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Light grazing of crop residues by sheep in a Mediterranean-type environment has little impact on following no-tillage crops

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A B S T R A C T

Crop residue is often grazed by sheep after harvest, over the dry summer period from December to March in Mediterranean environments. However, soil cover provided by crop residues is a key component of conservation agriculture for maintaining favourable soil structure and high yields.

A series of 31 site × year experiments was conducted to assess the effect of summer stubble grazing on residue levels and following crop yields. Relatively light grazing, with stocking rates below 10 dry sheep equivalent (DSE) and between 90 and 471 DSE days ha^{-1}, had no significant effect on the amount of residue, soil properties, soil water, weeds or yield in the following crop. The main effect of grazing was to knock down and scatter the standing crop residues. However, longer term grazing at relatively high intensity (956 DSE days ha^{-1}) on heavy soil, over both summer and winter, as in a pasture phase, did significantly reduce residue levels, infiltration and yield (by 59%). The effect of summer grazing on soil mineral N was small and inconsistent, with increased mineral N, by about 3–7 kg N ha^{-1}, following grazing at two of the 13 sites. By contrast, higher mineral N, by 2–15 kg N ha^{-1}, was measured in the ungrazed plots at three of the 13 sites. This was due to increased growth of legume pastures in the absence of grazing.

More research is needed to confirm the yield effects when cropping after an annual pasture/fallow that is grazed over summer and winter, particularly on different soil types.

1. Introduction

In the Mediterranean-type environment of southern Australia, crops are generally sown in autumn between the end of April and early June and mostly harvested between November and December. Traditionally, the crop residue is grazed by sheep after harvest, over the dry summer period from December to March. In the last decade, no-tillage cropping systems, or conservation agriculture (CA), has been widely adopted across Australia (Fisher et al., 2010; Llewellyn and D'Emden, 2010). In Victoria and Western Australian, an estimated 81% and 89% of producers, respectively, have adopted this conservation farming method (Llewellyn and D'Emden, 2010). Soil cover provided by crop residues is a key component of CA for maintaining a favourable soil structure and high yields (Wall, 1999; Wairiu and Lal, 2006; Flower et al., 2008; Fuentes et al., 2009; Govaerts et al., 2009; Derpsch et al., 2010). Therefore, retention of most or all of the crop residue is a common recommendation in no-tillage systems (Derpsch et al., 2010).

This requirement for full residue retention has resulted in some concerns regarding livestock grazing of residue in no-tillage systems due to the effect on soil cover and perceived problems

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Table 1
Site, location and soil type of sites in northern and southern Victoria and Western Australia.

Site	Location	Soil type
northern Victoria		
B[1]	36°34′19.9″S; 142°48′59.9″E	Clay loam
U	35°28′48.3″S; 143°16′02.1″E	Sandy loam
H	35°44′23.4″S; 142°25′16.5″E	Sandy loam
Q	36°44′09.8″S; 142°01′29.0″E	Cracking clay
southern Victoria		
I	38°05′42.5″S; 144°00′00.8″E	Sandy loam
LB	37°43′59.6″S; 142°48′28.3″E	Clay loam
WR	37°53′34.4″S; 143°37′47.0″E	Clay loam
Western Australia		
C	31°38′28.8″S; 117°14′54.7″E	Red sandy clay loam
M1	31°31′40.0″S; 117°02′52.0″E	Sand over grey clay loam
M2	31°31′21.8″S; 117°02′43.1″E	White sand over yellow sand
W1	32°53′05.3″S; 117°34′05.9″E	Grey sand over loam
W2	32°53′33.9″S; 117°32′59.9″E	Red sandy loam with gravel
Y	32°32′10.2″S; 117°27′29.8″E	Sandy gravel loam over clay

[1] Site/paddock identification: B = Banyena, U = Ultima, H = Hopetoun, Q = Quantong, I = Inverleigh, LB = Lake Bolac, WR = Werneth, C = Cunderdin, M1 = Meckering 1, M2 = Meckering 2, W1 = Wickepin 1, W2 = Wickepin 2, Y = Yealering.

including trampling, compaction and reduced infiltration, weed seed burial and transport and erosion (Blanco-Canqui and Lal, 2009; Bell, 2010; Bell et al., 2011). This has led to a perception that no-till is incompatible with livestock (Govaerts et al., 2005; Fisher et al., 2010). However, most farmers still consider it important to maintain livestock for a more sustainable and diverse system; as a result of reduced price risk, increased profit from using the residue as a feed source, greater flexibility in summer weed control and nutrient cycling (Entz et al., 2005; McRobert et al., 2010; Fisher et al., 2012). Most farmers aim to maintain 50–70% ground cover or a minimum of 2000 kg ha^{-1} of cereal residue to mitigate the risk of surface structural degradation and erosion (Leonard, 1993). Nonetheless, many farmers want to know what impact livestock grazing of crop residue over summer has on their no-tillage yields, in both the short and long term (Fisher et al., 2012). The aim of this research was to determine if summer grazing of residue impacts the following crop yields in the no-tillage system.

