MALLEE CATCHMENT
TECHNICAL BULLETIN

Technical Bulletin # 18

Healthy soils with break crops in the Mallee

Above: Harvesting the plots at the Ouyen site. Photo: DPI.

This technical bulletin focuses on the implications for soil health of including break crops within cereal dominated systems in the Mallee. Conclusions are based upon field research conducted in the Mallee over a period of two years with above average rainfall.

The identification of management strategies to increase water use efficiency (WUE) in cereal based cropping systems is an ongoing priority within the low rainfall Mallee environment. While the inclusion of break crops in continuous cropping systems may provide several benefits to the subsequent cereal crop, it may also change groundcover production and maintenance; and thus susceptibility to soil erosion.

The project quantified ground cover and above ground biomass for all break crops sown in 2011, and the stubble loads remaining from 2010 relative to wheat, in three replicated field experiments at Ouyen.

At a glance

- Lupins, canola, hay and fallowing were evaluated as break crops to determine their impact on soil erosion risk within the low rainfall Mallee environment;
- The project quantified ground cover and above ground biomass for all break crops sown in 2011, and the stubble loads remaining from 2010 relative to wheat, in three replicated field experiments at Ouyen;
- Soil under the three experiments was assessed to determine their susceptibility to wind erosion based on aggregate size;
- The proportion of ground covered by stubble or crop was sufficient for the risk of soil erosion to be considered low for most of the year and for most cropping options;
- The risk of soil erosion due to limited ground cover appeared to be highest just prior to sowing and early in the season when ground cover was dependent on stubble produced by some of the break crop options.

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Above: Canola break crop growing on a swale at Ouyen. Photo: DPI.

Left: Biomass cuts being taken by field staff. Photo: DPI.

Background

Over the past decade a highly efficient cropping system based largely on more intensive cereal production using no-till farming has developed in the Mallee. However, the long term viability of this system is starting to be questioned by local growers who see potential benefits of including break crops to reduce grass weed populations, reduce cereal diseases, increase WUE in the cereal phase, and increase nitrogen inputs through N fixation.

While break crops are well suited to the Mallee and may provide production benefits to intensive cereal crop sequences, crops that perform poorly have the potential to cause significant environmental damage to the landscape through a lack of ground cover promoting erosion processes.

This project aimed to evaluate a range of break crop strategies and assist landholders to select options to optimise the objectives of crop productivity and the protection of the soil resource.

Experimental design

The evaluation site was located at Ouyen in the Victorian Mallee and had typical dune, slope and swale soil types. A separate experimental design was created for each of the three soil type areas of the paddock, each being a randomised block design with three replicates and 10m x 5.4m plots. Experiments commenced in 2010 with seven crop options including wheat, lupins sown at low (50kg/ha) and high seeding rates (100kg/ha), canola sown at low (1kg/ha) and high seeding rates (3kg/ha), wheaten hay and chemical fallow. These were rotated in 2011 with wheat treatments from 2010 being sown to a break crop (2 x lupin, 2 x canola), fallowed or re-sown with wheat. All the break crop treatments from 2010 were sown to wheat in 2011. There was no grazing on the site during or between seasons. Crop varieties were Mandelup narrow leaf lupins, Pioneer 43C80 imidazolinone tolerant canola and Yitpi milling quality wheat.

Treatments were assessed for stubble load, crop biomass and ground cover.

Ground cover was quantified by photographing each plot (about 2m x 2m section) over the course of the season and categorised 120 points as stubble, green material (crop and weed) and soil using the software SamplePoint (Booth et al 2006).

Results

Seasonal conditions and grain production

Rainfall was unusually high during this research project. The average annual rainfall for Ouyen is 331mm, with 215mm falling in the April to October growing season. In 2010, the rainfall to December was 395mm and the growing season rainfall was 270mm, with more than half falling from August to October. Rainfall between harvest at the end of the first year, and sowing in 2011 was extremely high for the Mallee with over 400mm falling during that period. Rainfall during 2011 to December was 487mm and the growing season rainfall was 167mm.

