PERSISTENCE OF TEMPERATE PASTURES IN A SUBTROPICAL ENVIRONMENT

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Summary. The persistence of two autumn-sown temperate pastures, containing a perennial ryegrass (*Lolium perenne*) and a biennial ryegrass (*Lolium multiflorum*), was monitored over the first summer via detailed physiological measurements. Pastures were subjected to different winter and spring defoliation, and summer irrigation, managements. By relating defoliation to different plant development stages, the late winter/early spring period following sowing was identified as having the most significant effect on pasture production and composition the following year. Defoliating at the three leaf stage of ryegrass plant growth in this critical time led to enhanced survival of ryegrass plants and tillers, decreased incursion of summer grasses, and increased production of leaves, roots and daughter tillers in the following year, than defoliating more frequently.

INTRODUCTION

In subtropical dairy regions of Australia, temperate perennial pastures (primarily ryegrass/white clover) which provide winter and spring feed, lack persistence and generally need to be re-established or oversown after two years. Loss of pasture plants over the first summer following autumn sowing is a key determinant of pasture persistence, and the decline of the temperate species is associated with an increase in tropical grass species (2). Recent studies (1, 4) have indicated that management, particularly grazing management, has a large influence on persistence of these temperature pastures. Furthermore, glasshouse studies (5) suggest that defoliation at the reproductive phase in ryegrass significantly affects tiller initiation and may ultimately affect persistence.

The present study investigated the effects of winter and spring defoliation management and summer irrigation management on plant survival over the first summer. Defoliation management was related to various plant development stages such as stem elongation (SE) and the 3-leaf stage of the regrowth cycle, to identify the period during which defoliation has the greatest impact on persistence. Two pasture types were examined, a perennial ryegrass (*Lolium perenne*) cv. Yatsyn/white clover (*Trifolium repens*) cv. Haifa pasture and a biennial ryegrass (*Lolium multiflorum*) cv. Noble/Haifa white clover pasture; this paper deals exclusively with the ryegrass components of the 2 pastures.

MATERIALS AND METHODS

The experiment was located on river flats at Casino on the subtropical north coast of NSW (lat. 26 S), and undertaken between March 1994 and June 1995. Plots were laid out in a split plot design, with summer irrigation as the main treatment, and winter/spring defoliation management factorially arranged as sub-treatments, replicated 3 (Yatsyn) or 4 (Noble) times. The experimental site was sprayed with glyphosate to control summer grasses (primarily *Pennisetum clandestinum* and *Paspalum dilatatum*), cultivated to a fine seedbed, and sown on 22 March 1994 with either 20 kg/ha Yatsyn and 5 kg/ha Haifa, or 7 kg/ha Noble and 6 kg/ha Haifa. At sowing, 250 kg/ha molybdenum superphosphate and 100 kg/ha muriate of potash were applied, with 80 kg urea/ha 2 weeks later. This fertiliser application was repeated in April 1995. Fertiliser was applied in September at rates calculated to replace nutrients normally returned through grazing. Prior to November 30, all plots were irrigated weekly to replace evapo-transpiration.

Treatments details were as follows:

Summer irrigation (November 30 to April 6): nil **or** replace evapo-transpiration losses at 7 to 10 day intervals.

Defoliation interval: (i) Yatsyn; from June 1994 to 2 cycles of 3 leaf regrowth prior to estimated time of SE (early September), plots were defoliated at the 3 **or** 1 leaf/tiller stages of regrowth; from there until SE (mid-November) for both of the previous treatments, plots were defoliated at the 3 **or** 1 leaf stages; from SE until 2 cycles after SE (early February) each previous treatment was defoliated at the 3 **or** 1 leaf stages, **or** not defoliated. During summer, all plots were defoliated at the 3 leaf stage.

(ii) Noble; from June 1994 to SE (mid-October), plots were defoliated at the 3 **or** 1 leaf/tiller stages of regrowth; from SE to 2 cycles after SE (late December), plots either continued to be defoliated as before, **or** were not defoliated.