2. Materials and methods

2.1. Site description

Thirteen farm trial sites were used: with three in southern Victoria at Inverleigh (I), Lake Bolac (LB) and Werneth (WR); four in northern Victoria at Banyena (B), Hopetoun (H), Quantong (Q) and Ultima (U); and six in Western Australia which were spread across four farms at Cunderdin (C), Yealering (Y), Meckering (M1, M2) and Wickepin (W1, W2). The latter two sites had two trials on each farm in different fields (Fig. 1). The soil types varied from sand through to cracking clays (Table 1).

2.2. Experimental design and grazing management

The trials were designed as randomised blocks with two treatments at each trial site, which consisted of residue grazed by sheep in summer and no grazing over summer. The trials were located in relatively large paddocks, ranging from 25 to 100 ha, with sheep roaming freely, except for the fenced (un-grazed) areas. Four replicates were used in Western Australia and southern Victoria and three replicates in northern Victoria. The trials in Western Australia and southern Victoria were conducted with the same plots assessed over a three-year period between December 2010 and December 2013. Each plot was 5 m x 5 m, arranged in a continuous row with a 2 m border between the grazed and un-grazed treatments and 5 m between blocks/replicates. The un-grazed areas were fenced for the duration of grazing, using 1.1 m high steel mesh and the corners of all the plots had permanent markers. In northern Victoria, single year trials were conducted with B and U assessed in 2011 and H and Q in 2012 (Fig. 1). Fenced plots were 15 m × 20 m and were located randomly within a few hectares in a uniform part of the paddock, with the grazed plots adjacent to these.

In most cases the paddocks were grazed over summer and cropped in winter, except in some cases where the paddocks were left as a winter pasture and grazing occurred in both summer and winter. In 2010 prior to treatment establishment, grazing of winter pasture occurred at Y in Western Australia, which meant no residue remained for summer of 2010, so there was no un-grazed treatment at this site and year. Also, both M sites were grazed over the summer of 2010/2011 through to the end of winter 2011; however, the fenced, un-grazed controls were in place. Livestock were excluded for four years at Q, U and B and five years at H in northern Victoria, prior to commencing the trials. In southern Victoria, livestock were excluded from I, LB and WR sites from the early 2000s. Management of the crops and sheep was undertaken by the farmer, with the un-grazed areas fenced after crop harvest and before any animals were introduced into the paddocks.

Grazing intensity and duration at each site was managed by the farmer. Data collected from the farmer included stock type, class utilised and stocking rate in dry sheep equivalents (DSE) (Turner and Alcock, 2000).

2.3. Crop management

2.3.1. Crop types

In the summer of 2010/11 the first grazing treatments were on wheat residue at the C, M1, M2, W1, W2, I and LB sites. Canola residue was present at WR and B and pasture at Y (Table 2). In 2011 canola was seeded at C, W1 and W2, wheat at Y, WR and B and barley at U, I and LB. In 2012 wheat was sown at C, M1, M2, W1 and W2, canola at Y, I and LB and barley at H, Q and WR. In 2013 wheat was sown at C and W2 and barley at Y, while the other three sites W1, M1 and M2 were pasture (Table 2).

2.3.2. Seeding

In 2011 sites U and B in northern Victoria were seeded using a disc opener and in 2012 tine and knife point were used at H and Q sites, respectively. In southern Victoria a disc opener was used at the WR site for all years 2010–2013. In Western Australia tine and knife point seeders were used at all sites, except in 2013 at W2 where a disc opener was used. The crop row spacing for the northern Victorian trials was B 30 cm, U 36 cm, H 30 cm, Q 38 cm; southern Victoria I, LB and WR 18 cm and Western Australia C 19 cm, M1 and M2 25 cm, W1 and W2 30 cm, Y 20 cm.