THE IMPACT OF DEFOLIATION ON THE REPRODUCTIVE POTENTIAL OF BURR MEDIC AND SUBTERRANEAN CLOVER

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SUMMARY

The vertical distribution of plant parts within uncut subterranean clover and burr medic swards was measured using a stratified cut method at 5 cm intervals from the top of the canopy to ground level. The 2 species differed markedly in the distribution of branch, flowers and burr. Subterranean clover presented branch and burr only in the O-5 cm height interval and flowers in the 0-10 cm height interval despite these plots growing to a final height of 20 cm. The burr medic displayed a more erect growth habit. These plots grew to a height of 35 cm and presented branch, flowers and burr at all height intervals within the canopy with a greater number of flowers presented higher in the canopy than at lower height intervals. A second experiment quantified the amount and type of biomass that was removed when swards of the 2 species were defoliated to 2 cm until flowering and then to 5 cm until maturity. Defoliation of subterranean clover plots through to the end of the season removed predominantly petiole and leaf fractions. This was in contrast to the burr medic plots for which defoliation removed largely leaf, branch, flowers and burr from the second harvest onwards. The data are discussed with reference to the ability of the 2 species to persist in a grazed system.
Keywords: subterranean clover, burr medic, defoliation, canopy structure

INTRODUCTION

Subterranean clover and annual medics are important components of pastures grazed in southern Australia. The long term persistence of these legumes in pastures is largely determined by the intensity and timing of defoliation (Watkins and Clements 1976). The intensity of defoliation is the amount of biomass removed by grazing animals while the timing of defoliation is important with respect to the type of biomass (eg leaf, petiole, branch, flowers or seed) removed during the vegetative and reproductive phases of growth. The amount of leaf area remaining after defoliation determines the rate of recovery of photosynthesis and thus the regrowth of the pasture (Broughman 1956). Regrowth occurs from the growing points located at apical regions of the primary and secondary branches. It follows that, if these regions are removed and residual ieaf area is low, the rate of regrowth will be slow and, in extreme cases, the pasture will die. In contrast, if defoliation is managed so that adequate leaf area remains and growing points remain largely intact, regrowth can be relatively quick allowing animal production requirements to be met while still maintaining the pasture in a productive state. The number of flowers and burr that survive to maturity determines the seed yield -available for regeneration of an annual pasture in the following season. The number of flowers and burr produced depend on the number of floral initiation sites present at flowering (a function of the number and length of branches per plant) as well as the proportion of these flowers that survive to produce seed (Aitken 1955; Rossiter 1976). Assuming climatic and nutritional stresses to be at a minimum, flower survival depends on the amount of leaf area (and thus photosynthate) available for seed development as well as the number of flowers (and later seeds) ingested by animals.

The way a pasture presents its plant parts will affect both the amount of biomass removed as well as the ease with which growing points, flowers and seed are removed by grazing animals. It is generally accepted that burr medics (*Medicago polymorpha*) are more susceptible to grazing than subterranean clover (*Trifolium subterraneum)* because they have a more erect growth habit and flowers and seed are aerially borne rather than buried as is the case with subterranean clover seed. The difference in canopy structure between the 2 species no doubt plays a large part in the greater vulnerability of burr medics to defoliation during grazing. Yet the vertical distribution of plant parts has not been quantified in either species. Such information is necessary to determine the reasons why burr medics yield less during defoliation and to develop effective grazing management strategies for this species.

The work described in this paper was carried out to: 1. quantify the vertical distribution of plant parts within uncut burr medic and subterranean clover swards, and 2. determine the type and amount of biomass that is removed from burr medic and subterranean clover swards during defoliation throughout the growing season.

MATERIALS AND METHODS

Experiment I

Seed of burr medic *(M. polymorpha* cv. Circle Valley) and subterranean clover (*T. subterraneum* cv. Seaton Park) was sown into 4 m^2 plots on 11 th May 1992 to achieve a high (approximately 3000 plants per m^2) plant density. There were 3 replicates and the experiment was set out in a randomised complete block design with 3 blocks.

Plots were watered with the appropriate inoculum shortly after germination. Irrigation and fertiliser was supplied to the plots as required throughout the experiment. Irrigation ceased in late November to dry the plots out to harvest seed.

Harvests were done using a stratified cut system similar to that of Stem (1962). Harvests took place at early flowering (when 50% of randomly selected branches displayed at least 1 flower), mid-flowering (3 weeks after early flowering) and late-flowering (6 weeks after flowering when burr were the predominant reproductive structure present). Each cut represented a 5 cm layer of sward height and was 0.1 m^2 in area (20 x 50 cm). Cuts started at the top of the canopy and proceeded to ground level. Two sub-samples were taken from each stratified cut, 1 for dry matter determination (DM) and the other for separation into branch, leaf, petiole, flowers and burr. Each component was placed in an aluminium pie dish and dried at 80°C for 24 hours. From these samples the total DM of each of the components for each 5 cm stratified cut was determined and the percentage contribution of each component to the total DM calculated.

