Break crops can be grown in the Mallee with a low risk of wind erosion

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Abstract

Cropped soils in the Mallee are vulnerable to wind erosion. Cropping in the Mallee is dominated by cereal-intensive rotations using practices that minimise the risk of wind erosion. Break crops are being added to rotations to improve whole-farm productivity. Adding break crops may change the amount and timing of ground cover and increase the risk of wind erosion on some soils. Three existing field experiments in the Mallee were used to assess the risk of wind erosion under twelve crop sequences in 2011. The experiments were conducted within one paddock on three soil types (dune, slope and swale). Break-crop treatments were canola, lupin, wheaten hay and chemical fallow. Continuous wheat was included as the benchmark practice for the district. Risk of wind erosion was assessed using a simple matrix based on soil aggregation and ground cover. Soil was sampled for dry aggregates between seasons and once during the season. The proportion of ground covered by crop or stubble was monitored throughout the second year using digital photography. The risk of wind erosion was classified as low between seasons for all break-crop treatments conducted in the prior year due to stubble retention. After sowing in autumn the following year, the first year's stubble from most break-crop options did not provide enough ground cover to maintain a low risk. However, within ten weeks of sowing, crop growth provided the additional ground cover required for the risk of soil erosion to again be classified as low.

Key words

break crops, wheat, lupin, canola, low rainfall, dune

Introduction

Soils in the Mallee are known to have one of the highest risks of wind erosion in Australia. The risk of wind erosion depends on the erodibility of the soil and exposure of soil to wind (McTainsh *et al*. 1990). Thus sandy soils, as occur on Mallee dunes, subject to long bare-fallowing are at the most severe risk of wind erosion. Minimising this risk has been a priority in the Mallee and is reflected in changes to farming practices over the last 15 years such as less winter fallowing and more crop production, increased stubble retention and the uptake of conservation tillage. Over the same period, cropping in the Mallee was dominated by cereals. Recently, farmers in the Mallee have expressed an interest in adding break crops to their rotations (Clough and Monks 2012, these proceedings) as a potential mechanism for increasing whole-farm crop productivity. Adding break crops to rotations may reduce the provision of ground cover and increase the risk of wind erosion for some soil types. This field research assessed the effect of adding break crops to cereal-based rotations on the risk of wind erosion. Dry soil aggregates and groundcover by plant material was measured in three existing field experiments sited on three major soil types in the Mallee. These values were used to classify the risk of wind erosion using a simple matrix that was readily available to farmers (McIntosh *et al*. 2006). This paper discusses the cumulative effect of the selected break-crop options and wheat treatments on the wind-erosion risk of three Mallee soil types.

Method

The field site was located in a cereal paddock at Ouyen on dune, slope and swale soil types (-35.056ºS, 142.331ºE). Long-term average annual rainfall at Ouyen is 334mm and the long-term average growing season rainfall (GSR April - October) is 214mm. The complete design and management of the experiments are presented in Clough and Monks (2012, these proceedings). Critical aspects of the design needed for discussion in this paper are provided here. Experiments with the following treatments commenced in 2010 on each soil type: continuous wheat (cv. Yitpi) for grain and for hay sown at 60kg/ha, lupin (cv. Mandelup) sown at low (50kg/ha) and high (100kg/ha) seeding rates, canola (cv. Pioneer 43C80) sown at low (1kg/ha) and high (3kg/ha) seeding rates, and chemical fallow. Canola, lupin, wheaten hay and chemical fallow are considered break crops within this paper. In 2011, all the break crop treatments from 2010 were sown to wheat (cv. Yitpi) and all plots sown to wheat in 2010 (except three plots deemed continuous wheat) were converted to break crop plots (Figure 1). This sequence of crops over two seasons produced 12 treatments, each with three replicates. There was no livestock on the site during or between seasons.

