Stolon formation in perennial ryegrass may aid persistence

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Abstract

The extent of stolon formation in separate 0.5ha blocks of 3 year old irrigated pasture containing 'Impact' and 'Yatsyn' perennial ryegrass (*Lolium perenne* L.) was monitored from November 1998 to June 1999, to investigate the role stolons play in survival of plants over summer. Results provide quantitative evidence for far greater stolon growth in the cultivar Impact than the more commonly grown cultivar Yatsyn. Stolon formation appears to be a regular morphological feature, which has distinct advantages in survival and maintenance of plant and tiller density in pasture. The formation of stolons by Impact ryegrass plants was extensive (134 vs. 2 in spring and 89 vs. 1g stolon dry matter/m^2 in autumn for Impact and Yatsyn pasture, respectively), which confirms previous field observations. Stolon formation led to colonisation of bare ground and maintenance of a stable Impact ryegrass plant population in pasture over the summer period, compared to Yatsyn pasture, where ryegrass plant density declined by 17 plants/m^2.

Key words

Ryegrass, stolon, persistence.

Introduction

Perennation of perennial ryegrass (*Lolium perenne* L.) relies on tiller replacement and survival (3, 8). Seedling recruitment is generally poor, particularly under the grazing management practiced in dairy production systems. Thus, lateral spread of the ryegrass plant predominantly relies on growth through tillering, and as this is slow and restrictive, gaps in the pasture created by the death of ryegrass plants are rapidly colonised by less desirable grasses and weeds (5,7). Lateral spread of ryegrass plants may sometimes be aided by the formation of stolons. Harris *et al.* (6) reported that perennial ryegrass growing in a lawn spread by means of stolons to cover patches of ground up to 0.8m in diameter. However, stolon formation in ryegrass plants is normally restricted to locations where the plant is severely shaded, for example through physical burial of tillers by worm castings and stock treading, or through shading of tillers by other plants in the pasture (1,2,9).

A perennial ryegrass plant in which stolon formation is a common means of vegetative propagation should, through rapid colonisation of gaps in pasture, maintain a higher density of ryegrass plants and tillers. Responding to anecdotal evidence from farmers and field agronomists, the author observed evidence of lateral spread of the perennial ryegrass cultivar 'Impact' by stolons in grazed pasture.

The aim of the current study was to compare the extent of stolon formation in Impact with the perennial ryegrass cultivar 'Yatsyn' through the summer period and to investigate the role of stolons in the maintenance of pasture density and survival of plants in intensively grazed dairy pasture.

Materials and Methods

The study was located at Montumana in north-west Tasmania (40?57'S, 145?30'E), and was undertaken between November 1998 and June 1999. The site was established as a cultivar demonstration trial in September 1995, with separate 0.5ha blocks of Yatsyn and Impact perennial ryegrass, both sown at 25kg/ha with 5kg/ha of 'Kopu' white clover (*Trifolium repens* L.). Both blocks were managed identically with regard to grazing, irrigation and fertiliser application. The soil is a krasnozem, the average annual rainfall is 1000mm, and the site was irrigated in the absence of effective rainfall.

Stolon formation. In November 1998 and late January and early June 1999, 20 pasture turves (0.06m^2) were taken at random positions in each pasture type to a depth of 60mm, using a quadrate with a blade edge. Soil was washed from the turves, live ryegrass stolons cut free from the roots and tillers, and dried at 80^{o}C for 24 hours to determine stolon yield on a dry matter (DM) basis.

Plant density. The number of individual ryegrass, other grass and broadleaf weed plants per 0.09m^2 quadrate, placed at 20 set locations along an identifiable transect within each pasture type, was recorded in November 1998, and February and May 1999. The same quadrates were monitored every 2 weeks from March to May 1999, and any seedlings that had germinated from seed set the previous spring were marked with coloured wire loops, and their survival recorded until June.

Tiller and growing point densities. The number of ryegrass tillers and white clover growing points in a 120mm diameter soil core (60mm deep) was recorded from 30 cores per pasture type taken at random positions in November 1998, and February and May 1999.

