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SURVIVAL OF OVERDRILLED RYEGRASS IN DAIRY PASTURES CONTAINING PASPALUM

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ABSTRACT

The growth and survival of ryegrass plants Introduced in autumn/winter into dairy pasture containing paspalum, were monitored in a series of field experiments from 1978 until 1982.

In each experiment plant losses were highest (30-40% of total) in the summer following their introduction resulting in only small short term improvements (<500 kg DM/ha) in seasonal production About 208 of total losses were directly related to damage caused by cow grazing (severe grazing, "pulling", dung and wine deposition, trampling). The mechanisms accounting for the other 80% were less easy to quantify but apparently Involved factors like competition for light, water and nutrients, climatic stresses and subtle animal damage to plant growth points, leaves and roots.

Large plants (20-30) tillers had a higher probability of surviving summer than did small plants (< 10 tillers) A number of modifying factors were used in an attempt to improve the size and therefore survival of introduced ryegrass plants. These included additions of nitrogen fertiliser in late winter/spring, Irrigation during summer/autumn and continuous severe clipping of resident herbage surrounding introduced ryegrass plants. Only the clipping treatment significantly improduced ryegrass survival.

A short (14 d) grazing interval over summer was also detrimental to ryegrass survival, compared to a long interval (28 d). The presence of summer growing paspalum as the main resident competitor reduced ryegrass survival compared to other resident species, and the effect was most noticeable if the plants were further stressed by grazing at a short interval over summer.

Practical methods of reducing competition between established species and establishing ryegrass seedlings are discussed.

Keywords: pasture renovation, ryegrass persistence, ryegrass survival, *Paspalum dilatatum*, *Lolium perenne*, seasonal pasture production, grazing damage, competition control, nitrogen, irrigation, grazing interval.

INTRODUCTION

High stocking rates, hard grazing and frequent dry, hot (daily screen maximum > 25°C) weather during summer and insect damage have often lead to high losses of sown pasture species in northern New Zealand dairy pastures, allowing volunteer paspalum (Paspalum *dilatatum* Poir.) to dominate (Brougham 1960, Percival 1977, Baars et *al.* 1980). This leads to low spring pasture production, a serious problem on seasonal dairy farms since about 80% of total milkfat production can be achieved from July to January (Campbell and Bryant 1978). Paspalum is a stronger summer competitor than is ryegrass mainly because of its superior growth potential (C, v. C_3 plant), its ability to accummulate carbohydrate reserves that can be used to combat climatic stresses, and its prostrate growth habit, which restricts removal of leaf area during grazing (Thorn 1984).

Farmers have attempted to redress the species balance by overdrilling improved ryegrass cultivars such as 'Grasslands Nui' and 'Ellett' perennial ryegrass (*Lolium perenne)* (Sangakkara *et al.* 1982) but results have been variable, even in overdrilled Pastures bandsprayed with herbicide to reduce competition from resident species (Kunelius et al. 1982, Betteridge and Baker 1983).

Despite widespread overdrilling of grass seed in dairying regions there have been no reports of the persistence and contribution of the introduced species to seasonal herbage production. The work described here and in greater detail by Thorn (1984) had three objectives:

(i) to measure the persistence of overdrilled perennial ryegrass.
(ii) to identify factors influencing persistence.
(iii) to develop methods of achieving satisfactory persistence of perennial ryegrass introduced into pastures containing paspalum.

MATERIALS AND METHODS

Study Area

The study was located at the No. 5 Dairy, Ruakura Animal Research Station. Ground frosts are common averaging 28% of cool season days (May-August). Dry spells during December-March are also common, often accompanied by high day temperatures (screen maxima of 25°C or greater).

Soils range from well drained Bruntwood silt loams to imperfectly drained Te Kowhai silt loams. Annual maintenance dressings of K, P and S were applied as potassic superphosphate during the study period. No lime was applied during the experiments and the pastures (25 years old) had not received lime over the previous 10 years (pH 5.6).

Pasture composition in summer was 45-55% paspalum and 8-10% ryegrass. Ryegrass and Poa spp. each comprised 30-35% of the pasture in spring. White clover (*Trifolium repens* L.) ranged from 20-30% throughout the year. Paspalum occupied 30-40%, and after dry summers, up to 60% of the experimental area. Most but not all was located in areas that supported predominantly paspalum.

The study area was regularly sampled for insects such as grass grub, Argentine stem weevil and black beetle. Insect numbers were considered too low to cause measurable sward deterioration.

Experimental design and treatments

Results from three field experiments are described in this paper. Experimental details are summarised in Table 1 and given in greater detail in Thorn (1984).

