4. STUBBLE MANAGEMENT TRIALS

4.1 Long-term comparison of stubble management strategies - Perth, Tas

Location:
"Oakdene" Perth, Tasmania .

Funding:
GRDC (2005-08), currently NRM North.

Researchers:
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Background/Aim:
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.) were funded by GRDC in 2005 to evaluate different stubble management options. GRDC funding finished in June 2008 and NRM North recognised the benefits of continuing the trial with funding for a further 3 years.

The aim of this trial is to compare the long term effects of different stubble treatments on crop establishment, growth, grain yield and quality. The sustainability of the treatments will also be evaluated with comparison of soil physical, chemical and biological data.

Growing season rainfall (Apr-Nov):
502 mm (plus 150 mm irrigation)

Summary of findings:
- Five stubble management strategies were compared: fully retained; fully retained with higher sowing rate; cut and baled; burnt and incorporated with Lemken discs.
- Fully retained stubble resulted in some soil improvements such as increased worm populations.
- Grain yield from plots where stubble was retained (fully retained and cut and baled) tended to produce higher yields compared with plots where stubble was burnt. The wet season and irrigation may have masked any greater potential yield benefits from plots with retained stubble treatments.

Trial information:
After discussion with key farmers the stubble treatments chosen for the trial were:
- Fully retained
- Fully retained with a high sowing rate. (Up until 2008-09 the treatment on these plots was stubble fully retained and incorporated with offset discs)
- Lemken discs (fully retained and incorporated with Lemken discs).
- Cut and baled (stubble cut low with windrower and removed)
- Burnt (a 'cool burn' mid autumn)

The trial was sown on 24th May with Revenue wheat at 85 kg/ha (115 kg/ha in high sowing rate plots) and DAP at 200kg/ha using a Baldan disc drill. Waterlogged conditions in 2009-10 resulted in poor establishment and growth of canola the previous year, hence stubble loads were minimal. Plots were 50m long x 8m wide and there were four replicates in a randomised complete block design. Fertilisers, herbicides and fungicides applied to the crop are summarised in Table 1.

Table 1: The dates and rates of in season applications of fertilisers, herbicides and fungicides applied at Perth, 2010-11.

	Date	Rate
Fertilisers		
Winter crop boost	23/9/10	12 L/ha
Urea	13/10/10	115 kg/ha
Herbicides		
Hussar OD	23/9/10	100 ml/ha
Fungicides		
Opus	20/10/10	500 ml/ha
Talstar	20/10/10	100 ml/ha
Opus	11/11/10	500 ml/ha
Talstar	11/11/10	100 ml/ha
Prosaro	16/12/10	300 ml/ha

Measurements included: Ground cover, establishment counts (20/plot), soil temperature (3 readings/plot), soil moisture content (3 samples/plot), penetrometer (10 readings/plot) and weed counts (10/plot). For the fully retained and burnt treatments further assessments of invertebrate populations and soil fauna biomass were conducted: Pitfall traps (2 per plot) were constructed from plastic tubs containing ethylene glycol, inserted at ground level and check every 14-21 days. Spade tests (5 holes/plot) were dug to assess changes in populations of worms. Bacterial and fungal biomass levels were conducted by Soil Foodweb International. Prior to harvest quadrat samples (8 x 0.5m^2) were cut from plots and these are currently being processed. Plots were machine harvested on 8th February 2011.

Results and discussion:

The season: 2010 was a wet season in Northern Tasmania with soaking rains in winter and spring, which lead to much of the trial area being waterlogged for extended periods. June in particular was very wet (Decile 8-9) and the rain continued throughout spring. Above average rainfall and additional irrigation over flowering and during grain fill meant the crop would have rarely been under stress from lack of water. The wet finish to the season then continued and as with commercial crops grain harvest was subsequently delayed.

Plant establishment: Stubble load from 2009-10 was low and patchy within the plots and resulted in minimal sowing problems but as expected there was a higher stubble load in the fully retained plots compared to other treatments (Table 2). In contrast to previous years the stubble load did not affect plant establishment and there was no significant difference between burnt, fully retained and cut and baled plots (Table 2). Plant establishment was best in the Lemken and the high sowing rate plots which were not significantly different from each other (Table 2).

Soil temperature: The lower ground cover scores broadly correlated with soil temperature and reflect the degree of shading. The treatments with the highest straw cover (fully retained) resulted in significantly lower soil temperatures compared with other treatments when measurements were taken at early establishment (Table 2). Further temperature measurements were taken on the 2nd September where similar significant trends were shown and the 14th October by which time there were no significant difference between treatments (data not presented) when the plants were at approximately Zadoks growth stage 32.