Experiment 2

To determine the amount and type of biomass removed from high density swards of the 2 species, seed was sown into 1.5 m^2 plots to achieve a plant density of 2000 plants per m^2 . Plots were defoliated to 2 cm until flowering and then to 5 cm until maturity to simulate the spring ‘flush’ when amount of feed on offer far exceeds animal intake. There were 6 harvests in all throughout the growing season starting approximately 7-8 weeks after sowing and occurring every 9-12 days. Plant material cut at each harvest was bagged and then weighed for fresh weight (FW). A sub-sample was then taken for DM determination and an additional sub-sample taken for separation into leaf, branch, petiole, flowers and burr.

RESULTS

*Vertical distribution **of** plant parts*

Leaf, petiole and branch The 2 species differed in the way in which plant parts were presented within the sward (Table 1). Medics were higher (35 cm) than subterranean clover (20 cm). In Circle Valley plots, leaf, petiole and branch were presented at all height intervals within the canopy while the more prostrate-growing Seaton Park presented branch only in the O-5 cm height interval and achieved height through petiole elongation rather than through the use of erect-growing branches as was the case with Circle Valley. This was also reflected in the total amount of dry matter allocated to petiole and branch within the canopies of the 2 species. For example, at flowering, Seaton Park allocated almost 19 g of dry matter as petiole; 5 times the amount allocated in Circle Valley plots (approximately 4 g). In contrast, Circle Valley allocated 25.5 g of dry matter to branch compared with 10.3 g for Seaton Park. By maturity, the amount of dry matter as branch was similar for both species (24 and 29 g for Circle Valley and Seaton Park respectively), although the amount allocated to petiole was still 4.7 times greater in Seaton Park (5.7 g) compared with Circle Valley (1.2 g).

Flowers and burr During early and mid flowering in Circle Valley, flowers and burr were present at all height intervals greater than 5 cm within the canopy, with more flowers higher in the canopy than at lower height intervals. By maturity, Circle Valley swards had collapsed from a height of 35 cm to 20 cm and the majority of burr had fallen to the O-5 cm height interval. Seaton Park presented flowers only in the first 10 cm of canopy and burr only in the O-5 cm height interval despite these plots growing to a final height of 20 cm.

Table 1. Petiole, leaf and branch dry matter (g) and the number of flower heads and burr in 0-5 cm and >5 cm height intervals within pure, ungrazed swards of subterranean clover (cv. Seaton Park) and annual medic (cv .Circle Valley) harvested at 3 times during flowering. Numbers are averages and standard errors (in brackets) of 3 replicates*. Area sampled was 0.1 m^2 (Experiment 1)

Harvest	Species	Height	Petiole		Leaf		Branch		Flowers		Burr	
Early	Subclover	0-5	9	(4)	9	(4)	10	(4)	187	(83)	0	(0)
		>5 cm	10	(0)	18	(0)	0	(0)	0	(0)	0	(0)
	Medic	0-5	1	(0)	1	(0)	10	(3)	0	(0)	0	(0)
		>5 cm	4	(1)	17	(4)	15	(3)	150	(18)	0	(0)
Mid	Subclover	0-5	Not sampled[B]									
		>5 cm	Not sampled[B]									
	Medic	0-5	1	(0)	1	(0)	10	(4)	0	(0)	0	(0)
		>5 cm	2	(0)	11	(3)	19	(4)	290	(8)	1394	(20)
Late	Subclover	0-5	2	(1)	0	(0)	30	(2)	131	(20)	1150	(151)
		>5 cm	3	(0)	10	(0)	0	(0)	25	(8)	0	(0)
	Medic	0-5	1	(0)	3	(1)	22	(3)	0	(0)	802	(140)
		>5 cm	0	(0)	4	(1)	2	(0)	30	(3)	412	(9)

[A]Values for all height intervals above 5 cm have been pooled. In early flowering sub clover plots only 1 replicate grew higher than 5 cm and hence values for this harvest have no standard errors as n=1. Standard errors for all other height intervals >5 cm represent an average standard error.
[B]Subterranean clover was not sampled during mid-flowering. The medic flowered earlier than expected (85 days instead of the expected 98 days) while subterranean clover flowered as expected at 112 days from sowing. This meant that the medic was sampled 2-3 weeks earlier than subterranean clover. Nevertheless all sampling was done at the same developmental stage despite being carried out on different days.

*Proportion **of** plant parts removed by defoliation*

Mechanical defoliation removed more than twice the amount of dry matter from Seaton Park than from Circle Valley plots. Circle Valley appeared to grow little following harvest 3 (90 days from sowing) as only about 11 g DM/m^2 was removed from these plots during harvest 4 and 5 compared to 71 g from Seaton Park plots (Table 2).

