Ryegrass Seeding Rate Alters Plant Morphology and Size-- Possible Implications for Pasture Persistence

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Ryegrass seeding rate alters plant morphology and size – possible implications for pasture persistence?

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Introduction

Poor persistence of perennial ryegrass (*Lolium perenne* L.) is a major dairy industry issue in New Zealand and Australia. New ryegrass seed is often drilled at 18-30 kg/ha, although previous research indicated that pastures drilled at 10-12 kg/ha can be just as productive (Frame and Boyd 1986; Praat *et al.* 1996). High seeding rates increase competition between developing seedlings for light, water and nutrients, reduce plant size (Harris 1990) and potentially survival.

The experiment reported here investigated the effect of plant density (created by differences in seeding rate) on plant morphology and survival. The hypothesis was that plants established from high seeding rates will be smaller and, therefore, less likely to survive the first summer; a period of substantial environmental stress (*e.g.*, high temperatures, low soil moisture, insect attack).

Methods

The experiment began in autumn 2011 at three sites in New Zealand, two in the North Island (Northland and Waikato, unirrigated) and one in the South Island (Canterbury, irrigated). Seed of modern diploid cultivars 'Alto' and 'Grasslands Commando', a modern tetraploid 'Grasslands Halo' (all infected with AR37 endophyte) and an old diploid 'Grasslands Nui' (with Standard endophyte) were direct-drilled into large plots at five seeding rates (equivalent to 6, 12, 18, 24 and 30 kg/ha of diploid ryegrass seed, adjusted upwards for heavier tetraploid seed) in a randomised split-plot design with five replicates. Coated white clover (*Trifolium repens* L. cv. 'Tribute') seed was broadcast at 8 kg/ha.

At all three sites, 10 individual plants per subplot were marked with a wire loop seven weeks after drilling. These plants were checked every 2-3 months for the first year and recorded as alive, dead, or missing. At the Waikato and Canterbury sites, the effects of seeding rate on early plant development were also characterised on randomly selected plants (*i.e.* not the marked plants) by measuring total tiller length (length of tiller from ground to tip of longest leaf), undisturbed pseudostem height (maximum vertical height above ground of the ligule of the oldest expanded leaf), tiller angle (angle between the tiller and ground level), number of tillers and lateral roots per plant, maximum root length, and the root and total dry matter (DM; shoot plus root) per plant. Data were analysed using GenStat 14.1 as a split plot design using REML with cultivar (main plot), seeding rate (sub-plot) and their interaction as fixed effects, and block, main plot within block and sub-plot within main plot as random effects. Marked plants recorded as missing were excluded from analyses. No interactions between seeding rate and cultivar were identified for any variable. This paper will focus only on seeding rate effects, which were greater than any recorded cultivar effects.

Results and discussion

One month post-drilling at the Waikato site, the tiller length of plants in the 6 and 12 kg/ha treatment was similar to those in the 18-30 kg/ha treatments. The undisturbed pseudostem height was less, however, resulting in more prostrate tillers (smaller tiller angle; Table 1) with less leaf area available above grazing height (4-5 cm).

Eight months post-drilling at the Canterbury site, ryegrass plants in the 6 and 12 kg/ha treatments were larger than those in the 18-30 kg/ha treatments (Table 1). Lateral root numbers per plant and total root weight showed similar differences. There were more tiller numbers per plant in the 6 and 12 kg/ha treatments than the other treatments, but mean tiller weight was similar for all treatments (Table 1).

Plant survival during the first year in Northland and Canterbury was similar regardless of seeding rate. In the Waikato, however, more plants survived ($P<0.05$) from August to December in pastures drilled at 6 to 18 kg/ha than at 30 kg/ha (Fig. 1).

The hypothesis that plant size (both shoots and roots) is reduced at high seeding rates was confirmed. These findings are consistent with Brougham (1952), who reported a curvilinear decline in tillers/plant as seeding rates of short rotation ryegrass increased from 11 to 67 kg/ha. However, the relationship between plant size and survival in the current study was variable. There was a significant effect of seeding rate on survival at only one of the three sites, Waikato, which had the highest overall plant mortality of all the sites. Under conditions which cause plant mortality, lower seeding rates may aid survival, but in less stressful environments, survival of smaller plants may be similar to that of larger plants.

Table 1. Average seeding rate effects on perennial ryegrass plant morphology at Waikato and Canterbury sites.

	Seeding rate (kg/ha)						
	6	12	18	24	30	SED	*P* value
One month post-drilling (Waikato)							
Total tiller length (mm)	164	175	181	175	191	11.7	NS
Undisturbed pseudostem height (mm)	24	30	32	34	39	2.9	<0.001
Tiller angle (degrees)	35	41	44	46	43	3.1	<0.01
Eight months post-drilling (Canterbury)							
Tillers per plant	24	18	13	13	10	1.3	<0.001
Lateral roots per plant	75	61	52	48	45	4.0	<0.001
Maximum root length (mm)	81	80	82	76	80	3.7	NS
Root mass per plant (mg DM/plant)	109	80	62	61	49	8.1	<0.01
Total mass per plant (mg DM/plant)	1094	780	598	569	444	68.1	<0.001
Mean tiller mass (mg DM, shoot + root)	45.6	43.3	46.0	43.8	44.4		

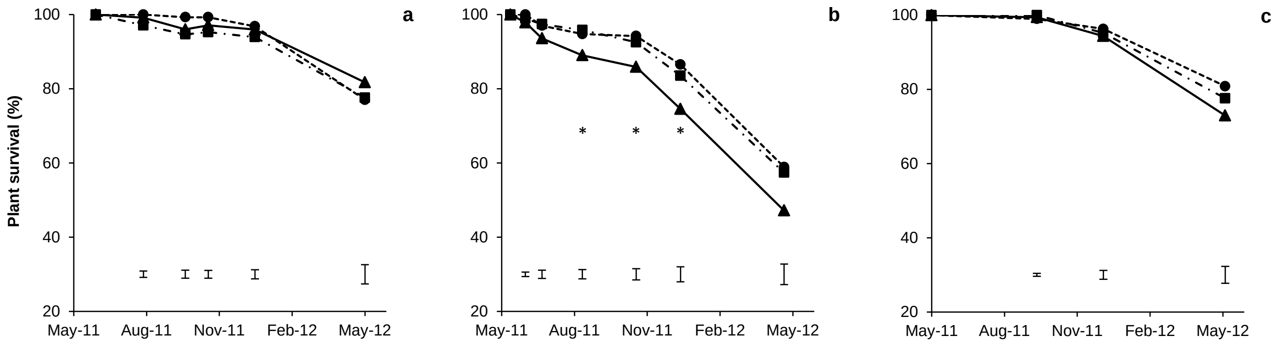

Figure 1. Survival of perennial ryegrass plants in pastures drilled at 6 (●), 18 (■) and 30 kg/ha (▲) seed in (a) Northland, (b) Waikato and (c) Canterbury.

Conclusion

Ryegrass seeding rate affects plant size and morphology. Its relationship with plant survival during the first year may depend on the amount of stress placed on the pasture, rather than plant size *per se*. The impact of ryegrass seeding rate on long-term pasture persistence is still to be determined.

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