Experiment 1

Treatments (a) Main plot coulter type: triple disc v. chisel
(b) Sub plot — bandspraying paraquat in 40 mm band widths (5 *l* in 500 *l* water/ha) at drilling v. no spraying
(c) Sub subplot — species: 'Grasslands Nui' perennial ryegrass v. 'Grasslands Nui' perennial ryegrass and 'Grasslands Matua' prairie grass (*Bromus willdenowii*) mixture. Seed rates for ryegrass and prairie grass were 11.5 and 12.2 kg/ha, respectively.

Seed of recently harvested lines of certified first generation Nui ryegrass (level of *Acremonium* endophyte infection unknown) and second generation Matua prairie grass was overdrilled into hard grazed pasture (800-1000 kg residual DM/ha). No pesticides or fertilisers were applied at drilling. Soil moisture levels were adequate since 77 mm of rain fell over the 4 days preceding drilling. Two hours *were* allowed for drying of herbicide before harrowing with a bar harrow (Baker 1970).

Experiment 2

Treatments (a) ryegrass introduced into paspalum dominant areas (Pa plots) v. areas containing little or no paspalum (NPa plots).
(b) N fertiliser (urea) — 268 kg/ha as 4 split dressings of 67 kg/ha on 12 August, 9 September, 6 and 21 October, 1980 v. no nitrogen.

Experiment 3

Treatments (a) ryegrass introduced into paspalum dominant areas (Pa plots) v. areas containing little or no paspalum (NPa plots).
(b) grazing interval (S = short, L = long); SS — 14 days for study period (Table 1); SL — 14 days, from 21 September to 30 December 1981

-- 28 days, from 18 January to 2 June 1982; LL -28 days for study period (Table I); LS -- 28 days, from 29 September to 22 December 1981 -- 14 days from 11 January 11 June 1982 September to 22 December 1981 — 14 days from 11 January to 11 June 1982

(c) clipping of resident herbage surrounding transplanted ryegrass (C) v. no clipping (NC)

(d) irrigation — periodically from 15 December 1981 to 29 April 1982 v. no irrigation (+I v. -1)

TABLE 1: Summary of sowing dates, methods of establishment and management of three field experiments conducted from 1978-1982.

Variable	Experiment number 1[1]	2[2]	3[1]
Experimental period	20 April 1978-14 May 1980	19 May 1980. 21 May 1981	20 May 1981-11 June 1982
Seed	Commercial lines of Nui ryegrass		
Sowing date or date of introduction of seedlings	20-21 April 1978	29-30 July 1979	6-7 August 1981
Grazing management[3] (cows grazing at various intervals)	First grazed, 69d post-drilling; 60d over 1978 winter, thereafter at 26-36d	First grazed 47-54d post-transplanting thereafter at 14 or 21d	First grazed 45d (SS, SL), 53d (LL, LS) post-transplanting, thereafter see text
Method of establishment	Overdrilled (Duncan 30 Multiseeder)	Seedling transplants	
Number of tagged ryegrass plants	240	896	896
Plants identified/plot	6	14	14
Plot size	5 x 40 m	0.3 x 0.3 m	0.6 x 0.6 m
Treatment replications	5	8	4 (grazing interval level)

[1]Split plot design. [2]Factorial design. [3]Grazing completed in 2-3 hours

For experiment 2, 14 ryegrass transplants (each 1-3 tillers) were positioned in two rows of seven plants (150 mm between rows, 50 mm apart within rows) in Pa or NPa plots. In experiment 3, the spacing between rows was increased to 300 mm to allow for a border area between clipped (C) and unclipped (NC) areas of the plots. Throughout this experiment, the resident herbage on half the plot area (300 x 600 mm) surrounding one row of introduced ryegrass plants was kept trimmed to a 5-10 mm stubble.

Sward measurements

Plants were randomly selected and ringed with coloured telephone wire for permanent identification. Counts of all emerged tillers on ringed ryegrass plants were made before, after and between grazings. Yield measurements were made pre-grazing on other introduced ryegrass plants, by clipping to a stubble height of 40 mm.

Visual estimates of pre and post-grazing herbage mass were made in all experiments.

At each assessment, calibration quadrats were also visually assessed before cutting to ground level. The mean herbage mass estimate for each treatment was adjusted using the regression of visual grade on herbage mass for the quadrat assessments.