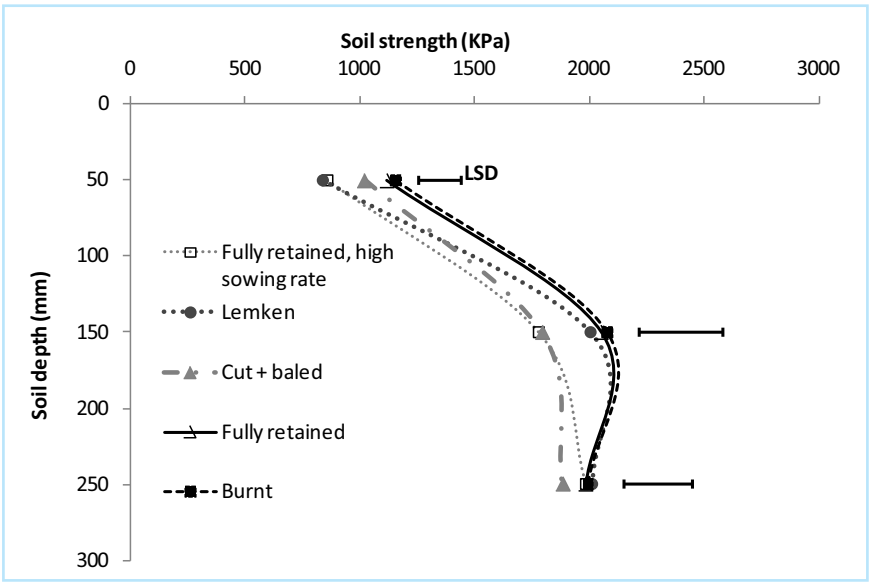
Table 2: Effect of stubble treatments on surface straw, plant density and soil temperature, at Perth, 2010-11.

Treatment	Surface straw scores 1 (none) – 10 (high)	Plant density 1st July (plants/m²)	Soil temp 16th June at 5 cm (°C)
Burnt	1.5	103.0	8.4
Fully retained, high sowing rate	5.5	123.8	7.9
Fully retained	6.3	104.2	7.7
Lemken	2.3	114.1	8.5
Cut + baled	1	106.1	8.3
P value	**<0.001**	**0.007**	**0.001**
$LSD_{0.05}$	**1.6**	**11.0**	**0.3**

Soil moisture: At the beginning of crop establishment (1st June) there was a significant (*P* = <0.001) difference in soil moisture at 40-60cm. At this depth gravimetric soil moisture content was significantly higher in the fully retained plots (33.7%) than either burnt and Lemken plots (27 and 25.5% respectively). The difference at this lower depth was probably carried over from the previous season. However, the high rainfall this season possibly masked any other soil moisture differences throughout the season. The moisture content was not significantly different between treatments for any other measurement dates; 1st June (crop establishment), 8th September (late tillering) or 30th November (end of flowering) for any depth interval measured; 0-10, 10-20, 20-40 or 40-60cm (only the first two depth increments on the 8th September were assessed) and data is not presented.

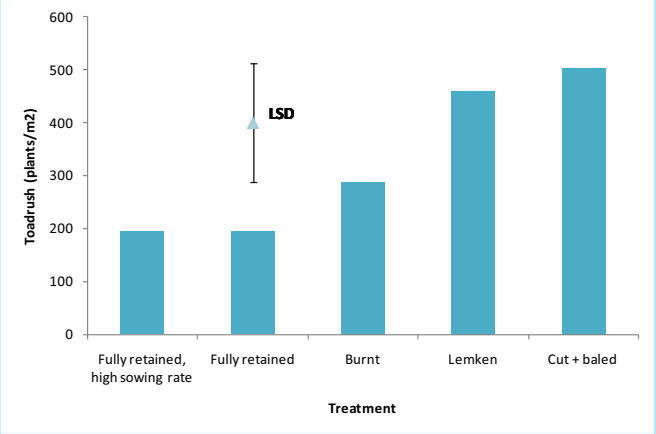
Soil strength measurements: Penetrometer tests measure the force to push a metal rod into the soil and the resistance force provides an indication of ease of root penetration. Measurements were taken on the 8th September at field capacity when soil moisture was not significantly different between plots (data not presented). Penetrometer measurements were made at 0-10, 10-20 and 20-30 cm depth intervals. Penetration resistance was significantly lower for both Lemken and the higher sowing rate plots than either fully retained or burnt plots at the 0-10 cm depth (Figure 1). This shows that mechanical tillage, for the Lemken and the high sowing rate plots (which had been disced until last season) had more of an effect of soil strength than any other stubble management option at this early stage of the trial. There was no significant difference between treatments below this depth (Figure 1).

