Manipulating the Composition and Yield of an Annual Pasture Prior to Cropping.

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ABSTRACT

An experiment integrating prime lamb and cropping enterprises was established at Rutherglen, Victoria in 1998 on a 14-year-old annual pasture. Grass herbicides and silage production (alone and in combination) were used to manipulate the composition of this poor-quality pasture in the two years prior to cropping. In 1998, following the application of grass herbicides in autumn, pasture production was decreased by 4.8 t DM/ha compared with the unsprayed control of 6.6 t DM/ha, although subterranean clover content increased from 11% of DM to 73% of DM. In 1999, after two years of grass removal, the subterranean clover content of the pasture had increased to 90%, and production was 5.9 t DM/ha, with few weeds and little bare ground. Cutting silage in spring 1998 increased the subterranean clover content of the 1999 pasture from 18% to 50%, with pasture production of 8.7 t DM/ha. In 1999, silage cutting decreased the density of subterranean clover seedlings in the herbicide-treated pasture, but increased seedling density in the untreated pasture.

KEY WORDS

Trifolium subterraneum, silage, grass herbicides, annual pastures, composition, emergence.

INTRODUCTION

One way to improve the yield and quality of cereal crops is to remove the grass, and increase the legume content of the previous pasture phase (13). This can decrease the carryover of cereal diseases (7), lower weed burdens (15) and increase the supply of soil nitrogen for the following crop (13). A whole-farm strategy to minimise competition from grass weeds can involve either chemical and/or cultural methods of control. Stephenson (14) reported that the selective removal of grasses increased the subterranean clover content of pastures, but there are few published data on the effects of silage production on annual pasture composition. Grass removal need not be detrimental to pasture and animal productivity, provided subterranean clover seedlings adequately fill in the gaps (11). Work as early as Donald (2) and lately Blumenthal and Ison (1) has shown the importance of subterranean clover density on dry matter yields. Ru *et al*. showed the importance of subterranean clover seedling density in increasing winter pasture production (9). The project described in this paper is called “Quality Meat - Quality Wheat” and fully integrates pasture, prime lamb and cropping into a system. The experiment is situated at Rutherglen, Victoria, in a 600 mm average annual rainfall zone. One aspect of this experiment, the effects of the chemical removal of grasses and silage making, on pasture production and composition and clover seedling emergence, is reported and discussed in this paper.

MATERIALS AND METHODS

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^{o}29’ E, 36^{o}02’ S) in northeast Victoria. Soil type was a bleached-mottled, eutrophic, yellow dermosol (4). At the beginning of the experiment, the soil phosphorus (Olsen) content (0-10 cm) was 12.3 mg/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 on plots of 0.5 ha each. Treatments consisted of no herbicide and grass herbicides applied in June/July, in factorial combination with no silage and silage production in October. In 1998 a mixture of 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.) was applied on 24th July. In 1999, Fusion? alone was applied on 25th June. In 1998, wrapped bale silage was cut on 5th October from the silage only treatment and on 21st October from the grass removed + silage treatment. In 1999, silage was made using the same method on the 4th October for both silage treatments. In both years, 25 wethers/ha were used to strategically graze pasture in autumn/winter, before pastures were shut up for silage production. Plots were stocked with 14 lambs/ha from November to March. All plots were top-dressed with 11 kg P/ha single superphosphate in March of both years.

Seedling densities of subterranean clover were determined three weeks after the autumn break from 50 and 30 (15 cm x 15 cm) quadrat counts per plot in 1998 and 1999 and 2000 respectively. Before silage was cut, the botanical composition of each pasture was recorded with either the dry weight ranking method of 't Mannetje and Haydock (8) incorporating the modifications of Jones and Hargreaves (5) in 1998 and the rod point technique method of Little and Frensham (6) in 1999. Pasture growth was measured using five 1 m diameter exclusion cages/plot that were shifted at monthly intervals. Herbage mass was measured using the BOTANAL method (16). Herbage dry mass was visually estimated on a 1-5 scale (50 estimates/plot), which was calibrated against 20 (25 cm x 25 cm) quadrat cuts of pasture that represented the full range of the 1-5 scale. Linear or quadratic regression equations were developed for each calibration cut and were used to convert the visual ratings to kg DM/ha.

