Effect of Nitrogen Fertilizer on Reproductive Tiller Development in Perennial Ryegrass

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EFFECT OF NITROGEN FERTILIZER ON REPRODUCTIVE TILLER DEVELOPMENT IN PERENNIAL RYEGRASS

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Abstract

The objective of this study was to compare reproductive tiller development in two ryegrass (*Lolium perenne* L.) cultivars, when fertilized with nitrogen. Plots of the cultivars 'Grasslands Ruanui' and 'Ellett' ryegrass were sown in April 1996. Half of each plot received nitrogen fertilizer (30 kg N/ha) after each grazing by dairy cows from September 1996 to May 1997 and from October 1997 to April 1998. Ryegrass tiller dynamics was monitored from September 1996 to March 1998. The proportion of reproductive tillers in the total tiller population was higher, on average, over the first flowering period (October 1996 to January 1997) for 'Ellett' (19.5%) than for 'Grasslands Ruanui' (13.0%) ryegrass, and there was no response to nitrogen. Over the second flowering (September 1997 to January 1998), 'Ellett' ryegrass slightly increased the proportion of reproductive tillers in response to nitrogen (averaging 20%) while 'Grasslands Ruanui' decreased ($P<0.05$) the number of reproductive tillers (averaging 6%). Significant cultivar x nitrogen interactions occurred in December 1997 and January 1998 when reproductive tiller number for nitrogen treated plants averaged 24.1% for 'Ellett' compared with 7.8% for 'Grasslands Ruanui' ryegrass. This work suggests current

New Zealand ryegrasses (here represented by 'Ellett') may produce more reproductive tillers in response to spring applied nitrogen fertilizer than do older types. To encourage vegetative tillering from the bases of dying reproductive tillers and the likelihood of improved ryegrass persistence, applications of nitrogen fertilizer in early summer are recommended.

Keywords: ryegrass, tillering, reproductive tillers, ecotypes, cultivar selection, persistence, nitrogen, cow grazing

Introduction

Farmers and researchers in intensive dairying regions of New Zealand are concerned about the lack of persistence of current (post-1975) perennial ryegrass cultivars. Two morphologically distinct ryegrass ecotypes have been widely used as sources of parent material. The first provided 'Grasslands Ruanui' and the second, most of the current cultivars such as 'Ellett', 'Yatsyn 1', 'Grasslands Nui' and 'Bronsyn'. 'Ellett' ryegrass developed more reproductive tillers than did 'Grasslands Ruanui'; consequently, it was more dependent on early summer replacement of reproductive tillers with vegetative tillers for perennation than was 'Grasslands Ruanui' (Matthew et al., 1993), especially after the second flowering (Bahmani, 1999).

On average, New Zealand dairy farmers apply 90 kg N/ha/yr to their pastures. Worthwhile pasture responses to late autumn/early winter, later winter/early spring, and summer applications of nitrogen (O'Connor, 1982; Harris et al., 1996) have been reported. L'Huillier (1987) noted that ryegrass swards containing current cultivars had a low tiller density in summer due to poor survival of vegetative tillers, a situation that could be improved by the application of nitrogen.

Thus, this paper compares the effect of nitrogen fertilizer on reproductive tiller development in established 'Ellett' and 'Grasslands Ruanui' ryegrass swards, and discusses possible implications for persistence.

Material and Methods

The trial site was at the Dairying Research Corporation, Hamilton, New Zealand on a fertile clay loam soil supporting intensive dairying (3.2 cows/ha).

The trial layout was a split-plot design. There were four blocks divided into main plots (12 x 6m) of the endophyte-free perennial ryegrass cultivars 'Ellett' and 'Grasslands Ruanui'. Seeds were direct-drilled on 24 April 1996 following spraying with glyphosate. Each plot was divided into two sub-plots, one of which received nitrogen fertilizer (urea, 30 kg N/ha) after each grazing. A total of 240 kg N/ha was applied from September 1996 to May 1997 and 180 kg N/ha from October 1997 to April 1998. Maintenance applications of P, K, and S were applied annually. Dairy cows rotationally grazed the plots.

Ryegrass tiller dynamics was monitored using three fixed circular (6.4 cm d) frames per sub-plot, randomly located over ryegrass drill rows in September 1996. Counts of live ryegrass tillers within each frame commenced on 17 September 1996; tillers were also tagged with coloured plastic tubing. At about monthly intervals until March 1998, new tillers were counted and tagged with different coloured tubing. Tags were removed from dead tillers and counted. Vegetative tillers were classified as reproductive when the first node became visible above ground level. Reproductive tillers appeared from September to January (spring/early summer).

Data were analysed as a split-plot design ANOVA using Genstat 5 to determine treatment effects on reproductive and vegetative tiller number. Square root transformation was required for some reproductive tiller number data but means on the original scale are presented for simplicity.