Stubble load was measured by collecting all standing and fallen stubble in two 0.25m^2 quadrats in each plot in January 2011 and just prior to sowing in April 2011. Stubble was dried at 60°C and weighed. The proportions of ground covered by stubble or plants were measured in January, July and October 2011 using overhead photography. The proportion of ground covered in each photograph was determined by classifying 120 randomly-selected pixels in each photograph as soil, stubble or plants using the software *SamplePoint* (Booth *et al*. 2006). A few points (< 10) could not be classified in each photograph and were excluded. Soil was sampled three times to measure the proportion of dry soil aggregates with diameter > 0.85mm (%DA >0.85mm). Soil was sampled to 25mm, passed through a 0.85mm sieve in the field and both soil fractions were weighed (Leys *et al*. 2002). In January 2011, soil was sampled from ten randomly-selected plots in each soil type that had been disturbed by sowing in 2010. Root architecture is not known to affect aggregate size, however, in September 2011 and January 2012, soil was sampled from all plots to cover this possibility.

Results

Soil aggregates

The highest risk of soil erodibility occurred in January 2011 on all soil types when %DA >0.85mm was the lowest (Table 1). Since %DA >0.85mm was not always measured at the same time as ground cover, a conservative approach was taken when using the wind erosion risk matrix (McIntosh *et al.* 2006) and the lowest %DA >0.85mm measured on each soil type was used to calculate the minimal ground cover required for the risk of wind erosion to be classified as low. The %DA >0.85mm measured in January 2011 showed that at least 25% ground cover was required on the dune and slope and 15% on the swale.

Table 1: Proportion of dry soil aggregates (%DA >0.85mm) present under various crop sequences in three soil types at Ouyen in north-western Victoria.

	January 2011*			September 2011			January 2012		
Soil type	Dune	Slope	Swale	Dune	Slope	Swale	Dune	Slope	Swale
Mean %DA > 0.85mm	22	23	32	41	36	51	40	33	46
Standard deviation (%)	7.0	10.0	8.6	5.1	5.8	5.3	8.1	6.7	6.3
Minimum %DA > 0.85mm	16	9	24	35	28	46	28	28	40
Maximum %DA > 0.85mm	36	32	34	50	38	56	43	38	54
				P=0.24	P=0.29	P<0.01	P=0.86	P=0.82	P=0.30

%DA >0.85mm was only compared between treatments within the same soil type and sampling time.* No P values given as data is from a subset of plots.

Ground cover between crops

Annual rainfall at Ouyen was above average during this experiment (558mm in 2010 and 487mm in 2011). The growing season rainfall was 272mm in 2010 and 167mm in 2011. Rainfall was very high during the summer between seasons (381mm). The proportion of ground covered by stubble in January 2011 is given in Table 2. Ground covered by weeds in January 2011 averaged less than 1.5% for all soil types. Stubble load measured in January differed with treatment for all soil types (P<0.02). Stubble ranged from 534 – 1933 kg/ha on the dune, 512 – 2472 kg/ha on the slope and 381 – 2312 kg/ha on the swale in the chemical fallow and continuous wheat treatments. Stubble load accounted for 51% of the variation in ground cover on the dune, 78% on the slope and 80% on the swale for all crop types. The proportions of ground covered by stubble just prior to sowing were estimated from the stubble loads measured in April 2011 (data not shown) using the relationship between stubble load and ground cover in January 2011 for each soil type (Table 2).

Ground cover between sowing and harvest

Ten weeks after sowing (July 2011), the proportion of ground covered by stubble was significantly lower in wheat sown after a fallow than in fallow after a wheat crop (P<0.001). There were also significant differences between treatments for the proportion of green material in the slope and swale (P<0.01) but no difference between treatments on the dune due to the young crop providing relatively little ground cover compared to crops on other soils and the presence of weeds in the fallow. The proportion of bare soil was consistent in each soil type averaging 54% on the dune, 47% on the slope and 42% on the swale (Figure 1).

