EFFECT OF DEFOLIATION INTENSITY ON THE ABSOLUTE AND RELATIVE GROWTH RATES OF 'GRASSLANDS PUNA' CHICORY

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ABSTRACT

The response of absolute and relative growth of 'Grasslands Puna' chicory (*Cichorium intybus* L.) to defoliation intensity was examined in a glasshouse. Five defoliation intensities (0, 50, 100, 150 and 200 mm above media level), at 3 week intervals with 4 replications were arranged in a completely randomised design. The aboveground relative growth rate of Puna chicory increased exponentially as defoliation intensity increased, resulting in defoliation intensity not decreasing average absolute growth rate until weeks 9-12. However, there were significant differences in belowground mass between defoliation intensities from week 6 onwards. Defoliation above 150 mm, with 3 week intervals, is suggested to maintain aboveground absolute growth rate and belowground mass.

KEYWORDS

Puna chicory, absolute growth rate, relative growth rate, defoliation intensity

INTRODUCTION

The regrowth of perennial forages after defoliation is critical to the performance of grazing systems. Plant absolute growth rate (AGR) depends on the amount of plant biomass and its relative growth rate (RGR). The removal of biomass by defoliation should result in a reduction in AGR unless defoliation increases RGR in such a way that the loss of biomass is fully compensated for by the increase in RGR (Hilbert *et al*., 1981; Oesterheld, 1992). The effects of defoliation intensity and the time for recovery from a defoliation event on the aboveground and belowground RGR and AGR of several grasses has been studied (Oesterheld and McNaughton, 1991 and Oesterheld, 1992), but there has been no similar study on forage chicory (*Cichorium intybus* L. cv. 'Grasslands Puna'). Our objective was to examine the effect of defoliation intensity on the absolute and relative growth rates of Puna chicory in glasshouse conditions.

MATERIALS AND METHODS

The experiment was conducted from 14 September 1993 to 15 March 1994 in a glasshouse, the Plant Growth Unit, Massey University, Palmerston North, New Zealand (latitude 40° 23' S). Seeds of Puna chicory were germinated in trays (300 X 400 mm) of sand under mist in a glasshouse. Seedlings underwent vernalisation artificially for 4 weeks, 4-5°C at night and 25°C during daylight. When the fifth true leaf appeared, the seedlings were transplanted to pots (PB 28, 16.8 litre in volume, 300 mm in depth), with six plants per pot initially, then thinned to three plants per pot three weeks later. A standard long term medium was used, made up of peat and pumice (3:2 by volume) amended with lime (1.0 kg/m^3), dolomite (3.0 kg/m^3), and Osmocote® (long term 8-9 months, 2.0 kg/m^3 and short term 3-4 months, 1.0 kg/m^3) as a base starter fertiliser. Air temperatures were maintained by heating or ventilating at 10°C - 15°C/25°C-30°C (night/day). Liquid nutrients (1 g/litre) were supplied through the automatic irrigation system twice daily (5 mins each time). The liquid fertiliser used was Peters® Professional water soluble NPK fertiliser (27 + 6.5 + 10) plus trace nutrients (Mg, B, Cu, Fe, Mn, Mo, Zn).

A completely randomised design (CRD) was used, with 5 defoliation intensities (0, 50, 100, 150 and 200 mm above media level) and 4 replications at 3 week intervals. For the 0 mm cutting treatment, buds on crown were uninjured. Total aboveground and belowground masses at each defoliation were measured. All mass data are presented on a dry weight basis, oven-dried at 80°C for 48 hours. Leaf area per plant was measured by using a LI-Cor LI-3100 Leaf Area Meter (Lambda Instruments Co., Lincoln, NE, USA).

The aboveground AGR for each period and belowground mass at each defoliation were analysed by using a completely randomised design model (SAS Institute, 1990). The relationship between aboveground RGR and defoliation intensity was analysed by using a regression model (SAS Institute, 1990). Leaf area ratio (LAR), specific leaf area (SLA) and leaf weight ratio (LWR) were also calculated at each defoliation (Hunt, 1978).

RESULTS AND DISCUSSION

The aboveground RGR of Puna chicory increased exponentially as defoliation intensity increased (Fig. 1), similarly to the defoliation responses of two perennial grass species, *Briza subaristata* and *Stipa bavioensis* from the flooding pampa of Argentina in a controlled environment (Oesterheld, 1992). The aboveground AGRs of Puna chicory were not affected by any defoliation intensities until weeks 9-12. However, there were significant differences in belowground mass between defoliation intensities from week 6 onwards (Table 1).

The aboveground mass removed was fully compensated by the exponential increase in the aboveground RGR over 9 weeks, in agreement with the results of Oesterheld (1992). However, this increase was at the expense of a decrease in belowground mass, suggesting taproots of Puna chicory supplied the most immediate energy for regrowth after defoliation, especially for the 0 mm cutting treatment. Nevertheless, this compensation capacity was depleted by repeated defoliations as the belowground mass decreased continuously, particularly under the more severe defoliation treatments. Eventually, during weeks 9-12, the aboveground AGR decreased significantly as defoliation intensity increased, although the aboveground RGR still increased exponentially as defoliation increased. It was only in weeks 9-12 that LAR increased due to an increase in LWR but not SLA (data not presented).

More severe defoliations would appear to require more time to recover from defoliation compared with less intensive defoliations. Belowground mass was unaffected by the 150 and 200 mm defoliations, whereas belowground mass declined under the 0, 50 and 100 mm cutting treatments (Table 1). It is suggested that defoliation above 150 mm with 3 week intervals will not be detrimental to the persistence of Puna chicory, in agreement with the results from grazing experiments with Puna chicory (Li *et al*., 1997), but more severe defoliation will be detrimental unless the regrowth time is increased so that belowground mass recovers.

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Table 1
Aboveground absolute growth rate (AGR) and belowground mass for Puna chicory under different defoliation intensities

Defoliation height	week 0-3	week 3-6	week 6-9	week 9-12
	Aboveground AGR (g/plant/week)			
0 mm	4.6	7.2	8.3	3.8
50 mm	4.7	6.8	6.1	5.2
100 mm	2.8	8.3	8.0	5.8
150 mm	2.9	9.0	9.8	7.5
200 mm	5.6	7.9	7.1	11.1
s.e.m.	1.10	1.13	1.47	1.26
significance	NS	NS	NS	**
	Belowground mass (g/plant)			
	week 3	week 6	week 9	week 12
0 mm	38.9	27.7	18.2	17.1
50 mm	37.4	33.7	22.4	22.2
100 mm	38.5	38.8	33.6	26.3
150 mm	41.6	44.8	52.8	45.8
200 mm	41.8	53.9	62.9	55.5
s.e.m.	3.73	2.32	5.33	3.59
significance	NS	**	**	**

** P < 0.01; NS, not significant.

Figure 1
Relationships betrween aboveground relative growth rate of Puna chicory and defoliation intensity at (a) week 0-3, (b) week 3-6, (c) week 6-9 and (d) week 9-12.