Silage cutting and grass removal in the pasture phase, their effect on two consecutive cropping years

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Abstract

A large scale experiment at Rutherglen demonstrated the combined effects of pasture grass removal and silage cutting on two years of cropping in the years 1998-2000. Grass removal reduced the size of grass weed populations, disease and increased yield in the following crop. The cutting of clover silage decreased grain protein whilst the cutting of grass silage increased grain yield. The decrease in grain protein after removal of clover silage was a result of a reduction in available N. The increase in yield following the grass silage removal was a result of reduced weed populations and increased N fixation. Increased grain yield due to soil nitrogen was more apparent in the first year after pasture with no follow on effect in the second year of cropping.

Key Words

Subterranean clover, Silage, Pasture, Wheat, Canola, Nitrogen

Introduction

Annual mixed pastures have formed the mainstay of the SE Australian cropping rotations for over 80 years. While pasture production can result in crop benefits, such as the increased availability of N, it would appear that the quality of annual pasture is generally declining to the extent that crop production following pasture is not at its optimum. Research has provided techniques for the manipulation of pasture to maximise crop and animal performance (1), but there is anecdotal evidence to suggest that these modern methods of pasture improvement are incompatible with prime lamb production. The Quality Meat Quality Wheat project was conducted at Rutherglen to demonstrate what effect grass removal and silage making had on lamb production using silage as a supplementary feed. The follow-on effects of two years of pasture treatment on wheat and canola and a following wheat crop is investigated in this paper.

Methods

Pasture treatments

The experiment was established on a poor quality 14-year-old pasture composed of the following annual species: barley grass (*Hordeum leporinum*), silver grass (*Vulpia* spp), soft brome (*Bromus mollis*), annual ryegrass (*Lolium rigidum*), subterranean clover (*Trifolium subterraneum* cv. Trikkala), capeweed (*Arctotheca calendula*) and curled dock (*Rumex crispus*). The site was located on the Rutherglen Research Institute farm (146?29' E, 36?02' S) in north-east Victoria. Soil type was a bleached-mottled, eutrophic, yellow dermosol. At the beginning of the experiment, the soil phosphorus (Olsen) content (0-10 cm) was 12.3 µg/g and the pH($CaCl_2$) (0-10 cm) was 4.6, increasing to >7.0 at 70 cm depth. Four pasture treatments were imposed in 1998 and continued on the same plots in 1999, with four replicates of 0.5 ha each. Treatments consisted of (i) no herbicide and (ii) grass herbicides applied in June/July, in factorial combination with (iii) no silage and (iv) silage production in October. The grass herbicides in 1998 were: Fusion? (Crop Care, fluazifop-p + butoxydim, 59 g/ha + 70 g/ha a.i. respectively) and Simagranz? (Crop Care, simazine 630 g/ha a.i.) applied on 24th July. In 1999, Fusion? alone was applied on 25th June. The silage treatments in 1998 were: wrapped bale silage cut on 5th October from the silage only treatment and from the grass removed + silage treatment on 21st October. In 1999, silage was made using the same method on the 4th October for both silage treatments. In both years wethers were used to opportunistically graze pasture in autumn/winter, before pastures were shut up for silage production. From November to March in 1998 and 1999 lambs grazed the plots. All plots were top-dressed with 11 kg P/ha single superphosphate in March of both years.

Crop Treatments

Two weeks prior to sowing in 2000 and 2001 the germinating pasture was sprayed with knockdown herbicide. In 2000, each plot was split randomly and wheat (*Triticum aestivum* cv Diamondbird) and canola (*Brassica napus* cv Insignia) were direct drilled with a Duncan triple disc on 12th May, 2000. Sowing rates were 145 kg/ha and 5 kg/ha respectively, with 145 kg/ha of double superphosphate (NPKS 0:16.8:0:4) applied at sowing. In 2001, all plots were direct drilled with an Agrowdrill to wheat (*Triticum aestivum* cv Galaxy H45) at a rate of 100 kg/ha with 90 kg/ha DAP.