RESULTS

In all experiments, total losses of introduced ryegrass plants were strongly influenced by season (eg. Fig. 1). The pattern of loss for prairie grass (experiment 1) was similar to that for ryegrass, but in this paper only data for ryegrass will be presented. Losses of ryegrass plants were consistently highest (30.40%) in the summer/autumn following their introduction. Over the establishment year losses ranged from 56-64% of the total ryegrass plants introduced. Up to 20% of the total losses of ryegrass plants was directly attributable to "animal effects" such as severe grazing to a stubble height of 10 mm or less, "pulling", dung and urine deposition, trampling (Fig. 1). This failure to survive was emphasised by only small improvements (< 500 kg DM/ha) in winter/spring dry matter production in the first year following overdrilling.

Results from experiment 1 showed that larger plants (more tillers) survived longer than did smaller plants (Fig. 2). Plants that survived the establishment year (group 1, Fig. 2) had on average 17 tillers/plant at the beginning of summer (December) while those lost over the first summer (group 2, Fig. 2) had an average of only 10 tillers/plant. Group 1 plants survived until the end of the study (May 1980) when their average tiller number while still 17/plant, had reached 34/plant during the previous spring. Neither bandspraying of herbicide (27% of area sprayed) nor coulter type (experiment 1) improved ryegrass survival.

Despite a shortlived tiller number increase of 6% in response to N fertiliser in September/October in experiment 2, and tillering responses to irrigation of 80% in January 1982 (experiment 3), this did not improve the survival of introduced ryegrass plants.

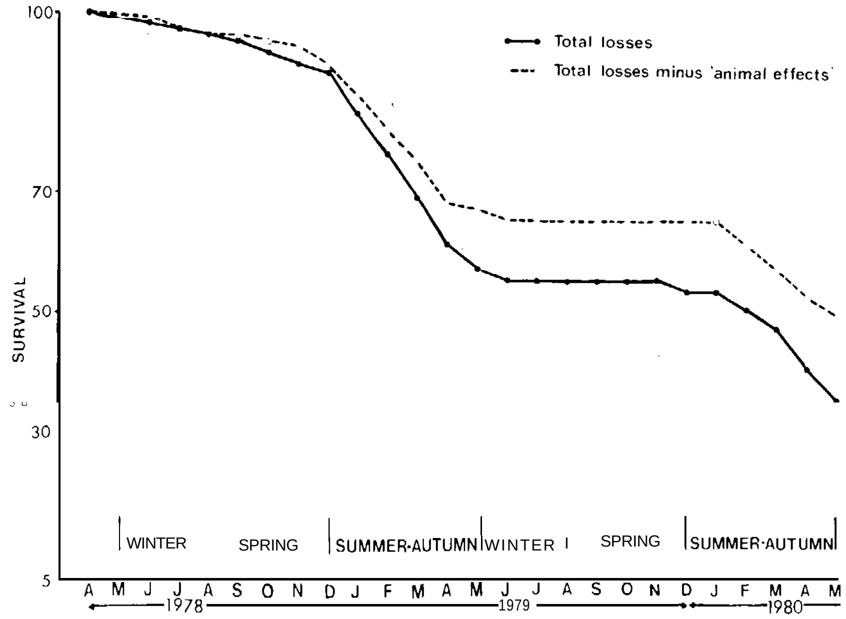

Figure 1: (experiment 1) Seasonal survival of overdrilled Nui ryegrass over a two year period.

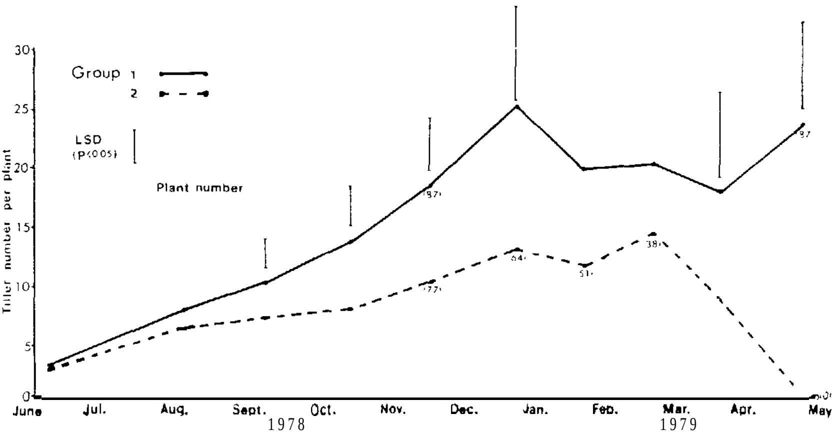

Figure 2: (experiment 1) Pregrazing tiller numbers for Nui ryegrass plants classified into Group 1 (survived the establishment year) and Group 2 (lost over the first summer following the overdrilling).