Table 2: Proportion of ground covered (%) by stubble in each 2010 treatment as measured in January 2011 and as estimated from stubble load measured in April 2011. Measurements were taken prior to sowing in 2011.

	Stubble, January 2011 (% ground covered)			Estimated stubble, April 2011* (% ground covered)		
2010 treatment	Dune	Slope	Swale	Dune	Slope	Swale
Fallow	37	34 a	32 a	28	32	33
Hay	42	32 a	33 a	31	33	36
Low Lupin	29	46 ab	43 ab	33	47	38
Low Canola	-	45 ab	53 ab	*	44	51
High Lupin	39	45 ab	53 ab	43	47	34
High Canola	49	54 b	60 b	41	47	52
Continuous wheat	44	60 b	59 b	39	49	60
	P=0.23	P<0.001	P=0.04			

Treatments were only compared within the same soil type and sampling time. Values with different letters were statistically different. - Low canola was omitted due to poor crop growth. * P values are not provided for estimated values.

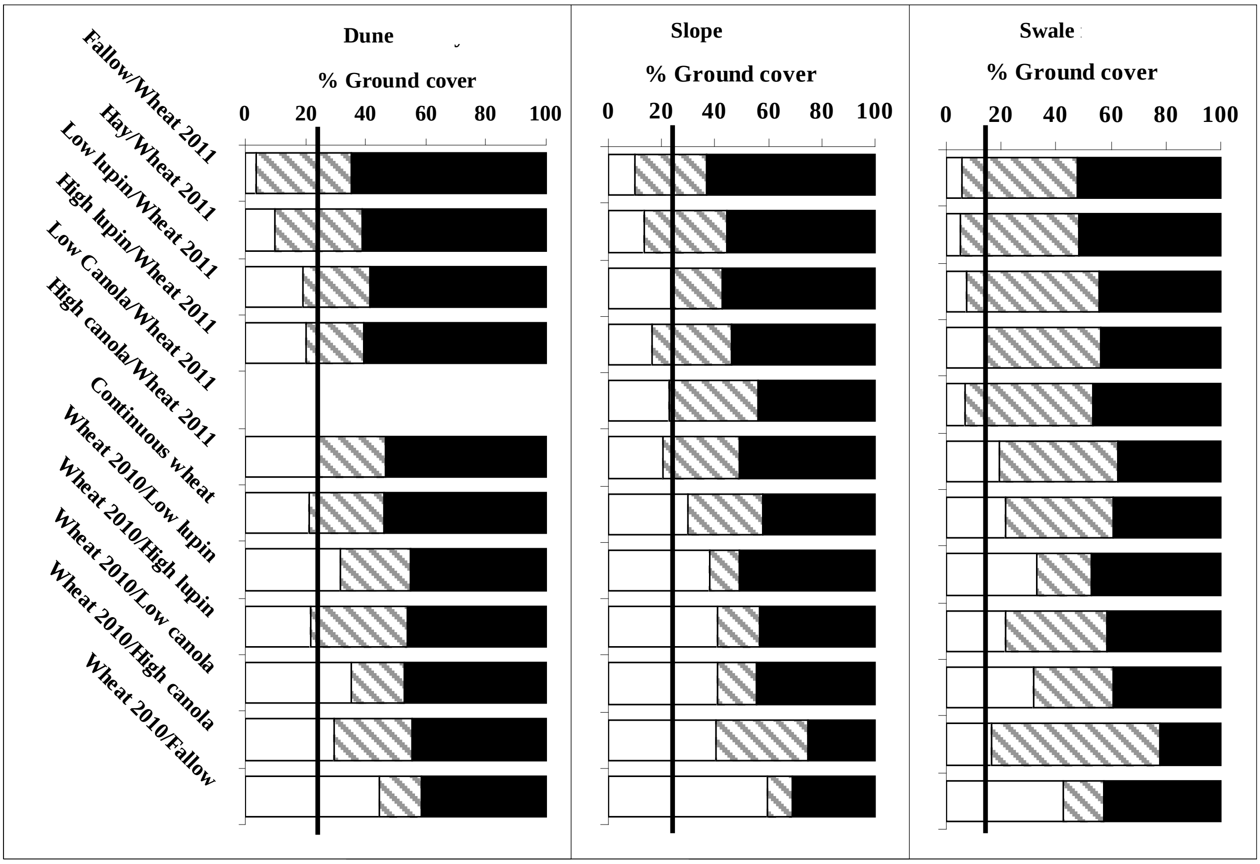

Figure 1: Proportion of area covered by stubble (white), plant (grey stripe) and bare soil (black) on 5th July 2011 in each treatment on the dune, slope and swale. Vertical lines indicates the percentage of ground cover required for the risk of soil erosion to be low using the wind erosion risk matrix from McIntosh *et al.* (2006). (Low canola/Wheat 2011 on the dune is omitted due to poor crop growth in 2010.)

In October 2011, the proportion of bare soil did not statistically differ between treatments within each soil type. Mean proportion of bare soil was 45% on the dune, 43% on the slope and 39% on the swale. By October, the crops were starting to senesce and it was difficult to distinguish stubble from senesced crop. Subsequently, results for stubble and crop are presented as one value: 55% on the dune, 57% on the slope and 61% on the swale and were not significantly different between treatments within each soil type.

Discussion

After the favourable growing conditions of 2010, ground cover due to stubble in January 2011 was adequate for the risk of soil erosion to be classified as low in all treatments (Table 2) including fallow which utilised wheat stubble from the prior season (2009). However, some treatments barely met the minimal ground cover requirements such as hay on the slope and low lupin on the dune. Under drier conditions, these break crops may not produce enough biomass to provide sufficient ground cover between crops. Estimates of stubble just prior to sowing in April 2011 indicated that some treatments were unlikely to have sufficient stubble remaining at that time to satisfy the critical level of ground cover required to maintain a low risk of soil erosion. This applies to the treatments on the dune: fallow, hay and possibly low lupins.