Measurements

Crop emergence counts were conducted one month after sowing, counting both sides of a 50 cm ruler randomly placed 20 times along the rows (1.78 m^2 /plot). Weed counts were conducted before spraying in 2000 using a 225 cm^2 quadrat (0.45 m^2 /plot). In 2000, take-all disease was assessed through visual observation of crown infection at maturity on 100 random plants per plot. In 2002 individual take-all root assessments at Z32 were conducted on 40 random plants per plot. In both years herbage cuts were taken to ground level (both side of 50cm ruler x 20 (1.78 m^2 /plot)), dried at 65?C, DM calculated and the sample ground through a 0.5mm sieve and tested for Kjeldahl total N. Cereal head counts were undertaken at anthesis by counting the herbage sample before sub sampling. Whole plot grain harvest was undertaken with a commercial combine harvester and weighed in a bulk bin fitted with a digital balance. Grain protein was calculated as Total Grain N*5.7 and expressed on an 11% moisture basis. Data was analysed by ANOVA using the GENSTAT 4.2 package.

Results

The Rutherglen Research Institute has a long-term average annual rainfall of 598 mm. In 2000 the April-Nov growing season was 510 mm which was higher than the average of 439mm.

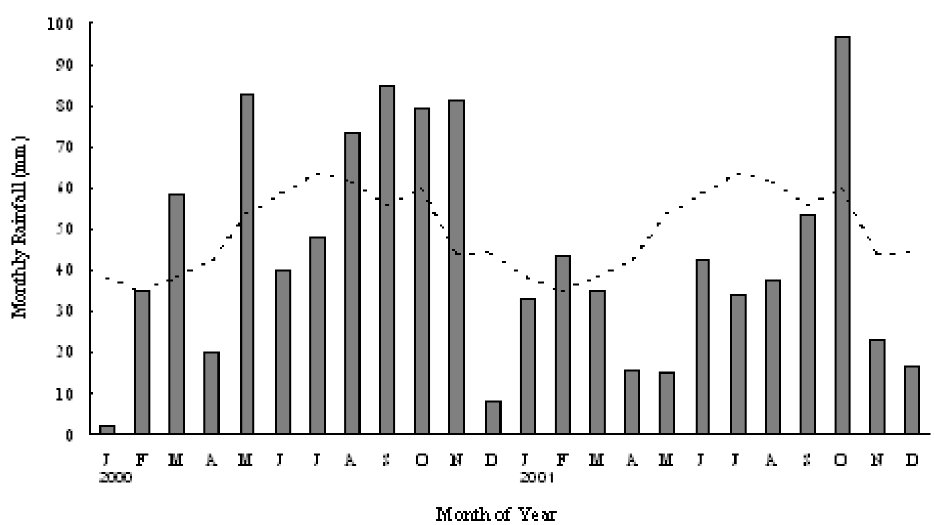

Figure 1: Monthly rainfall, January 2000-December 2001 (vertical bar) and monthly long term average rainfall (--) Rutherglen.

A good seasonal break in May was followed by a dry winter and then a wet spring (Figure 1). In 2001 the growing season was 318mm which was significantly less than the mean. Rainfall was low throughout the whole season until October. A frost occurred on the 20th October 2001. The wet August-November period lead to waterlogging and late grass germination in the canola. The data for this is not presented in this paper.

Grass populations were higher in control plots and least in the grass removed and grass removed+silage plots (Table 1). There was a trend towards decreased grass numbers in the silage treatment. The control had the lowest nitrogen uptake at anthesis while all other treatments had similar N uptake. The number of fertile heads followed a similar trend. The removal of grass reduced crown take-all incidence. At harvest, the yield was lowest in the control and highest in the grass removed treatments. The silage treatment was intermediate between these extremes. Grain protein content was similar for all treatments bar the grass-removed treatment cut for silage, which was significantly lower. The grass-removed treatment removed the most N in grain, both silage treatments were similar and the control was the lowest.

Table 1 Agronomic performance, disease level and yield of wheat in 2000

	Control	Silage	Grass Removed	Grass Removed +Silage	lsd (P<0.05)
June grass weeds/m^2	209	98	19	12	119.6
Anthesis N uptake (kg/ha)	53	69	92	84	21
Wheat heads/m^2	297	431	471	458	73.9
Crown take-all incidence (%)	3.1	1.9	0	0	ND
Grain yield (t/ha)	2.12	3.15	4.57	4.20	0.81
Protein (11% moist.)	11.6	11.6	12.6	10.8	1.3
Grain N removal (kg/ha)	48.2	71.7	113.3	89.3	19.6

ND=not determined

The data for wheat sown in 2001 includes the canola and wheat split plots from the 2000 season. During most of crop growth, no significant effect of previous pasture history was evident, though this changed post anthesis. Wheat on wheat plots had a significantly greater incidence of take all on the roots than wheat growing after canola. The nitrogen uptake at anthesis was 37% higher in the wheat after canola than wheat after wheat. The grass-removed treatment had more fertile heads than the control or silage treatments. The grass removed+silage treatment had the highest yield and the control the lowest. Protein content was highest in the control but coupled with the low yield also had the lowest N removal in grain. The grass removed+silage treatment had the highest N removal due to the significantly higher yield.

