baled (SCB)	6.47	5.4		12.39	32.55	181.5
Fully retained (SFR)	5.99	5.4	10.3	11.86	33.63	202.9
<b>F prob</b>	<b>&lt;.001</b>	<b>1 rep only</b>	<b>&lt;.001</b>	<b>0.002</b>	<b>0.001</b>	<b>0.132</b>
<b>LSD (P=0.05)</b>	<b>0.501</b>		<b>0.33</b>	<b>0.480</b>	<b>2.108</b>	<b>37.96</b>
<b>CV%</b>	<b>4.5</b>		<b>1.3</b>	<b>2.5</b>	<b>4.4</b>	<b>13.3</b>

**Soil moisture:** During establishment moisture content in the top 20cm of the soil profile was significantly higher where stubble was retained (SFR, SCB) compared with Burnt stubble (Table 6.13) Soil moisture content in SFR plots was also significantly higher than in Lemkin incorporated plots.

Measurement in early November showed higher moisture content in SFR plots for all depths 0-20cm, 20-40cm, and 40-60cm. However there was considerable variation in the data and statistically these results were not significant. Even with pooling of data (0-60cm) the effect was not significant (P=0.16, data not presented).

**Soil penetrometer:** Penetrometer resistance provides an indication of ease of root penetration. Although not significant, mean penetration depth at a force of 2000 kPa (average of 5 readings) was highest for the SFR treatment and lowest for the Burnt treatment. This improvement in soil structure has occurred after only 2 seasons of stubble retention.

**Weed populations:** With a good strike prior to sowing, the in-crop germination of weeds was minimal in most plots compared with 2006-2007. Nevertheless there were large differences in weed populations between stubble treatments (Figure 6.15) . Where stubble was removed (SCB) there were significantly higher densities of *Vulpia* spp and ryegrass (*Lolium perenne*). Although not significant SFR plots also tended to have more *Vulpia* and ryegrass while there tended to be less grass species with stubble incorporation treatments. The higher populations in the SCB compared with SFR may be the result of greater shading and possibly more compounds such as acetic acid being leached from SFR plots resulting in reduced germination of weeds.



▲ Figure 6.15: Effect of different stubble treatments on weed populations (plants/m<sup>2</sup>) of Vulpia, rye grass (*Lolium perenne*), fog grass (*Holcus lanatus*), and sub clover (*Trifolium subterraneum*), at Perth, 2008, l.s.d. = 5.08, 4.38, 1.39, and 0.29 respectively.

In contrast, and although not significant ( $P=0.18$ ), both cultivated treatments tended to increase the density of subclover (*Trifolium subterranean*) compared with the stubble retained treatments, presumably due to seed at depth being brought to the surface by cultivation.

Fog grass (*Holcus lanatus*) tended to be at higher densities in Burnt plots but populations were small and data was variable and not significant ( $P=0.10$ ). *Poa annua* and spear thistle (*Cirsium vulgare*) plants were also counted in small numbers but there were no apparent trends and data is not presented.

**Invertebrate populations:** Spade tests showed significantly higher worm numbers (Table 6.14) where stubble had been retained (now two seasons of retention). Pit fall traps tended to show more worms in the SFR plots. Interestingly there were significantly more flies and gnats captured in the traps. This may relate to the higher soil temperatures increasing survival or changing the soil biota that these insects feed on. It may also be a function of the trapping procedure with less cover around the traps where stubble was burnt. Alternatively there may also be less predators where stubble was burnt although this was not reflected in predator numbers. With a number of other insects captured there were no significant differences and populations were low.

▼ Table 6.14: Effect of different stubble treatments on invertebrate populations using spade test and pitfall traps, Perth 2007-08.

Treatment	Spade test:	Pit-fall trap – Average number of:		
	average no. worms	worms	flies	gnats
Burnt	1.00	0.56	2.25	10.72
Fully retained (SFR)	3.90	1.25	1.03	4.56
F prob	0.033	0.171	0.002	0.052
LSD ( $P=0.05$ )	2.458	1.22	0.377	6.251
CV%	44.6	59.9	10.2	36.4

**Grain yield:**

Harvested grain yields were not high (Table 6.15) given the amount of irrigation but were reduced by considerable harvest losses with quadrat counts suggesting losses of up to 1 t/ha. There were no significant treatment effects on grain yield, however there was a strong trend ( $P=0.11$ ) for the SFR treatment to significantly out-yield the Burnt treatment (Table 6.15). Other treatments were intermediate but the highest yielding of these was the partial stubble retained treatment (SCB).

**Yield components:**

Six quadrats ( $0.25\text{m}^2$ ) were taken prior to plot harvest to assess the yield components (Table 6.15).

As discussed the final plant density was not significantly different between treatments. There were no significant differences between treatments for seed weight ( $P=0.56$ ) and number of seeds per pod ( $P=0.62$ ). However the number of pods per plant was significantly higher in the SFR and SCB treatments compared with Burnt plots. This presumably related to the higher moisture content available in the stubble retained plots thus enabling greater survival of developing pods.

▼ **Table 6.15: Effect of different stubble treatments on grain yield, plant height and yield components, Perth 2007-08.**

Treatment	Plot yields (t/ha)	Plant ht (mm)	No. pods /plant	No. seeds /pod	100 seed (wt/g)	Harvest Index
Burnt	3.43	975	26.8	2.12	50.54	47.10
Lemkin	3.59	948	21.1	2.20	50.89	45.80
Digestor + disc	3.68	1060	28.8	2.34	50.73	45.46
Cut + baled (SCB)	3.76	1112	35.9	2.17	51.56	46.13
Fully retained (SFR)	4.04	1128	39.8	2.24	50.85	47.53
<b>F prob</b>	<b>0.107</b>	<b>0.008</b>	<b>0.005</b>	<b>nsd</b>	<b>nsd</b>	<b>nsd</b>
<b>LSD (<math>P=0.05</math>)</b>	<b>0.450</b>	<b>103.7</b>	<b>8.99</b>			
<b>CV%</b>	<b>7.9</b>	<b>6.4</b>	<b>19.2</b>			

The slower growth in the SFR plots did not appear to have carry-over effects to maturity. There were no significant differences in plant height at maturity. Similarly the ratio of grain produced to total dry matter (harvest index) did not vary between treatments.

It is worth noting that the trial site was well irrigated over spring and early summer. While this masked the greater soil moisture deficit in the Burnt plots it assisted with ensuring sufficient moisture for the later maturity of the SFR plots.

The net effects may change in a wetter season where moisture conservation through stubble retention is a limitation.

Although GRDC funding for this project will finish June 30th of this year it appears likely that the project will continue for another 2 seasons with Landcare funding after which time changes in some of the soil biology and physical properties should get interesting.