EFFECTS OF NITROGEN FERTILISER ON THE GROWTH OF RYEGRASSES WITH DIFFERENT TOLERANCES TO PULLING

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ABSTRACT

Plots of high endophyte pipeline ryegrass (*Lolium perenne* L.) lines, coded A1 and A3, were established on the Dairying Research Corporation No 2 Dairy in May, 1994. Three plots of each line were drilled on a silt loam and three on a peaty silt loam soil. Half the area of each plot received nitrogen (N) fertiliser (30 kg N/ha) following grazings from September, 1995 to February, 1996. Line A1 consistently pulled more than did A3 and pulling was worse on the peat. N fertiliser increased post-flowering tillering especially for A1. Line A1 had a higher leaf shear strength (6.21 vs 5.91 kg, SED = 0.087*) and a wider leaf (3.40 vs 3.22 mm, SED = 0.054*) than A3. These morphological differences were considered important determinants of the observed pulling differences, and since A1 outyielded A3, plant losses due to pulling did not cause a serious loss of herbage dry matter.

KEYWORDS

Dairying, dairy cow, *Lolium perenne* L., nitrogen fertiliser, leaf shear strength, leaf morphology, tillering, persistence

INTRODUCTION

'Ryegrass pulling' describes the physical removal of clumps (including 2-5 cm of roots) of ryegrass plants from the sward by cows during grazing. We have noted that certain ryegrass lines were more susceptible than others to pulling. This was interesting since their parents were selected from the same ecotype (Cumberland and Honore, 1970), suggesting a genetic component to the pulling phenomenon. Increased ryegrass pulling has been correlated with usage of high rates of nitrogen fertiliser (Tallowin *et al*. 1986), while others (Harris et al., 1996) have shown regular inputs of N fertiliser stimulated vegetative tillering after decapitation of flowering tillers, possibly improving plant persistence. Water stressed ryegrass was also prone to pulling (Tallowin, 1985), and farmers contend ryegrass pulling was more likely on peat than on silt loam soils.

This paper compares the responses to N fertiliser of 2 pipeline high endophyte ryegrass lines (coded A1 and A3) that were shown by Thom et al. (1996) to have different tolerances to pulling. Plots were drilled in May 1994 and the N treatment began in October 1995.

METHODS

Plots (12 x 4 m) of the ryegrass lines A1 and A3 were arranged in a randomised block design with 6 replicates. Three blocks were located on a Te Kowhai silt loam soil (Haplic Andaquept) and three on a Te Rapa peaty silt loam (Humic Haplorthod). Seed was cross-drilled (7 kg/ha each pass) after treatment with 1.08 kg a.i./ha of glyphosate. Aran white clover (*Trifolium repens* L.) was drilled at 3 kg/ha. N fertiliser (30 kg/ha) was applied on 7 occasions after grazing to half the area of each main plot from October 1995 to February 1996, a total of 210 kg N/ha.

Plots were rotationally grazed to post-grazing residuals of 1000-2600 kg DM/ha by dairy cows stocked at 4.4/ha. Counts of "pulled" ryegrass clumps were made in two 1 m^2 frames per subplot. Herbage accumulation was estimated by pasture probe before and after grazings. The shear strength of the most recently expanded leaf blades was measured in April 1996 using the Warner-Bratzler shear machine (Easton, 1989). Leaf width was measured 3-6 cm from the ligule using a Vernier calliper. Three circular (63 mm d.) frames per subplot were permanently located over ryegrass plants in September 1995 for the study of tiller dynamics; details are given in Thom et al. (1996).

RESULTS AND DISCUSSION

Cumulative total pulling of ryegrass clumps was higher for A1 than A3 (22.8 vs 12.3 pulls/m^2, SED = 2.40*), confirming previous results (Thom *et al*., 1996). Both lines suffered more pulling on the peat than on the silt loam soil (23.8 vs 11.2 pulls/m^2), confirming farmer observations. This may occur because the peat had a lower soil strength (penetrometer resistance) than the silt loam soil (Houlbrooke, 1996).

Pulling levels were about half those reported for the first summer (Thom *et al*., 1996), when there was a severe dry spell of 64 days from 23 November, 1994 to 26 January, 1995, supporting the findings of Tallowin (1985). Although others have correlated increased pulling with high inputs (>400 kg N/ha) of N fertiliser (Tallowin et al., 1986), and cumulative totals for N treated plots were higher (19.8 vs 15.3 pulls /m^2), differences were not significant for inputs of 210 kg N/ha.

Herbage accumulation was similar for A1 and A3 (8.9 vs 8.4 t DM/ha) and for N treated and untreated plots (9.0 vs 8.3 t DM/ha). The yield advantage to A1 despite a higher level of pulling during the 1994/95 and 1995/96 summers, suggests it was capable of compensating for such losses. Tiller counts within fixed frames supports this theory since A1 produced a prolonged post-flowering N response (Harris *et al*., 1996), increasing tiller numbers by an average of 50% from November, 1995 to April, 1996, compared with 10% for A3 which was limited to November/December.

We speculate that possible differences in the leaf shear strength of A1 and A3 may lead to different forces being applied to ryegrass clumps by cows during grazing. Our results (Table 1) showed A1 had a higher leaf shear strength than did A3, and are similar to those of Easton (1989). The dry weight of each leaf portion was also highly correlated with shear strength (r = 0.80 ***, 0-3 cm; r = 0.69 ***, 3-6 cm) for both lines. Inoué et al. (1994) associated narrow leaves with low strength and a smaller cross-sectional area. Our measurements showed A1 had wider leaves than A3 (3.396 vs 3.216 mm, SED = 0.0535*), although for unknown reasons, A1 had wider leaves on the silt loam than on the peat soil (3.621 vs 3.171 mm, SED = 0.0804*); the trend was the same for A3 (3.252 vs 3.179 mm). These differences in leaf morphology help explain why A3 was more tolerant of pulling than was A1; the leaves of A3 were likely to break easier than those of A1 thereby reducing the forces applied to clumps during grazing and the likelihood of pulling.

This experiment identified differences in leaf morphology which could affect the relative ability of ryegrasses to withstand pulling. A1 had a more consistent post-flowering tillering response to N fertiliser than did A3, which might combat pulling losses. These results provide useful directions to plant breeders, especially since Easton (1989) reported leaf shear strength was highly heritable. It is interesting that A1 outyielded A3 despite greater pulling losses. This suggests, at least in the short-term, that the levels of pulling measured were not important for sward productivity. Tallowin et al. (1986) concluded similarly for pastures continuously grazed by cattle. Presumably, over a longer period, higher losses from A1 would reduce its persistence compared with A3. Despite the higher growth potential of A1, it will not be released as a commercial cultivar because farmers associate pulling with reduced pasture production.

Table 1
Shear strength (kg) of youngest fully expanded leaves of lines A1 and A3 in April 1996

Line	Leaf Shear Strength[a]	
	1	2
A1	6.21	5.08
A3	5.91	4.87
SED	0.087	0.070

[a] First and second measurements were made 3 and 6 cm from the ligule, respectively.

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