

## Effects of Concord ryegrass and nitrogen fertiliser on feed production on a seasonal dairy farm

E.R. THOM and R.A. PRESTIDGE  
Ruakura Agricultural Centre, MAF Technology, Private Bag, Hamilton

### Abstract

The seasonal production of autumn-sown Concord Italian ryegrass was compared with that of an existing perennial ryegrass pasture. Concord (10 kg/ha) was direct-drilled into large plots previously sprayed with glyphosate or was undersown into the existing pasture. Nitrogen fertiliser (25 kg N/ha) was applied to half the area of each plot on 3 occasions during June and July. The major objective of the experiment was to examine the effects on pasture production in late winter-early spring (early lactation) when cows are often underfed. During late winter-early spring, direct-drilled and undersown plots accumulated 44 and 20% more dry matter (DM), respectively, than did the existing pasture (2.5 t DM/ha). Addition of N increased overall accumulation during early lactation by 18%. The direct influence of Concord on pasture accumulation was restricted to winter/spring, as was the pasture response to N. Argentine stem- weevil populations were low and were not affected by winter applications of N. This work suggests Italian ryegrasses, like Concord, can be used to boost feed production during early lactation on dairy farms, and that winter N applications can be used to enhance their contributions. Further farmlet work is required to determine the milk production responses possible from the use of Italian ryegrasses.

**Keywords** *Lolium multiflorum*, Italian ryegrass, direct drilling, seasonal herbage accumulation, early lactation period, pasture botanical composition, tiller density, major element composition, Argentine stem weevil populations

### Introduction

Underfeeding cows in early lactation limits production of milk solids at the stocking rates necessary in intensive dairying (Bryant & Trigg 1982; Thomson *et al.* 1984).

Italian (*Lolium multiflorum*) and hybrid (*L. multiflorum* x *L. perenne*) ryegrasses like Concord, 'Grasslands Moata', Corvette and 'Grasslands Manawa' can produce more dry matter (DM) during winter-spring than perennial ryegrasses like Ellett and 'Grasslands SuperNui' (Lancashire 1982; Percival *et al.* 1989; P.J. L'Huillier pers. comm.) Mixtures of Ellett and Concord have also been shown to produce more DM in winter-spring than did Ellett sown alone (Edgecombe 1988; Thorn & Prestidge 1988).

O'Connor *et al.* (1989) concluded that nitrogen fertiliser (N) could be profitably applied in June-July to increase feed production in early lactation. The work they summarised was with pastures based on perennial ryegrass, and no data are available describing similar N responses for pastures where Italian ryegrasses have been undersown into existing pasture or direct-drilled after herbicide application.

This paper reports on a current experiment aimed at measuring the impact of autumn-drilled Italian ryegrass and winter-applied N on feed production in early lactation (July to September). This experiment is the first in a series of three culminating in a farmlet evaluation when-milk production-responses will also be measured.

### Materials and methods

#### Site

The experiment was conducted at the Ruakura Agricultural Centre on 6 adjacent 0.25 ha paddocks. Soils were mainly silt or clay loams with some areas of peaty loam. Their fertiliser history was maintenance dressing of P, K and S each autumn. In autumn 1989 the existing pasture was predominantly perennial ryegrass (34%) and white clover (30%) with some paspalum (4%), prairie grass (3%), weeds (13%), *Poa* spp. (2%) and dead material (14% of DM).

#### Experimental design and treatments

A split-plot experimental design was used with 3 main plot treatments located at random within 6 block replicates. Main plots (each 8 x 50 m) were: (i) existing pasture (control, EP); (ii) existing pasture undersown with 10 kg/ha of Concord ryegrass (US); (iii) Concord direct-drilled (10 kg/ha) after spraying existing pasture with 1.5 l/ha of glyphosate (DD).

Subplots (8 x 25 m) received 25 kg N/ha on 1 June, 30 June and 28 July 1989. **Glyphosate** was applied on 11 April 1989 and Concord ryegrass was drilled into treatments (ii) and (iii) on 14 April 1989. All plots were grazed on 1 April 1989 to a residual of about 900 kg DM/ha.

#### Grazing management

The plots were rotationally grazed by dairy cows, the first being 80 days from drilling (3 July 1989). The second grazing was on 24 August 1989 and then plots were grazed at 3- to 6-week intervals until autumn 1990.