TABLE 2: (experiment 3) The mean effects of the presence or absence of paspalum (Pa, NPa) on spring, summer and autumn deaths (%) of ryegrass plants.

	Spring	Early-summer	Late-summer	Autumn[1]			
				SS	SL	LS	LL
Pa	2[2]	19	28	40	14	5	10
NPa	3	16	21	18	19	9	8
Signif.	ns	ns	*				

[1] Plot type × grazing interval interation significant at $P<0.05$ level.
[2] Data are percentages derived from ratios of numbers of deaths during the season over the number of survivors at the beginning of the season (random losses due to dung, urine and "pulling" excluded).
*Significant at $P<0.05$ level, ns non-significant

TABLE 3: (experiment 3) The effects of grazing interval (SS, LS, SL, LL) and clipping of surrounding herbage (C, NC) on the component yields (mg) of ryegrass plants in June 1982.

	Grazing treatment[1]					Clipping treatment[2]		
	SS	LS	SL	LL	(SED)	C	NC	(SED)
Shoot (> 40 mm tiller length)	130	85	570	827	(190.7)	447	41	(98.4)
Shoot (<40 mm and above ground level)	512	409	1008	1134	(168.7)	918	84	(147.1)
Root[3]	248	182	390	505	(58.7)	365	116	(40.6)
Totals	890	676	1968	2466	(367.5)	1730	241	(264.9)

[1] Data from C plot areas only.
[2] Data from NP plots only.
[3] Yield in a 48 mm dimeter soil core to a depth of 150 mm.

For experiment 2, summer and autumn losses of ryegrass in paspalum dominant plots (44% and 38%, respectively) were higher than for ryegrass plants growing in paspalum-free plots (35 and 21% respectively), although differences failed to reach significance in autumn. However, similar results were obtained in experiment 3, with

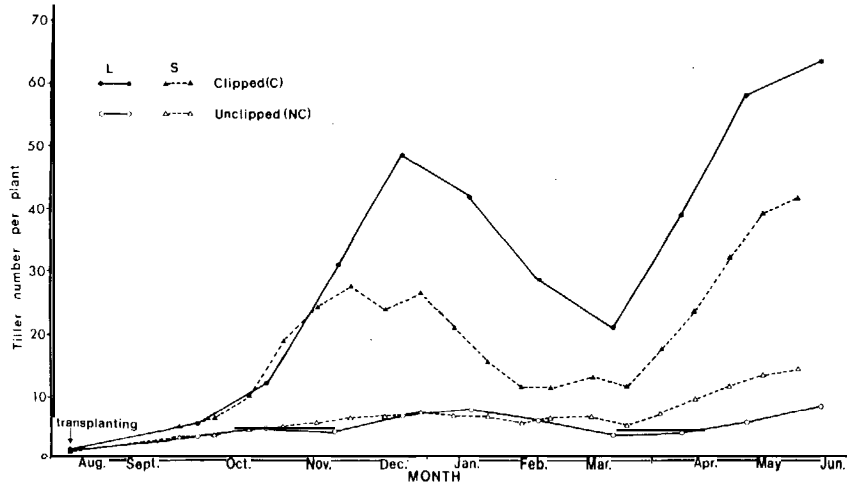

Figure 3: (experiment 3) Tiller numbers for ryegrass plants in clipped (C) and unclipped (NC) areas of plots defoliated at a short(S) or long(L) interval (expressed as main effects). From 21 September until 8 March, significant differences were detected between plants in C and NC, within each grazing interval. Statistical comparisons were not possible from mid March to early June.

TABLE 4: (experiment 3) The mean effects of clipping of surrounding herbage (C,NC) on spring and autumn deaths (%) of ryegrass plants.

	Spring	Early-summer	Late summer[1]				Autumn
			SS	SL	LS	LL	
C	0.5[2]	4	19	7	18	6	10
NC	4	34	36	39	68	36	27
Significance	***	***					***

[1]Clipping x grazing interval interaction significant at $P < 0.35$ level.
[2]Data are percentages derived from ratios of numbers of deaths during the season over the number of survivors at the beginning of the season (random losses due to dung, urine and "pulling" excluded).
***Significant at $P < 0.001$ level.

significant effects confined to late summer and autumn (Table 2). Here, autumn ryegrass survival was worse in paspalum dominant plots when a short grazing interval had been maintained throughout all seasons (treatment SS, Table 2). Earlier results (experiment 2) also confirmed that significantly higher summer losses occur for plants grazed at a short interval (49%) compared to those grazed at a long interval (30%), although there was no interaction with plot type as in experiment 3. In addition, root, shoot and consequently total plant dry weight at the end of experiment 3 (June 1982) for ryegrass plants receiving the SS and LS treatments were substantially less than for those receiving the SL and LL treatments (Table 3).