RESULTS

Monthly rainfall data from January 1998 to May 2000 and long-term monthly averages are presented in Figure 1. In the 1998 growing season (Apr-Nov), 460 mm of rain fell, which was greater than the long-term average of 439 mm. The start of the autumn break was on 13th April though the following month was extremely dry. In 1999, the growing season rainfall was 387 mm. The start of the autumn break was on 22nd March, though April was quite dry until follow up rain in May. From December 1998 to March 1999, 127 mm fell compared with the long-term average of 156 mm. The 1999/2000 summer was considerably wetter, with 193 mm received in the corresponding period.

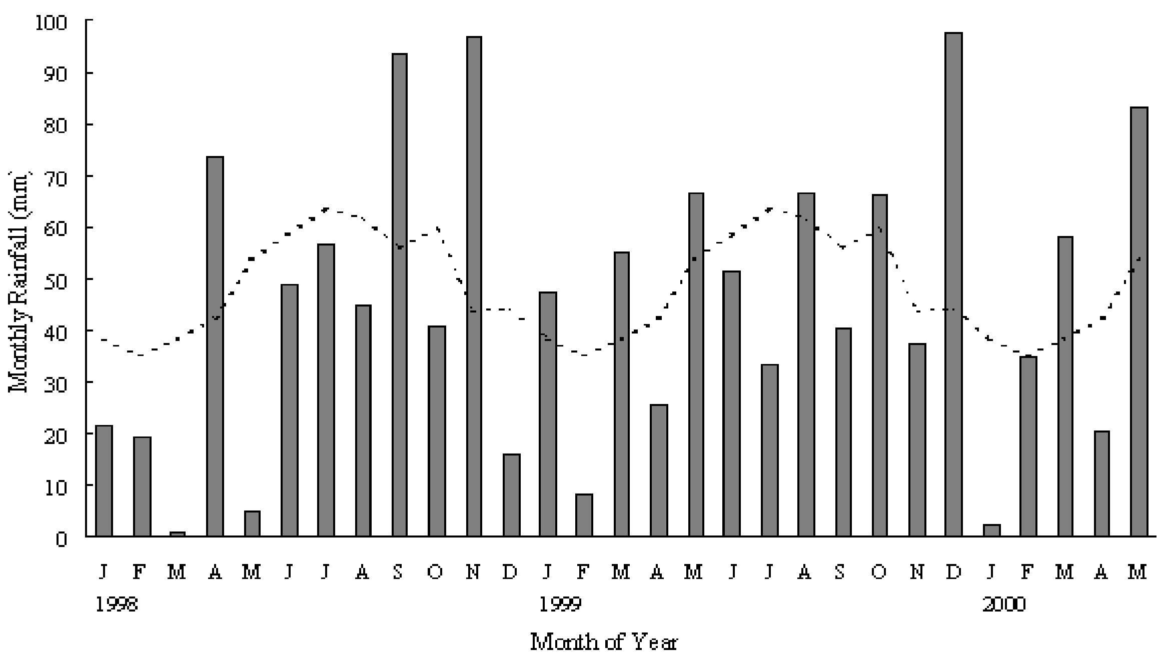

Figure 1. Monthly rainfall, January 1998-May 2000 (vertical bar) and monthly long-term average rainfall (- -) at Rutherglen.

At the commencement of the experiment in autumn 1998, the pasture contained 1312 (sd ?705, n=50) subterranean clover plants/m^2. As annual grasses made up the bulk of this pasture, the grass removal treatment in winter drastically decreased herbage production in the first (1998) spring (Table 1). Correspondingly, the proportion of subterranean clover in the spring 1998 DM increased (Table 1). Even so, the distribution of subterranean clover plants was patchy and there were many areas of bare surface soil (data not presented). The subsequent seedling densities of subterranean clover in autumn 1999 showed significant (P<0.05) differences between all treatments (Table 1). The control had the lowest density of 498 plants/m^2 compared with 1527 plants/m^2 in the grass removed, no silage treatment. Cutting silage in 1998 resulted in a doubling of the subterranean clover density to 813 clover plants/m^2 in 1999, while the grass removal + silage cutting treatment applied in 1998 decreased seedling density to 1177 plants/m^2 in 1999 (Table 1).

Table 1. Pasture production (DM), and subterranean clover content and emergence densities, following pasture manipulation with grass herbicides and silage production.