Figure 1: Effect of stubble management treatments on soil strength (KPa) at Perth, 2010-11.



Weed populations: Toadrush populations varied between plots with the fully retained plots showing the smallest populations (Figure 2). These weeds appeared to have no effect on the wheat crop and were probably a sign of the observed generally greater waterlogging and surface water in the plots where stubble had been removed or incorporated. Thistle, ryegrass, subterranean clover and field madder were also present but there was no significant difference in any other weed populations between any treatments (data not presented).

Figure 2: Effect of stubble treatments on weed populations (plants/m^2) of toadrush at Perth, 2010-11.



Invertebrate populations and soil fauna: Spade tests showed significantly higher worm numbers where stubble had been fully retained compared with burning (Table 3). Slug populations in fully retained plots were also significantly higher than in the burnt plots (Table 3). A number of other insects were captured in the pit-fall traps e.g. gnats, flies, crickets, spiders and earwigs but there were no significant differences and populations were generally low (data not presented). Bacterial and fungal biomass levels were in the desired range according to the research laboratory that performed the analysis, however there was no significant difference between treatments (Table 3). There was also no significant difference in the biomass of other soil fauna tested, namely flagellates, amoebae, ciliates or actinobacteria nor the ratio of bacteria to fungi between treatments (data not presented).

Table 3: Effect of stubble treatments on invertebrate populations and biomass carbon, at Perth, 2010-11.

Treatment	Spade test (average) worms	Tile trap (average) slugs	Total bacteria (µg/g)	Total fungi (µg/g)
Burnt	1.1	3.3	111	191
Fully retained	5.8	9.3	96	245
P value	**0.001**	**0.027**	**ns**	**ns**

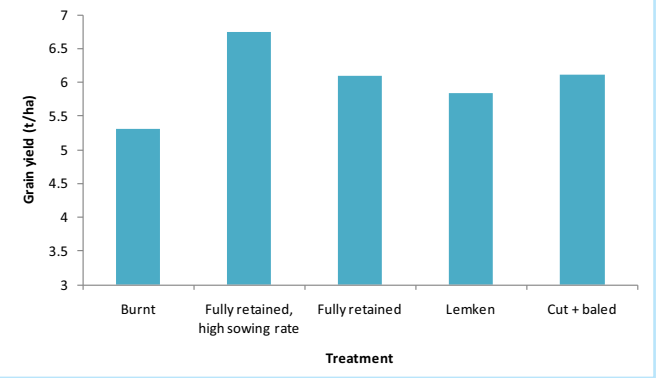
Dry matter production: At harvest dry matter production was similar for treatments aside from the fully retained, higher sowing rate plots, which had significantly higher biomass than other treatments (Table 4).

Table 4: Effect of stubble treatments on dry matter production at flowering and harvest, Perth, 2010-11.

Treatment	Dry matter at harvest (t/ha)
Burnt	13.8
Fully retained, high sowing rate	17.5
Fully retained	14.5
Lemken	15.1
Cut + baled	15.3
P value	**0.027**
$LSD_{0.05}$	**2.08**

Grain yield: Overall, harvested grain yields were reasonable given the waterlogging through winter and spring and delay in herbicide and fungicide applications (Figure 3). Under the wet conditions plant tillering was likely to have been reduced and thus the benefit of the higher sowing rate was more likely to be realised. Though not significant, (P = 0.076) yield tended to be greater from the higher sowing rate plots and yield from burnt plots tended to be lower than other treatments. In contrast to previous trials, plant establishment and thus yield at harvest was not significantly lower with stubble fully retained. This allowed the benefits of retaining stubble compared to burning to be realised in the current season. It is likely that the positive effects from stubble retention were diminished by the relatively wet season and irrigation.

Figure 3: Effect of stubble treatments on yield (t/ha) at Perth, 2010-11.



Summary:
Five stubble management strategies were compared: fully retained, fully retained with a higher sowing rate, cut and baled, incorporated with Lemken discs and burnt. There was no significant effect of stubble management on grain yield, however as the burning of the stubble tended to reduce yield, the sowing rate increased the yield compared to other treatments. The wet season would have masked any improvements in increased soil water holding capacity with stubble retention. Fully retained plots did however have increased earthworm activity and tended to produce greater dry matter production. Improvements in soil resistance in retained stubble plots are yet to be realised. Plots which had been consistently disced or disced recently had lower resistance to root penetration in the top soil than the other treatments, where no tillage has occurred for over 5 years. However, this lower soil strength did not translate to better establishment or yields. Soil improvements with different stubble management treatments should continue into the future, where benefits in yield should be realised, particularly in drier seasons.