#### Weed control

DD plots were sprayed with MCPB (6 l/ha) on 6 June 1989 for flatweed control. Other plots were sprayed with a mixture of MCPA (1 l/ha) and MCPB (2.5 l/ha) on 20 July 1989.

### Measurements

#### Plant and tiller density

Concord plant numbers were counted on 31 May 1989 in 10 quadrats (each 0.01 m<sup>2</sup>) per subplot; later, tillers of Concord ryegrass, perennial ryegrass, *Poa* spp., paspalum and summer grass were counted at 2-monthly intervals in 5 randomly located quadrats per subplot.

#### Botanical composition

**Herbage** in each subplot was sampled by ground level clipping and was dissected into Concord ryegrass, perennial ryegrass, *Poa* spp., paspalum, summer grass, prairie grass, white clover, weeds and dead material of all species, before drying at 100 °C for 36 hours and weighing. Sampling was bi-monthly from 28 March 1989.

#### Herbage mass

Before and after grazing, **herbage** mass on each subplot was estimated with a capacitance probe. Twenty probe readings were made per subplot and seasonal calibration equations were used to calculate **herbage** mass as described by L'Huillier & Thomson (1988).

#### Chemical composition

Pasture **herbage** from each subplot was sampled monthly for chemical analyses from 6 June 1989 until October 1989, and thereafter bi-monthly. From June until October 1989, Concord **herbage** was also separated and analysed for N, P, K, Mg, S, Ca and Na contents by standard procedures (Thorn *et al.* 1989).

#### Argentine stem weevil populations

Egg and larval populations were estimated at 8- to 32-day intervals from July 1989 to April 1990. **Ryegrass** tillers were cut to ground level from 5-10 random areas within each subplot. Eggs were counted, and larvae heat extracted, from 200 **ryegrass** tillers randomly selected from the bulked samples.

#### Data analysis

Analysis of variance models were used to test for treatment differences at each measurement date. As tiller density data covered a wide range and included some zero values, a log (x + 1) transformation was used to equalise the variances. A square root transformation was used for all insect count data. However, for ease of interpretation of tiller density and insect count data, arithmetic means are presented.

### Results

#### Climate

Long dry periods occurred; rainfall in late summer/autumn 1989 was only 60% of the long term average (264 mm). Comparable data for late winter-early spring (July, August, September) and summer 1989/1990 were 80 and 55% of the respective long-term average rainfalls of 331 and 241 mm. June, July and August were also colder than normal with the number of ground frosts (less than -1 °C) 57% above the long-term average of 28. July had 21 ground frosts (long-term average 10.8).

#### Seasonal herbage accumulation

**Herbage** accumulation from sowing until the first grazing in early July (autumn/early winter) was greatest on US plots and least on DD plots (Table 1). This effect was reversed during late winter-early spring as **herbage** accumulation on DD and US plots exceeded those on EP by 1100 and 500 kg DM/ha, respectively. This trend was not maintained over spring as more **herbage** accumulated on US and EP than on DD plots (Table 1), but during summer and autumn differences between treatments disappeared.

N fertiliser increased **herbage** accumulation by 200 and 500 kg DM/ha in autumn/early winter and late winter-early spring, respectively, after which the effect disappeared (Table 1).

There were no significant interactions between N and main treatments.

#### Plant and tiller counts

Establishment counts in May 1989 showed 44% more Concord plants in DD plots than in US plots (956 vs 664 plants/m<sup>2</sup>, SED = 31). Concord tiller densities were also greatest on the DD plots until February, 1990 when levels had declined to about 100 tillers/m<sup>2</sup> (Table 2). N did not affect Concord tiller density nor were there any significant treatment interactions.

Perennial **ryegrass** tiller densities were highest in the existing pasture from October until December (3600 tillers/m<sup>2</sup>) and were lowest in the previously sprayed (DD) treatment (900 tillers/m<sup>2</sup>). Undersown pastures had intermediate levels (2200 tillers/m<sup>2</sup>). *Poa* spp. tiller densities were always highest in the DD plots but this effect was significant only in October 1989 (1545 vs approx 900 tillers/m<sup>2</sup> for US and EP treatments). By February 1990 *Poa* spp. had disappeared from all plots.

