EFFECTS OF GRAZING DAMAGE ON WHITE CLOVER STOLON MORPHOLOGY

J.R. Caradus and D.F. Chapman

AgResearch Grasslands, Private Bag 11008, Palmerston North, New Zealand

ABSTRACT

In two trials the effect of white clover stolon growing point removal due to grazing damage by sheep on stolon growth and morphology was investigated. Damage to the main stolon growing point did not affect stolon branch appearance rate, so that with a reduced node appearance rate on main stolons there was an increased proportion of nodes branching on damaged stolons. Compensatory growth by branch stolons after main stolon growing point removal occurred when measured as stolon elongation rate.

KEYWORDS

Grazing, growth, morphology, stolon, white clover (*Trifolium repens* L.)

INTRODUCTION

The stoloniferous nature of white clover (*Trifolium repens* L.) contributes significantly to its perenniality. However, because of the tendency in some seasons, for stolons to be found above soil level perenniality may be threatened in a grazed sward environment. There is evidence that under drought conditions continued grazing by sheep will result in white clover stolon removal (Curll and Wilkins, 1982). These conditions occur mostly in summer and autumn when surface and aerial stolon growth is maximal (Hay *et al.*, 1987). Additionally, it has been observed that there was a higher loss of apices on stolons of clovers grown in rotationally grazed compared with set-stocked swards resulting in lower number of nodes on the primary stolon of third- and fourth-order plants under rotational grazing than under set-stock grazing (Hay *et al.*, 1991). However, there is no published data describing the effect in the field of grazing damage to stolons on stolon growth and morphology. The effect of differing intensities and location of leaf removal on subsequent stolon growth in a controlled environment has been described (King *et al.*, 1978). In a field study, the effects of different methods and intensities of defoliation including grazing by sheep or cattle, and cutting at different frequencies on a range of plant morphological characters did not distinguish between plants subjected to stolon damage and those undamaged (Briseño de la Hoz and Wilman, 1981).

The aim of this study was to determine the effect of damage to white clover stolons caused by sheep grazing on stolon growth and morphology during summer.

MATERIALS AND METHODS

At Palmerston North all volunteer white clover was removed from a 12 month old high endophyte perennial ryegrass (*Lolium perenne* L.) sward using dicamba based selective herbicide. Two trials were established by planting 10, 2-month old seedlings into 1 m rows (plots), with 1 m spacing between rows and 0.5 m spacing between traverses. Trial 1 was established in autumn 1989 and trial 2 in spring 1989. There were 32 and 40 cultivars and breeding lines in trials 1 & 2, respectively. There were five replicates in trial 1 and four replicates in trial 2 arranged in a randomised block design. Both trials were in the same paddock and grazed simultaneously with sheep, seven times in the first year and 10 in the second year. Intervals between grazing ranging from 24 d in spring to 60 d in winter.

On 6 December 1990, 10 days after grazing stolons were marked using wire staples at a young node with a leaf less than half open. Three stolons were marked per plot. ‘New’ stolon growth was harvested after 60 d, during which time grazing by sheep had occurred twice. Only 73% and 68% of marked stolons were harvested in trials 1 and 2, respectively.

Measurements were made of :
a) length of main and branch stolons, b) number of nodes on main and branch stolons, c) number of branches on the main stolon, and d) leaf, stolon and flower dry weight.

Several plant attributes were derived from these measurements: a) stolon elongation rate of main and branch stolons, b) node appearance rate on main and branch stolons, c) branch appearance rate, d) leaf dry weight gain per day, e) stolon dry weight gain per day, e) proportion of nodes branching, f) internode length, g) proportion of stolon to total shoot dry weight, h) total stolon elongation rate, i) total node appearance rate, and j) total shoot dry weight gain per day.

Each harvested stolon was also categorised as either damaged due to grazing when the main stolon growing point had been removed, or undamaged, and the two groups compared by analysis of variance.

RESULTS AND DISCUSSION

Thirty six and 32% of marked stolons harvested were categorised as damaged due to grazing in trials 1 and 2, respectively. There was similarity between the two trials for effect of damage upon the plant characteristics measured (Table 1). Stolon damage did not affect total stolon elongation rate due to the compensatory increase in branch stolon elongation rate as main stolon elongation rate was curtailed by stolon growing point removal. Total stolon node appearance rate was reduced by stolon damage due entirely to the impact on the main stolon. Branch stolon node appearance rate increased by 30-80% but was unable to compensate for the loss of main stolon node appearance rate. While the proportion of nodes branching dramatically increased as might be expected from previous observations (Sanderson,1966), stolon damage had no impact on branch appearance rate.