Pasture composition. In November 1998, and February and May 1999, 50-60 pasture samples (from an area approximately 0.005m^2) were taken at random positions in each pasture to an estimated grazing height of between 40 to 50mm from ground level. Samples were sorted into ryegrass, clover, other grasses and weeds, then dried at 80^{o}C for 24 hours to determine percentage botanical composition by DM.

Statistical analysis on all measurements was undertaken by an analysis of variance.

Results

Stolon formation

There was a significantly greater (P<0.001) mass of ryegrass stolons in all turves from the Impact pasture compared to the Yatsyn pasture (Figure 1), and all of the Impact stolons were at or within 3mm of the soil surface and attached to living plants. This was in contrast to the Yatsyn pasture, where a small amount of stolon was present under some turves, and in most cases was linked to decaying plant crowns beneath the soil surface. No stolon material was observed in either pasture type below the 60mm sampling depth.

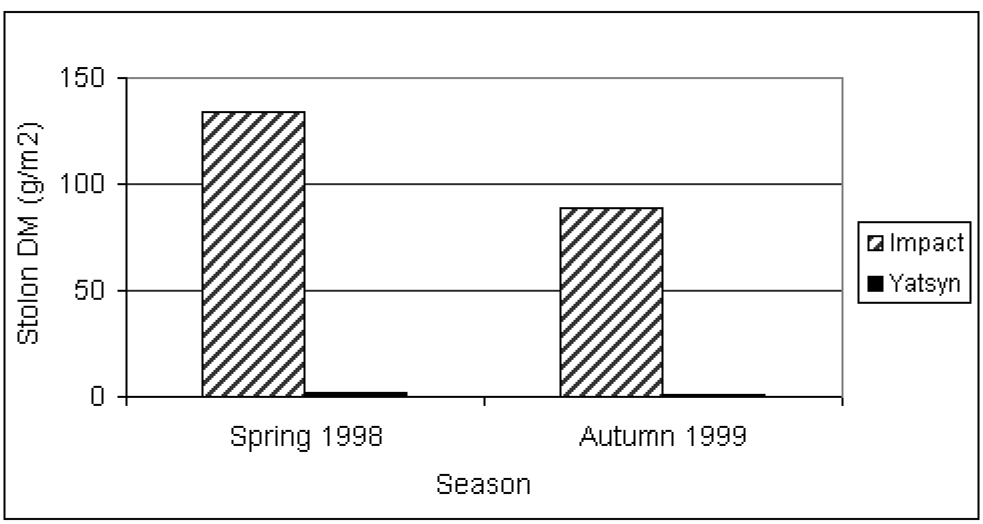

Figure 1. Stolon dry matter (g/m^2) in Impact and Yatsyn pastures in November (spring) 1998 and early June (autumn) 1999.

Most of the Impact stolons were less than 10mm long, but in instances where gaps had opened up in the pasture through death of plants, stolons greater than 100mm in length were observed to have rooted down in the gaps and tillered to form plantlets. By late autumn, stolon formation in both pastures had decreased significantly (P<0.001) from that measured in spring, with the DM of live stolon material declining by 35% in Impact pasture, and by 67% in Yatsyn pasture.

Plant density

There were significantly more (P<0.001) ryegrass plants in Impact than in Yatsyn pasture in spring 1998, and this difference had increased by autumn 1999 due to a 15% decrease (P<0.05) in Yatsyn plant density and a slight increase in Impact plant density over summer (Table 1).

Table 1. Mean density (plants/m^2) of ryegrass, other grass and broadleaf weed plants in Impact and Yatsyn pastures in spring (November) 1998 and autumn (May) 1999.

	Spring 1998		Autumn 1999	
	Impact	Yatsyn	Impact	Yatsyn
Ryegrass	146	114	151	97
Other grass	7	7	3	17
Broadleaf weed	1	4	1	1

In the Impact pasture, the increase in plant density was due to stolon spread resulting in 5 ? 2 (mean ? s.e.) new plants/m^2 in February and 2 ? 1 new plants/m^2 in May 1999, while an average of 2 ryegrass plants/m^2 died over the same period. There were no new ryegrass plants initiated from stolons in Yatsyn pasture, and no seedling recruitment of ryegrass plants was recorded in either pasture type.