The clipping of herbage of resident competitors (experiment 3) significantly reduced deaths, (Table 4), and increased tiller production (Fig. 3). For example, by the December measurement, on average the tiller number of the plants in clipped plots exceeded those in unclipped plots by 400%. This trend was also reflected in plant dry weight as at the end of the study plants in clipped plots were 6 times larger than those in unclipped plots (Table 3). Fig. 3 also shows how tiller production of introduced ryegrass plants was restricted with a short grazing interval as opposed to a long grazing interval, especially during summer (December-February).

DISCUSSION

These results emphasise the poor persistence of autumn overdrilled ryegrass and the resultant small, short term improvement in late winter/spring pasture production. The achievement of a large plant size (20-30 tillers/plant) is necessary to improve the chances of summer survival of introduced ryegrass plants.

The use of different coulters and the bandspraying of paraquat did not affect ryegrass survival since these treatments offered little disturbance to the growth of the major resident competitor (paspalum), which occupied 30-40% of the experimental area. Paraquat as applied affected only 27% of the plot area (40 mm bands) with a short lived reduction (about 3 weeks) in the growth of resident pasture (Baker et al. 1979). As paraquat is only weakly translocated by plants it is ineffective on the sub-surface rhizome system of paspalum. Glyphosate is a more effective herbicide for control of perennial volunteer species such as paspalum (Thorn et al. 1985). If applied in autumn (March) while the target plants are still actively growing, the chemical is translocated to all plant organs including subsurface rhizomes, effecting complete kill. However, the high rates (4-6 ℓ /ha) of glyphosate required to kill rhizomatous species, severely reduces resident clover growth for about 12 months making overdrilling of grass and clover mixtures a necessity.

Growth responses of introduced ryegrass plants to the clipping treatment were superior to that obtained in response to nitrogen fertiliser and to irrigation. Since the resident species as well as the introduced ryegrass were able to respond to both nitrogen fertiliser and irrigation, the introduced ryegrass was unable to gain sufficient competitive advantage over the resident species to improve their survival. On the other hand, the clipping treatment substantially reduced the growth of the resident species which allowed the introduced ryegrass to gain a competitive advantage over the resident species, as expressed by a larger size (Fig. 3) and better survival.

Grazing interval is an important determinant of ryegrass performance during summer/autumn (Fig. 3). The ryegrass plants subjected to frequent grazing over summer subsequently suffered most damage and deaths (Table 2). This agrees with the findings of Brougham (1960). Furthermore, the effect of paspalum on ryegrass mortality was greater when the introduced ryegrass plants were also suffering the stress of a short grazing interval (Table 2).

Practical implications

This work suggests that the extent of the loss of introduced ryegrass plants is of considerable practical significance. Lessening the impact of these losses primarily involves devising ways of reducing the competitiveness of the resident species. Two practical alternatives are suggested:

(i) Use of band or blanket applications of broad spectrum herbicides (eg. glyphosate) at or near overdrilling time.

(ii) Modification of post-drilling grazing management.

Pastures to be overdrilled are commonly hard grazed before drilling to reduce competition from resident species. After drilling they are left for about 2 months (as was the case in these experiments, Table 1) before being regrazed, a procedure designed to protect the young seedlings from damage by cow grazing and to reduce the risk of "pulling" that has merely been adopted from accepted management practices for pastures established after cultivation. However, this is not suitable for pasture renovation as the remaining resident species suppresses the growth of the establishing seedlings and reduces their chances of survival. Frequent grazings during the winter/spring following overdrilling (to simulate as much as possible the clipping treatment in experiment 3) would help control the growth of resident species and prevent etiolation and weakening of introduced plants, which would then be in better condition to face additional climatic and managerial stresses of summer (Miller

1973). Avoidance of grazing renovated pastures during wet weather and the use of lighter young stock would reduce trampling and grazing damage to young plants, as would restricting grazing to daytime because of reduced damage from dung deposition.

Frequent, hard grazings of renovated pastures during summer should be avoided. But when feed shortages occur in summer at high stocking rates there is limited opportunity to avoid hard grazing. However, restricting annual pasture renovation to say 10% of the farm area and feeding more supplements would help reduce the effects of overgrazing. Unless such steps are taken, with favourable climatic and soil conditions, volunteer paspalum is likely to increase its occupancy of the pasture.

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