Table 2 Agronomic performance, disease level, N uptake and yield of wheat in 2001 following canola or wheat in 2000, and following different pasture treatments in 1998/99.

	Canola/ wheat	Wheat/ wheat	lsd (P<0.05)
Tillers/m^2	285	263	NS
Root take-all incidence (%)	5.9	9.1	2.2
October N uptake (kg/ha)	120	76	14

	Control	Silage	Grass Removed	Grass Removed + Silage	lsd (P<0.05)
Heads/m^2	238	237	277	258	27
Grain yield (t/ha)	0.58	1.33	1.21	2.19	0.35
Protein (11% moist.)	13.6	12.6	13.0	12.3	0.8
Grain N removal (kg/ha)	15.8	33.2	30.4	52.7	7.7

NS=not significant

Discussion

As found by these authors and others, grass removal is an effective way of increasing the clover content of pastures whilst decreasing the proportion of grass (2, 1, 3). Similarly to Thorn and Perry (4) this had a positive effect in reducing the number of grass weeds in the 2000 crop, such that they did not warrant spraying in grass-removed plots. Grass removed plots had no discernible crown infection by take-all. One year of complete removal of grass hosts is the accepted method of control and this work verifies this practice. The decreased weed competition resulted in a higher number of wheat heads at anthesis, translating into higher grain yield in the grass removal treatments. The nitrogen uptake by the crop at anthesis was greatest in the grass removed treatment but when weeds biomass was included the N uptake was similar (data not presented). Making clover dominant silage for two years in a row greatly decreased grain protein and grain N removal whilst not affecting yield significantly. This is symptomatic of a lower amount of N being available towards the end of anthesis. It could be assumed that the large amounts of N removal from silage, even when recycling it through animals on the same plots, have decreased the accretion of soil mineral N. The effect of removing grass for two years in a row in the silage treatment, was enough to improve grain yield significantly, but not effect grain protein. This could be because weed competition had a greater influence on yield than the N removed in grass silage. Arguably there would have been significantly larger nitrogen fixation in this treatment compared to the control, as a result of the greater clover content in the final year of pasture.

The follow on effects of these treatments in 2001 showed no effect of previous pasture history on data collected up until anthesis. Instead previous rotation had a greater effect on crop agronomy throughout most of the season. The weedy, poor yielding 2000 canola crop gave an increase in anthesis nitrogen uptake but no significant increase in tiller numbers. While a positive boost to wheat crops from canola has been noticed by other researchers (5), low nitrogen uptake in the previous season's canola crop remaining for the 2001 crop cannot be discounted as the reason for our result. The significantly decreased take-all disease detected on roots following canola shows evidence of some "biofumigation" effect. Canola has been shown to have an effect at decreasing take all levels in wheat (6). The 2000 canola crop experienced a late germination of barley grass due to waterlogged conditions in August. This could not be controlled and would not have resulted in a complete disease break. The effect of two years of grass weed control in the grass removed treatments followed through into the second year of crop with no grass herbicide required in crop. This gave a small but significant increase in fertile wheat head numbers when comparing the grass removed treatment with the control. The frosting severely affected yield of some plots. The grass removed +silage treatment was least affected by the frost, therefore the higher yield may be a function of both the low frost damage, the low weed populations and the lower incidence of take-all.

Conclusion

Grass removal led to low numbers of grass weeds and take-all disease in the subsequent wheat crop and resulted in highest wheat yields. Silage making had a varying response depending on the quality of silage. Cutting pure clover silage had a large effect on subsequent grain protein as a result of N removal off paddock. The cutting of predominantly grass silage however resulted in grain yields higher than the control, most likely due to decreased weed competition and greater nitrogen fixation in pasture. Decreased weed levels was the only benefit of grass removal that lasted at least two years of cropping after pasture treatment.

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