The density of 'other grass' was not significantly different (P>0.05) between pastures in spring, but by autumn, had halved in Impact pasture while more than doubling in Yatsyn pasture (P<0.05). This was observed to be predominantly young winter grass (*Poa annua* L.) plants, germinating mainly in areas of bare ground in early autumn. The density of broadleaf weeds was low and similar between pastures (P>0.05), and remained relatively constant throughout the study.

Ryegrass tiller density and tillers per plant

Ryegrass tiller density in the Impact pasture was nearly double that of the Yatsyn pasture in spring (10973 vs. 5509 tillers/m^2, respectively; P<0.001). While tiller density declined significantly (P<0.001) over summer in both pastures, the Impact pasture still maintained close to double the tiller density of the Yatsyn pasture in autumn (7981 vs. 4707 tillers/m^2, respectively; P<0.001).

The decline in tiller density in Yatsyn pasture over summer was due to plant death, as tiller numbers/plant remained constant at a mean of 48 tillers/plant. The decline in tiller density in Impact pasture over summer reflected lower tiller numbers per plant (53 vs. 75 tillers/plant in autumn and spring, respectively).

White clover growing point density

In contrast to the tiller density, the density of white clover growing points in Impact pasture was 31% lower than in Yatsyn pasture in spring (377 vs. 545 growing points/m^2, respectively; P>0.05), and 13% lower in autumn (595 vs. 687 growing points/m^2, respectively; $P>0.05$). This was because clover growing point density increased over summer by 58% in Impact pasture, but only by 26% in Yatsyn pasture.

Botanical composition

The botanical composition reflected the plant and tiller densities. While over 85% of Impact pasture *on offer* throughout the study period was ryegrass, the ryegrass component of Yatsyn pasture fell from 81% of DM in spring to 68% in autumn, largely due to an increase in the contribution of other grasses to total DM. The clover and broadleaf weed components of feed *on offer* were similar between Impact and Yatsyn pastures for the duration of the study (each component comprising less than 5% of total pasture DM).

Discussion

The present study provides quantitative evidence that Impact perennial ryegrass is a morphologically different ryegrass genotype, in regard to stolon formation, than the more commonly sown genotype Yatsyn. Throughout the study, the formation of above-ground stolons by Impact ryegrass plants was extensive and appeared to be a regular morphological feature of the plant. In contrast, there was a much smaller amount of stolon material present in the Yatsyn pasture, of which most was below ground and appeared to be a survival mechanism to elevate growing points in response to burial of the plant crown through treading by grazing stock. The latter mechanism of stolon formation has been reported in New Zealand by Matthew *et al.* (9) and Brock and Fletcher (1).

The stoloniferous growth of Impact ryegrass resulted in maintenance of a stable plant population over the summer period, with any loss of ryegrass plants more than offset by recruitment of new plants from stolons, as there was no seedling recruitment observed in either pasture type. The Impact stolons effectively colonised bare areas of pasture created through loss of ryegrass and other plants. In the Yatsyn pasture, as with most ryegrass genotypes, the inability of ryegrass to colonise bare areas led to a greater ingression of other grass species that germinated in autumn. The competition for resources (such as light, water and nutrients) by these other grasses would be expected to increase as plants increase in size, which would provide stronger competition with the remaining ryegrass in the coming seasons.

The tiller density of Impact pasture in the present study was comparable to results reported by Fulkerson and Michell (4) in Tasmania, who recorded tiller densities of 3000 tillers/m^2 in autumn/winter, increasing to 10000 - 16000 tillers/m^2 in spring. The spring peak in tiller density observed in the current study is as expected in temperate environments (2,3,4). The lower density of white clover growing points in Impact than Yatsyn pasture probably reflects the greater competitiveness of Impact ryegrass pastures, although the percentage of clover DM *on offer* in both pastures was similar.

Conclusion

The current study quantified the far greater stoloniferous growth of the perennial ryegrass variety Impact over the variety Yatsyn. This provides a distinct advantage over other genotypes in survival and maintenance of plant and tiller density in pasture. However, the extent of stoloniferous development may differ dependent on soil type and grazing management regime. This study did not compare plant dynamics during the winter and it is possible that under a different management regime (e.g. non-optimal grazing) or without irrigation, the pattern of stolon formation might be different.

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