Results and Discussion

‘Ellett’ ryegrass produced more ($P<0.05$) reproductive tillers than did ‘Grasslands Ruanui’ over the first flowering period (19.5 vs 13.0% of total tillers, October 1996 to January 1997), and there was no effect ($P<0.05$) of nitrogen fertilizer. However, during the second flowering (September 1997 to January 1998), ‘Ellett’ ryegrass slightly increased reproductive tiller number whereas ‘Grasslands Ruanui’ decreased ($P<0.05$) reproductive tiller number in response to nitrogen, causing a significant ($P<0.05$) cultivar x nitrogen interaction in December 1997 and January 1998 (Figure 1).

Most authors (Curll and Williams, 1982; Thomas et al., 1990; Harris et al., 1996) showed that increased vegetative tillering was the usual response to nitrogen, but McKenzie (1998) confirmed ‘Ellett’ ryegrass favoured reproductive tillering when treated with nitrogen; a similar response was also shown for another perennial ryegrass (Wilkins 1995).

Persistence and perennation of perennial ryegrass relies on initiation of daughter tillers from reproductive tillers or the maintenance of existing vegetative tillers after flowering (Matthew et al., 1993). Since nitrogen fertilizer caused different responses for established swards, dependent on the propensity of the cultivar to produce reproductive tillers, management decisions relating to nitrogen applications should also consider ryegrass cultivar. For example, applying nitrogen to ‘Ellett’ ryegrass a few weeks before flowering could compromise its persistence, since extra reproductive tillers would have to be replaced after decapitation and death in early summer. However, applying nitrogen fertilizer to ‘Ellett’ ryegrass after flowering (December to February) should be beneficial, providing a stimulus for vegetative tiller production, and potential for increased sward persistency.

The poor persistence of some current New Zealand perennial ryegrass cultivars under intensive dairying (Thom et al., 1998), might be related to the production of a high proportion of reproductive tillers, and consequently increased susceptibility to stress in summer, when replacement of reproductive tillers is necessary. Suggested changes for improved persistence of 'Ellett', and possibly related cultivars, would be reducing the propensity to produce reproductive tillers. Breeding programmes aimed at reducing reproductive development would also have the added benefit of improving nutritive value of the pasture (Tallowin et al., 1989) and therefore animal performance.

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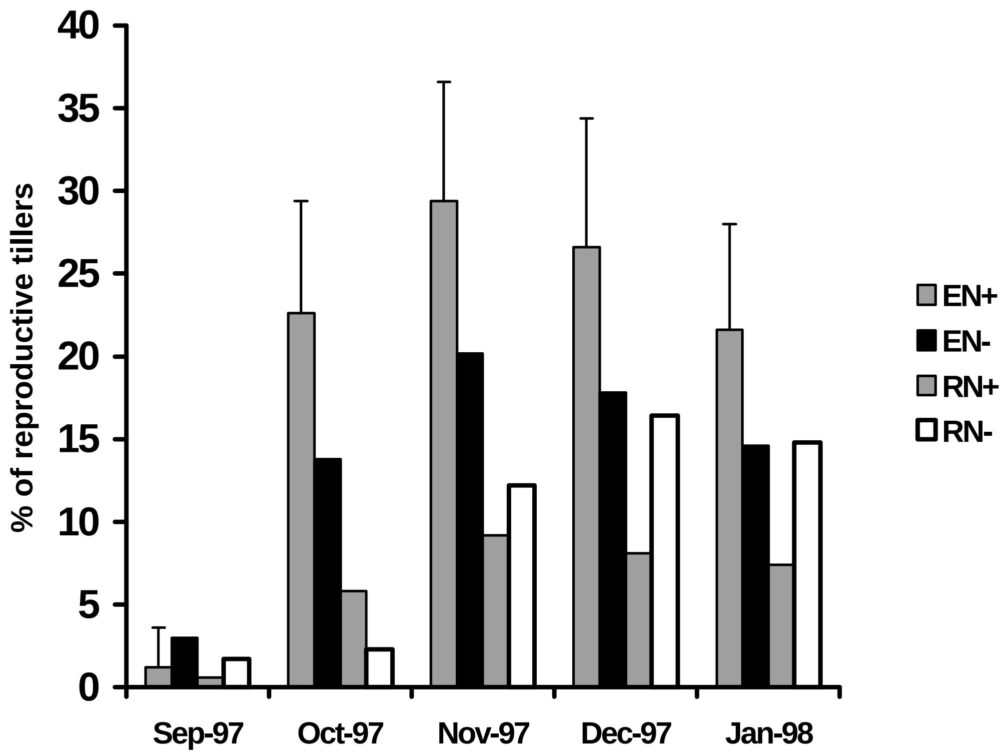

Figure 1 - Effect of nitrogen (N) fertiliser on reproductive tiller development (% of total tillers) in 'Ellett'(E) and 'Grasslands Ruanui'(R) ryegrass swards during the second flowering period. N+ with nitrogen; N- without nitrogen. Bars are $LSD_{5\%}$ for cultivar comparisons within each treatment.