Grain production

Grain production helps provide an overview of the conditions during this

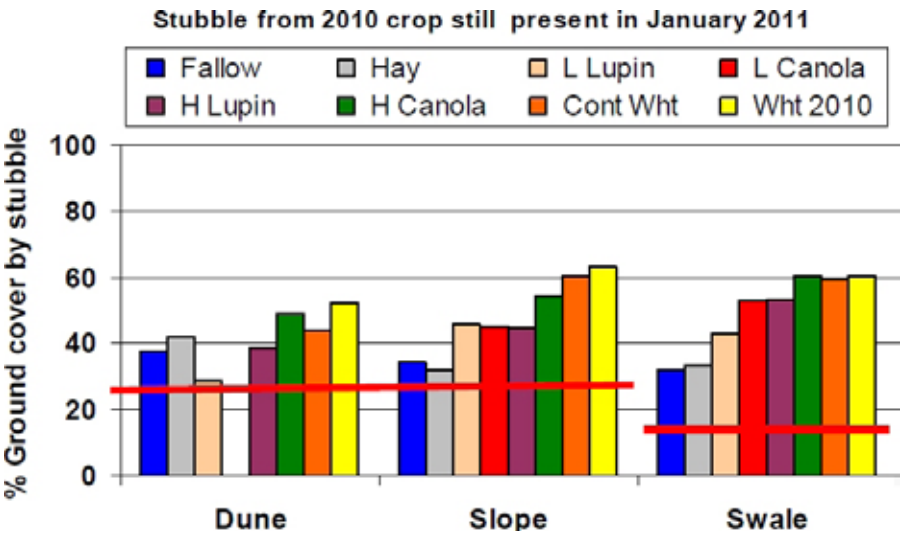

Figure 1. The proportion (%) of ground covered by stubble in January 2011 for three experiments; dune, slope and swale. Red line indicates the percentage of ground cover required for the risk of soil erosion by wind to be considered low according to McIntosh et al (2006). Note: January LSD: Dune NS; slope 17.68%; swale 24.51%. Given LSD cannot be used to compare Wheat 2010 (Treatments across soil types).

research. Break crops mainly produced less than 1 t/ha of grain with grain qualities meeting receival standards. Wheat crops over the two years ranged from 1.3 – 1.8 t/ha on the dune, 1.5 – 2.1 t/ha on the slope and 2.1 – 2.6 t/ha on the swale. Wheat produced in the second year has low grain proteins (>8.5%) and high test weights (>80 kg/hl). Wheat had yellow leaf spot in both years due to the paddock having a long history of growing the wheat cultivar, Yitpi, a susceptible variety that was used in the experiments due to its popularity in the district.

Soil aggregates

The proportion of soil that is in aggregates is an important component of soil erosion risk (McIntosh et al 2006). Soil aggregates with a diameter greater than 0.85mm (large aggregates) are considered to be at less risk of being eroded by wind than smaller soil aggregates. Soil aggregates were measured in summer (January 2011) and in spring (September 2011). Soil under each experiment had the lowest proportion of soil aggregates >0.85mm in summer. These lowest values were used for all assessments of the risk of soil erosion. The proportion of large soil aggregates; 22% on the dune, 23% on the slope and 32% on the swale, translated to a requirement for at least 25% ground cover on the dune and slope and 15% on the swale to meet the criteria for a low risk of soil erosion according to McIntosh et al (2006). This minimal ground cover value is represented by a red line on Figure 1.

Relationship between ground cover and biomass

Above ground crop and stubble biomass is often measured to assess crop growth. This technique was used in 2010 on the WUE trial at the Ouyen site. Crop and stubble biomass may be expected to be related to ground cover. This was the case for stubble and ground cover in January 2011, particularly on the slope and the swale.

