Defoliation management, tiller density and productivity in perennial ryegrass swards

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ABSTRACT

Lax spring grazing management followed by hard grazing at the time of anthesis has been suggested as a means to improve herbage production of perennial ryegrass pastures during summer and autumn by enhancing tillering activity. However, there is little comparative information on the effects of variation in the duration of the period of lax grazing. Thus, the aims of this study were (i) to investigate the effects of timing and duration of lax spring grazing on tiller dynamics, rates of leaf growth, botanical composition and pasture production in perennial ryegrass swards, with and without white clover, and (ii) to determine which physiological and/or morphological factors are important in influencing regrowth after defoliation of such swards. Two field experiments and one glasshouse experiment are reported.

In the first field experiment (September 1992 to March 1993), swards of perennial ryegrass (Grasslands Nui) with and without white clover (Grasslands Tahora) were rotationally grazed by sheep every 21 days to a residual height of 70-100 mm (lax) and every 14 days to a residual height of 30-50 mm (hard). Two periods of lax grazing (short release "SR" from 26 October to 8 December and long release "LR" from 15 September to 8 December) were compared against conventional hard grazing (early control "EC"). All treatments were grazed to a residual height of 30-50 mm every 14 days from 8 December until the end of the Experiment. Treatments were arranged in a factorial design with 3 replicates. Plots without white clover received 28 kg N ha^{-1} every two weeks as urea. During spring, herbage mass increased in SR and LR as a consequence of an increase in tiller weight. Leaf growth in ryegrass and white clover and sward productivity all increased after lax spring grazing, and responses were greater following LR than SR. Evidence of effects on ryegrass tiller densities were inconclusive, although tiller production appeared to be greater in SR and LR treatments than under conventional hard grazing. White clover responses were variable.

In the second field experiment (September 1993 to April 1994) plots were subjected to

similar grazing managements, the only differences being that all spring treatments were imposed at a consistent grazing interval of 21 days. There was also an increase in the number of replicates per treatment (from 3 to 4), and a reduction in N level (from 28 to 14 kg N ha^{-1} every 2 weeks). The results from this trial confirmed that SR and LR treatments, because of their greater percentage of reproductive tillers, increase ryegrass herbage production during spring by increasing tiller weight. During summer and autumn production remained high on SR and LR treatments due to enhanced tiller population density and leaf growth per tiller and/or stolon. White clover responses were variable, and in general SR and LR treatments tended to produce more leaf per locus than EC. For white clover, no statistical differences were observed in net production per unit of area (g m^{-2} day^{-1}).

Size/density compensation implies that at higher herbage mass, individual tille s are larger, but the population density is correspondingly decreased. To investigate the links between tiller dynamics and herbage production, and the relationship between sward height, tiller density and tiller size, an index of sward productivity (size/density compensation index, SDCI) was generated. Size/density compensation index was defined using the -3/2 self thinning relationship of plant ecology. Shoot density and tiller weight were plotted as X and Y coordinates, respectively and SDCI defined as the distance between the point plotted for a particular sward and a theoretical self-thin ing line of slope -3/2. A plot of herbage production from January to April against SDCI showed a strong positive correlation between SDCI and productivity. The results indicate that the distance from the -3/2 self-thinning line, or size/density compensation line, can be used as a predictor of sward productivity.

In a glasshouse experiment the effect of defoliation management on tiller size/density compensation (SDC) was studied. Under controlled environmental conditions perennial ryegrass swards growing from seed were defoliated to stubble heights of 20 mm, 40 mm, 80 mm, 120 mm and 160 mm twice a week (simulating continuous stocking) over a six month period. The results demonstrated an increase in tiller weight and a decrease in tiller population density as defoliation intensity decreased. The optimum combination

of tiller density and leaf growth per tiller which maximised herbage harvested per unit time was observed at a defoliation height of 120 mm.

The response of plants to defoliation was decreased total, below and above ground plant mass, gross and net photosynthesis per unit of ground area and tiller weight as the severity of cutting increased, while leaf appearance rate and gross and net photosynthesis per unit of leaf weight were increased.

The use of the -3/2 self-thinning rule to describe the relationship between tiller population density (X) and individual weight per tiller (Y) was also examined. For cutting heights between 40 mm and 120, the size/density relationship had a slope steeper than -3/2. For defoliation heights above 120 mm SDC slope was closer to 1.0. However, slope corrections for change in leaf area index (C_a) and leaf:non leaf ratio (C_r) largely explain observed deviations from the theoretical -3/2 size/density compensation line. Again, the plot of herbage harvested against SDCI showed strong positive correlation between the two.

It is concluded that lax spring grazing management of ryegrass-white clover swards (70 to 100 mm) followed by hard grazing (30-50 mm) at the time of anthesis enhances pasture production, particularly during the summer-autumn period, by increasing both tiller population density and net leaf growth per tiller and/or stolon. Effects were larger following an extended spell of lax grazing (12 weeks) than following a shorter spell of 6 weeks. Size/density compensation index was shown to be a predictor of sward productivity, sward productivity having a strong positive correlation with SDCI.

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

CHAPTER 3. (Experiments 1 and 2)

CHAPTER 4. (Experiment 3, glasshouse)

LIST OF FIGURES

CHAPTER 3.

CHAPTER 4.

CHAPTER 5.

LIST OF PLATES

CHAPTER 3.

CHAPTER 4.