Table 2. Total dry matter (g) removed from high density subterranean clover and burr medic plots (1.5 m^2) during the growing season. Plots were defoliated to 2 cm until harvest 3 and then to 5 cm until harvest 6. Numbers are averages and standard errors of 3 replicates (Experiment 2)

Harvest	Date	Seaton Park	SE	Date	Circle Valley	SE
1	13 Sept	74	6.1	20 Sept	9	3.9
2	23 Sept	37	9.2	30 Sept	13	7.1
3	5 Oct	76	11.0	11 Oct	49	14.6
4	14 Oct	11	1.6	21 Oct	7	2.8
5	24 Oct	45	2.2	1 Nov	4	1.0
6	1 Nov	15	1.3	-	-	-

The 2 species also differed in the type of plant material removed at successive defoliations (Figure 1). Defoliation of Seaton Park plots through to harvest 6 removed only petiole and leaf except on the last cutting date (132 days from sowing) when a small amount (10% of the total DM removed) of branch was defoliated and about 140 flower heads and 50 burr per 0.1 m^2 were removed.

In contrast, defoliation of Circle Valley plots removed branch, flower-heads and burr from the second harvest (79 days from sowing) onwards and petiole and leaf throughout the entire experimental period.

DISCUSSION

The location of branch, flowers and burr at all heights within the canopy of the burr medic predisposes this species to greater yield losses under grazing than the more prostrate growing, subterranean clover. When burr medic was defoliated as much as 10 to 20% of the total dry matter was removed as branch and, associated with this branch component were the aerially borne flowers and burr which were consequently also removed. Significantly more flowers and burr were defoliated from burr medic plots compared with subterranean clover.

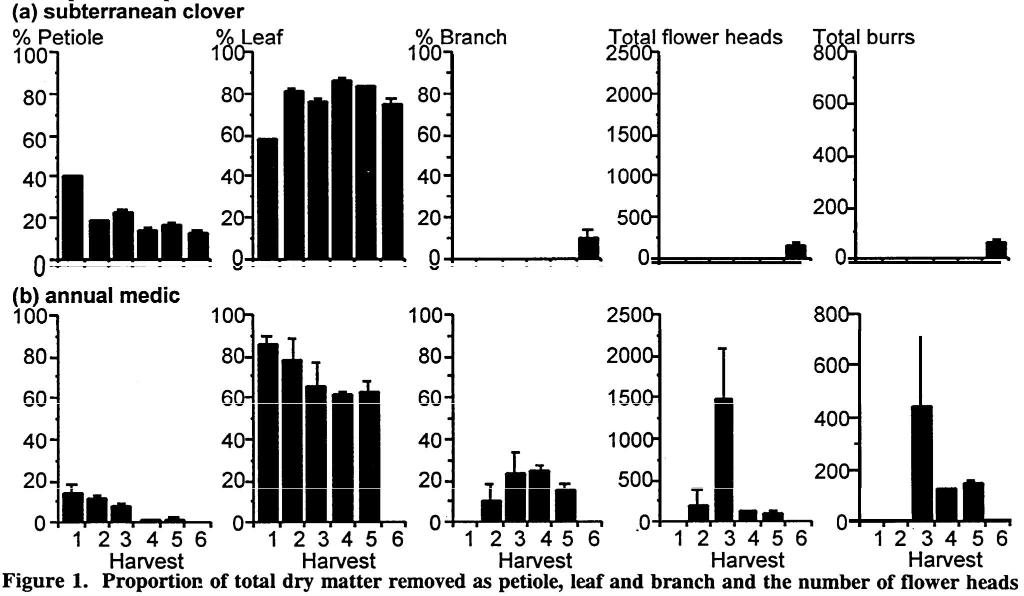

Figure 1. Proportion of total dry matter removed as petiole, leaf and branch and the number of flower heads and burr removed from (a) subterranean clover (cv. Seaton Park) and (b) annual medic (cv. Circle Valley) swards over time. Plots were defoliated to 2 cm until Harvest 3 (105 days from sowing) and then to 5 cm until maturity (Harvest 6; 132 days from sowing). Bars represent the mean and standard error of 3 replicates

In contrast, defoliation of subterranean clover swards removed predominantly the leaf and petiole fractions. The branch component in these swards effectively escaped defoliation because of its prostrate growth habit. As flowers and burr are produced from nodes along the primary and secondary branches, these also largely escape defoliation. In addition, burr are buried making subterranean clover an ideal plant for use in a grazing system.

Mechanical defoliation studies fall short of a grazed system because they fail to simulate the ability of animals to graze selectively both between plant species and between individual plant parts of the same species. Under mechanical defoliation in the present study, growing points, flowers and burr of subterranean clover largely escaped defoliation. What would happen in a grazed system? Given the opportunity, would sheep selectively graze growing points, flowers and burr? Or does accessibility of these plant parts largely determine how easily they are removed by grazing animals? The effect of grazing on the removal of plant parts in large swards of subterranean clover and burr medic is currently being studied.

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