Damaged stolons had lower absolute growth rates (although this was significant only in Trial 1) due entirely to reduced leaf absolute growth rate, which resulted in an increased proportion of stolon to leaf dry weight. Reduced absolute leaf growth rate due to main stolon growing point damage resulted from reduced node (leaf) appearance rate on the main stolon and the apparent inability of branch stolons to fully compensate in terms of node appearance rate. Additionally, early leaves on branches are smaller than leaves on the main stolon (Hay et al. 1993).

Internode length of damaged stolons was significantly greater than that of undamaged stolons. However, this effect may be an artifact of the method of calculating internode length. Removal of the growing point and young shoot internodes leaves the mature longer internodes for measurement. King *et al* (1978), found in a study where defined parts of the plant were systematically removed that removal of all leaves plus apical meristems caused a reduction in internode length compared with plants where only leaves were removed.

In both trials, percentage of marked stolons that were damaged varied from 0-88% among the cultivars and breeding lines. In Trial 1, additional measurements were made of clover content, clover dry weight, leaf number density, leaflet width and stolon growing point density (Caradus, 1991), but none of these were significantly correlated with percentage of marked stolons damaged within cultivars and breeding lines (r = 0.07, 0.12, 0.03, 0.03 and -0.17 respectively, df = 30, p>0.05). Only 4 cultivars were common to both trials. Percentage of marked stolons damaged was negatively correlated for these 4 cultivars between trials (r = -0.91, df = 2, p<0.10) suggesting that there was no genetic component associated with susceptibility of cultivars to stolon damage due to grazing.

Within cultivars percentage of marked stolons damaged during grazing ranged from 0 to 88% in both trials. Intercultivar comparison of grazing damage to stolon apices on stolon morphology was not undertaken since (a) rarely were there a similar number of damaged and undamaged stolons within a cultivar, and (b) the number of harvested stolons in each category within a cultivar was commonly low. However, a study of 7 white clover cultivars in Wales, compared under cutting and continuous grazing showed an 80-96% reduction in stolon length due to continuous grazing in late summer; the small leaved cultivar S.184 was least affected and the large leaved cultivar Katrina most affected (Evans and Williams 1984).

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Table 1
The effect of damage (stolon apex removal) due to grazing on stolon characters of white clover during summer in trials 1 and 2, comparing 32 and 40 cultivars and breeding lines, respectively. Standard errors are given.

Plant Character	Trial 1			Trial 2		
	Undamaged Stolon (n = 224)	Damaged stolon (n = 124)	p	Undamaged stolon (n = 224)	Damaged stolon (n = 104)	p
Stolon elongation rate (mm/wk)	6.0 ± 0.37	5.7 ± 0.53	ns	7.4 ± 0.47	7.3 ± 0.69	ns
- main stolon	4.7 ± 0.27	3.4 ± 0.33	**	6.0 ± 0.30	3.4 ± 0.39	***
- branch stolon	1.3 ± 0.13	2.1 ± 0.21	**	1.5 ± 0.23	3.9 ± 0.43	***
Node appearance rate 9no/wk)	1.41 ± 0.06	1.19 ± 0.07	*	1.38 ± 0.06	1.14 ± 0.07	*
- main stolon	0.84 ± 0.02	0.40 ± 0.02	***	0.93 ± 0.02	0.33 ± 0.02	***
- branch stolon	0.57 ± 0.04	0.78 ± 0.06	**	0.46 ± 0.02	0.82 ± 0.02	***
Branch appearance rate (no/wk)	0.25 ± 0.02	0.26 ± 0.02	ns	0.18 ± 0.01	0.20 ± 0.01	ns
Absolute growth rate (mg DW/wk)	12.1 ± 0.78	8.9 ± 1.0	*	19.0 ± 1.05	16.3 ± 1.52	ns
-leaf	7.4 ± 0.50	4.8 ± 0.56	**	12.0 ± 0.58	9.3 ± 0.93	*
-stolon	4.4 ± 0.31	4.1 ± 0.44	ns	6.2 ± 0.47	6.8 ± 0.70	ns
Proportion nodes branching	0.28 ± 0.02	0.85 ± 0.09	***	0.18 ± 0.02	0.75 ± 0.05	***
Internode length (mm)	5.1 ± 0.20	7.5 ± 0.40	***	0.64 ± 0.04	0.90 ± 0.06	***
Proportional stolon	0.38 ± 0.01	0.52 ± 0.02	***	0.66 ± 0.01	0.90 ± 0.06	***