At harvest, forage was cut to a stubble height of 50 mm and a sub-sample taken and dried to determine dry matter (DM). Before each 3 leaf harvest, two 0.1x0.3 m forage samples were cut at random from every plot to harvest height, and separated into ryegrass, clover, summer grasses and weeds. Plant density was determined from the number of independent plants per 0.09 m2 quadrat, placed at random in 2 locations per plot, and the number and DM of tillers per plant was determined from 2 randomly selected plants within each plot. Two 0.1x0.15 m forage samples, cut at random from each plot to ground level, provided tiller density measures, and were examined to establish the onset and extent of SE.

Approximately 15 individual ryegrass tillers were marked from plants along an identifiable transect within one plot from each major treatment. At each monitoring event, tillers were classed as being either vegetative, reproductive, or dead, and the production and survival of daughter tillers was also noted. Root DM was determined from one 80 mm (diameter) x 200 mm soil core randomly taken from one plot in each major treatment and cut into 50 mm vertical sections. Roots were separated from the soil using a Hydroelute Manifold root-soil separation system (6). Statistical analysis was undertaken via an analysis of variance, using a general linear model package in Minitab.

RESULTS

Reproductive development in Noble was earlier (SE began late September v. late October) and more extensive (100% v. <10% of tillers becoming reproductive) than in Yatsyn, with the result that most Noble plants had set seed and died by late December 1994.

Pasture production and composition

DM production from May to December 1994 of Noble ryegrass was 18% greater than for Yatsyn. Winter defoliation interval had the most significant effect on DM yield to December 1994 for both pasture types, with Yatsyn pastures defoliated at the 3 leaf stage producing 36% more DM (5888 v. 4324 kg DM/ha, P<0.001) and Noble pastures 47% more DM (7186 v. 4896 kg DM/ha, P<0.001), than pastures cut at the 1 leaf stage. Although spring defoliation interval showed the same trends, it was not as great.

The summer grass content of both pasture types was lessened by more frequent winter defoliation (P<0.001), and then increased greatly by more frequent spring defoliation (P<0.001), so that by December 1994, pastures subjected to more frequent defoliation had double the summer grass production of pastures more laxly defoliated. Ceasing defoliation after SE caused a 35% reduction in Yatsyn ryegrass DM production over summer (P<0.001), and a 41% reduction (P<0.001) in autumn/winter 1995.

Yield of Yatsyn ryegrass in autumn/winter 1995 was significantly affected by defoliation intervals the previous year, particularly during spring where pastures cut every 1 leaf/tiller had less ryegrass (P<0.020) and more summer grasses (P<0.030) in the second year than pastures cut every 3 leaves/tiller (Table 1). Winter and spring defoliation in 1994 also had a marked effect on the 1995 Noble pasture, with those plots cut at the 3 leaf stage then allowed to set seed, containing the most ryegrass, and the least summer grass, compared with plots treated differently. All values were significantly different at P<0.001.

Table 1. The effect of winter/spring defoliation intervals in 1994 on autumn/winter production (kg DM/ha)

of Yatsyn and Noble pastures in 1995.

Defoliation interval winter/spring*	Ryegrass (kg DM/ha)		Summer grass (kg DM/ha)	
	Yatsyn	Noble	Yatsyn	Noble
3/3	405	245	563	1159
3/1	293	-	714	-
3/0	-	937	-	939
1/3	330	-	731	-
1/1	236	0	747	1376
1/0	-	316	-	1879

*3=defoliated every 3 leaves/tiller, 1=defoliated every 1 leaf/tiller, 0=no further defoliation

In the second year, Yatsyn pastures which had received summer irrigation produced 17% more ryegrass (P=0.010) and 7% less summer grass (P>0.05), while Noble pastures produced 5 times more ryegrass (P<0.001), and 16% less summer grass (P<0.001), than pastures which were not irrigated over the summer.

Plant density

At SE, ryegrass and summer grass plant densities in both pasture types were not significantly affected (P>0.05) by defoliation interval. However, in autumn 1995, Yatsyn plots defoliated at the 3 leaf stage over the previous winter had more ryegrass (77 v. 56 plants/m2, P=0.002) and less summer grass (46 v. 60 plants/m2, P=0.012), than plots cut more frequently. Noble plots defoliated at the 3 leaf stage over winter/spring 1994 had significantly more ryegrass plants in the following autumn (35 v. 15 plants/m2, P=0.020) and slightly less summer grass (78 v. 81 plants/m2, P>0.05), than plots cut more frequently.