Crop biomass measured mid-season accounted for about 60% of the variance in ground cover measured in July for most crops. The relationship between canola biomass and ground cover was distinct from the other crops as expected given the differences in crop architecture. For instance, 50% ground cover was estimated to require about 1200 kg canola biomass/ha and 4300 kg wheat biomass/ha.

Ground cover between crops

The proportion of ground covered by stubble in January 2011 after the first season was adequate in all treatments for the risk of soil erosion to be classified as low (Figure 1). However, fallow treatments were reliant on stubble from the prior season and both fallow and hay treatments on the slope only just produced enough stubble to place them above the 'red line' (Figure 1). The proportion of ground covered by stubble in April was estimated using the relationships between stubble and ground cover discussed earlier. Estimates indicated that sufficient stubble remained in April 2011 to provide ground cover for all treatments except the fallow and hay treatment on the dune. The treatment with low input lupins on the dune was estimated to be marginally above the red line in April and thus soil in this treatment may also be at risk.

Ground cover after sowing

In July, stubble alone was insufficient to meet the minimum ground cover requirement for all but one treatment involving a break crop in 2010. At the same time, stubble from most wheat crops grown in 2010 was sufficient for the soil erosion risk to be classified as low. The sudden reduction in stubble from the break crops between April and July was mainly attributed to stubble being incorporated during sowing operations.

At this early stage of crop development, ground cover from the crop became important to provide ground cover above

the level required to maintain a low risk of soil erosion. By July, ground cover through stubble and crop growth was sufficient to maintain a low risk of soil erosion in all treatments and on all experiments.

Interpretation of these results must be viewed in the context of a season with above average rainfall. This rain has resulted in better break crop growth than in other years.

Implications of the findings

The conclusion of this and last year's project is that the break cropping options in this research can be included in cereal-based rotations in the Mallee without increasing the risk of soil erosion provided a few conditions are met. Firstly, stubble must be retained. Stubble is critical in ensuring a low risk of soil erosion at times when there is no other source of ground cover. This supports changes in the Mallee towards 'no-till' cropping. Secondly, soils need to be assessed for soil aggregation. The risk of soil erosion in the Mallee is highly dependant on the size of soil aggregates which has been shown in this and other Mallee studies (Jones and Browne 2011) to vary over time. Thirdly, selection of break crop needs to be taken with care as the choice of break crop may influence the risk of soil erosion. Choosing fallow or wheaten hay as a break in wheat production may lead to an elevated risk of wind erosion between seasons on dunes. This risk will be exacerbated if the following crop fails. This risk of soil erosion due to limited ground cover appeared to be highest just prior to sowing and early in the season for some break crop strategies during the time when ground cover was dependent on last years stubble.

Recommendations

- Practices that maintain stubble over summer and minimise disturbance of stubble during sowing are encouraged.
- Growers should work towards understanding the role of soil aggregates on the different soil types in their paddocks.
- The choice of break crop needs to be carefully considered in light of each soils' aggregation and the potential for crop and stubble production.

Further research

This project is funded to continue in 2012 with wheat sown over all treatments.

Additional investigation is needed to determine the effect of low seeding rate on the risk of soil erosion. Generally, sowing lupins or canola at the lowest seeding rate used in these experiments did not increase the risk of soil erosion compared to using high inputs with those crops. However, stubble estimates for the low lupins in April 2011 indicated that the risk of soil erosion may be elevated by sowing break crops at low seeding rates and this needs to be evaluated. Ground cover should be monitored using photography immediately before and after sowing as this time seems to be present the highest risk of ground cover falling below minimal levels.

Changes in soil aggregation over time and under different crop sequences need to be monitored as values can change during the year and are critical in assessing a soil's susceptibility to erosion.

Acknowledgements

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Further Information

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Information for this bulletin is based on the report *"Assessing the potential for break crops to improve soil health in the Mallee"*- a report for the Mallee CMA by DPI Victoria Future Farming Systems Research. A copy of the report can be downloaded from the Mallee CMA website: **www.malleecma.vic.gov.au**

Project Partners

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