Within column means followed by the same letter do not differ significantly at P=0.05

	1998 DM (kg/ha)	1998 Clover content (DM %)	1999 Emergence density (plants/m^2)	1999 DM (kg/ha)	1999 Clover content (DM %)	2000 Emergence density (plants/m^2)
Control	6620a	11a	498a	8320a	17a	104a
Silage cut	6506a	18a	813b	8674a	50b	247b
Grass removed	1831b	73b	1527d	5874b	90c	289b
Grass removed + silage	1674b	68b	1177c	5908b	88c	263b
l.s.d. (p=0.05)	469	21	235	1090	8	84

In 1999, pasture DM yields followed a similar pattern to 1998, though total production was greater. The control and silage cut treatments produced the same DM yields, which were greater than the grass removed treatments. Both grass-removed treatments had similar clover contents and DM yields in 1999, both of which were greater than the 1998 values. With one cut of silage in 1998, the clover content of the unsprayed pasture had increased from 18% to 50% by spring 1999. In May 2000, the control treatment had significantly lower clover seedling densities that the other treatments, while overall seedling numbers were much lower than in the previous two years.

DISCUSSION

The finding that selective grass removal significantly reduced pasture yields in the first year is consistent with that reported by Scammell (10) for the non-selective herbicide paraquat. Even though our initial subterranean clover density was high (1312 plants/m^2) in autumn 1998, significant competition from the grasses may have decreased clover densities prior to the application of the grass herbicides in late July. Scammell (12) showed that using desiccants to remove grass, the highest clover composition resulted from a late July application at Rutherglen. In our study subterranean clover pasture production was poor, though the clover content of the pasture was improved. The patchy distribution of subterranean clover plants contributed to this poor production and was aided by soil water lost from the bare areas. The May-

August period of 1998 had below average rainfall which did not aid the growth of subterranean clover. Broadleaf weeds (capeweed and curled dock) made up much of the remaining dry matter in both grass removal plots in 1998. This was similar to a Western Australian report on the selective removal of grass species (15). In contrast to Stephenson's (14) finding of no follow-on effects of grass removal on subsequent densities of subterranean clover, we found an increase in the grass removal treatment in autumn 1999. This difference may reflect differences in average annual rainfall at Rutherglen (600 mm) compared with Turretfield, SA (464 mm). During our experiment, good conditions for seed set were experienced, especially in November 1998. The subterranean clover density in the grass removed plots in 1999 was similar to the 1500 plants/m^2 calculated by Donald (2) to be necessary to achieve maximum dry matter yields at Canberra. In our work however, total yields from both grass removal treatments were similar in 1999, despite different emergence densities in autumn 1999. After two years of grass removal, these pastures were highly subterranean clover dominant. The control and silage cut pastures had significantly higher dry matter yields because of the greater grass contents.

Silage cutting of a clover-dominant pasture reduced the seed set of the legume. After silage cutting, greater evaporation may have occurred due to exposed bare ground as a result of the low pasture production. This could have also decreased seed burial through the earlier drying of the soil surface, increasing the amount of clover seed left on the soil surface to be consumed by grazing lambs over summer. Conversely in the grass dominant pasture, silage cutting had a positive effect on seed set because defoliation stimulated greater flowering. Less bare soil due to the grass residues may have decreased soil evaporation through the seed filling period and lead to greater seed burial. In both 1998 and 1999, favourable spring conditions aided pasture regrowth and subterranean clover seed set after silage cutting. As silage cutting reduced grass competition and removed most of the grass seed heads, there was an increase in clover seedling density and clover composition on the silage cut plots in 1999. In the autumn of 2000, clover emergence was poor compared with the two previous years. Three factors may have collectively contributed to this result. Firstly, heavy rains in February and early March 2000 induced a "false break" of clover and significant seedling mortality may have occurred before the next good rains were received in May. Secondly, Trikkala was the predominant subterranean clover variety in the trial and has a low level of hard seed (3). Thirdly, an intensive rainfall event in February washed much of the surface clover seed and burr to the fence lines, in all treatments except the control.

CONCLUSIONS

The removal of annual grasses, either with herbicides or by making silage, from a poor annual pasture lead to poor dry matter yields in the first year. The distribution of the remaining clover plants was poor and left areas of bare ground. Nevertheless, the clover seed set was good and the emergence densities of subterranean clover in the following autumn lead to good dry matter production in the following spring. However, the removal of grasses with herbicides offered less grazing opportunities, especially in the first year. Silage production offers a useful non-chemical technique to improve subterranean clover content of pastures by decreasing the grass weed content, however this was only successful in pastures with low subterranean clover contents. It can have detrimental effects on the seed set of subterranean clover dominant pastures. The pasture treatments tested in this project have lead to paddocks with varying nitrogen, cereal root disease and weed levels. Their effects on subsequent wheat and canola crops is being investigated in current work.

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