Ceasing defoliation after SE caused a 38% reduction (P<0.001) in Yatsyn plant density, and a six-fold increase (P<0.001) in Noble plant density the following autumn, but had no significant effect (P>0.05) on summer grass plant density in either pasture type. Summer irrigation had no significant effect (P>0.05) on autumn plant densities in Yatsyn plots, but significantly increased the number of Noble ryegrass plants (39 plants/m2 v. 10 plants/m2, P=0.030).

Root DM

In autumn 1995, Yatsyn plants defoliated at the 3 leaf stage in the previous spring had 82% more roots at 5 cm soil depth (P=0.060), 76% more at 10 cm (P=0.070), 54% more at 15 cm (P>0.05) and 112% more at 20 cm (P=0.008), than plants defoliated more frequently, despite similar root mass at SE. The average root mass of Noble plants in November was approximately double that of Yatsyn plants at all depths. Summer irrigation had no significant effect (P>0.05) on root mass of either pasture type.

Tiller density and DM

After summer, Yatsyn tiller density was 51% greater (2194 v. 1450 tillers/m2, P=0.003) in pastures defoliated less frequently the previous winter. Tiller size in autumn 1995 was not significantly influenced (P>0.05) by pre-SE defoliation, but there was a 23% reduction in tiller DM (P=0.003) in pastures which were not defoliated after SE. Noble tiller densities declined between SE and the end of the season, by

38% in plots cut every 3 leaves/tiller and by 72% in plots cut at every 1 leaf stage. In plots not defoliated after SE, this decline was less (19% decline in plots cut every 3 leaves then uncut, 37% decline in plots cut every 1 leaf then uncut). Noble tiller DM was significantly greater in less frequently defoliated plots at SE (83.0 v. 61.4 mg/tiller, P=0.003), and this trend was repeated in December, although DM values had approximately halved since SE. Again, not cutting plots after SE provided some respite, with tiller sizes declining at a lesser rate than in plots which continued to be defoliated.

Tiller initiation and survival

A low initiation rate and high death rate of Yatsyn daughter tillers over the summer caused a reduction in the net number of daughter tillers in this period. Under more favourable climatic conditions tiller initiation increased, and deaths decreased, causing the net number of daughter tillers/plant to increase in April/May 1995. Winter and spring defoliation management had the greatest effect on Yatsyn daughter tiller initiation and survival from November 1994 to June 1995, with plots defoliated at the 3 leaf stage producing more than twice as many daughter tillers as plants defoliated at the 1 leaf stage. Summer irrigation had no effect on Yatsyn daughter tiller initiation or survival, but waterlogging due to heavy summer rainfall increased daughter tiller deaths over late summer in plots which had been receiving irrigation.

DISCUSSION

This trial identified pasture management during the late winter/early spring period of 1994 as having the most significant effect on plant survival through summer and into autumn 1995, and confirmed the importance of summer irrigation and a grazing interval coinciding with the 3 leaf stage of ryegrass plant growth, on increased survival of temperate pastures over the summer (1, 4). Defoliating at a time best suited to the plant (the 3 leaf stage of growth) led to a greater production the following year of both leaf and root DM, greater survival of both individual ryegrass plants and tillers, less incursion of summer grasses and greater initiation of daughter tillers, than defoliating more frequently.

Despite being sown at one third the rate of Yatsyn, Noble ryegrass was one fifth more productive under optimal management, but less able than Yatsyn to produce under frequent defoliation. The greater responsiveness, in all measurements, of Noble compared to Yatsyn confirmed previous research on individual plants in a controlled environment (3), which found that biennial ryegrasses are more sensitive to harsh management than perennial ryegrasses.

ACKNOWLEDGMENTS

The authors sincerely thank Sam and Fleur Tonge, on whose property the study was conducted, and the Dairy Research and Development Corporation, for financial support.

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