The sudden reduction in stubble from the break crops between April and July 2011 was mainly attributed to stubble being incorporated during sowing operations as found in the southern Mallee (Jones and Browne 2011). Cover by stubble at ten weeks after sowing was insufficient to meet the minimum ground cover requirement for all but one break crop treatment from 2010 (high seeding rate canola on the swale) (Figure 1). At the same time, stubble from most wheat crops grown in 2010 was sufficient for the risk of wind erosion to be classified as low. However, ground cover from stubble (2010) and plant (2011) combined was sufficient to provide a low risk of wind erosion in all treatments and on all soil types. Thus, the crop was an important source of ground cover early in the season.

Conclusion

In summary, these experiments show that with above average rainfall, break crops can be included in cereal-based rotations on these soil types with low risk of soil erosion provided a few conditions are met. Firstly, stubble must be retained. Stubble was critical to ensuring a low risk of wind erosion at times when there was no other source of ground cover. This supported the transition to minimum tillage. Secondly, soils needed to be assessed to determine the %DA > 0.85mm. This value can vary within a year with cultivation and soil water (Leys *et al*. 2002) as shown at this site and other field sites in the southern Mallee (Jones and Browne 2011). Thirdly, careful selection of the break crop is needed. Choosing fallow or wheaten hay as a break in wheat grain production may increase the risk of wind erosion between seasons on dunes. This risk will be exacerbated if the following crop fails. The risk of soil erosion due to limited ground cover was 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 year's stubble. Sowing lupins or canola at low seeding rates did not create a high risk of wind erosion over summer or early in the season of 2011 compared to using high seeding rates in this wetter than average period. However, stubble estimates in April 2011 for low lupin indicated the risk of wind erosion may be elevated by sowing break crops at low seeding rates and this needs to be further examined.

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