**Table 1** Effects of Concord ryegrass and N fertiliser on seasonal herbage accumulation (t DM/ha).

Season	DD	US	EP	SED	Treatments <sup>1</sup>				
					Sig.	N	No N	SED	Sig.
Autumn-early Winter (12.4.89-3.7.89)	1.7	2.6	2.4	0.08	***	2.3	2.1	0.05	**
Late winter-early Spring (4.7.89-29.9.89)	3.6	3.0	2.5	0.13	***	3.3	2.8	0.07	***
Late spring (2.10.89-18.12.89)	4.1	4.6	4.7	0.15	**	4.5	4.5	0.10	NS
Summer (21.12.89-5.3.90)	2.2	2.2	2.2	0.29	NS	2.3	2.1	0.26	NS
Autumn (11.3.90-11.4.90)	1.2	1.3	1.4	0.11	NS	1.3	1.3	0.06	NS
Totals (12.4.89-11.4.90)	12.8	13.7	13.2	0.49	NS	13.7	12.8	0.30	**

<sup>1</sup> DD — Concord ryegrass direct-drilled; US — Concord ryegrass undersown; EP — existing pasture,

**Botanical composition**

The highest Concord contents of the DD and US plots coincided with the highest Concord tiller densities in August 1989 (Table 2). Concord content was greater in DD than US plots from May until October 1989. It declined during late spring, reaching 1-3% of DM by summer-autumn, and treatment differences disappeared.

Glyphosate herbicide reduced the perennial ryegrass content of the DD plots to less than 1% by May 1989, compared with 30% of DM in other plots. However, by November 1989 the perennial ryegrass content of DD plots had increased to 12% of DM and to 17% by April 1990. The perennial ryegrass content of EP was highest in August 1989 (59% of DM). EP always contained more perennial ryegrass than did US pastures, but the differences were not significant during summer and autumn when perennial ryegrass contents ranged from 1530% of DM.

*Poa* spp. content of all plots during winter-early spring was less than 8% of DM and no treatment differences were detected. From September until November, however, *Poa* spp. represented about 16% of DM in DD pastures-compared with only 8% in other plots. *Poa* spp. disappeared over summer-autumn.

Treatments did not affect the weed content of the plots except in April 1990 when there were more

weeds in plots where Concord had been introduced, and significantly more in DD than in EP plots (16 vs 9% of DM, SED = 2).

Glyphosate reduced the white clover content of DD plots. For example, in May 1989, the white clover content of DD plots was 14% of DM compared with about 30% for other plots. This trend continued throughout August-September when there was also less clover in plots receiving N than in those that did not (21 vs 27% of DM, SED = 3). By February 1990, there were no differences in the clover contents of all plots and the effect of N had disappeared.

By May 1989, dead material in DD pastures was 3 times higher than in other pastures (33 vs 12% of DM, SED = 5), but this difference had disappeared by August as dead material levels fell to about 4%. Dead material content increased again over summer and by mid February was higher in existing pasture than in plots drilled with Concord (45 vs 35% of DM, SED = 4).

Over summer-autumn, the summer grass content was higher in DD (19% of DM) and US (14%) plots, but differences were not significant.

**Chemical composition**

There were few significant treatment effects on the major element composition of pasture and Concord herbage, with the exception of N.

**Table 2** Concord tiller density (tillers/m<sup>2</sup>) and Concord content (% of DM) in DD and US pastures.

Date	Concord tiller density				Concord content			
	DD	US	SED <sup>1</sup>	Sig.	DD	US	SED <sup>1</sup>	Sig.
31.5.89					41	9	4	***
2.8.89	2250	980	472	*	66	35	5	**
15.8.89					46	22	3	***
27.9.89								
18.10.89	1450	1110	313	NS				
16.11.89					33	24	6	NS
6.12.89	900	510	132	*				
14.2.90					2	3	1	NS
19.2.90	100	160	60	NS				
11.4.90					1	1	—	NS

<sup>1</sup> Approximate standard error of treatment differences

**Table 3** Egg and larval Argentine stem weevil populations on direct-drilled Concord (DD), undersown Concord (US) and existing pasture (EP).

Date	Eggs/200 tillers <sup>1</sup>					Larvae/200 tillers <sup>1</sup>					
	DD	US	E	P	SED <sup>2</sup>	Sig.	DD	US	EP	SED <sup>2</sup>	Sig.
21.7.89	0.17	0.17	0	0.20		N S	0	0	0	—	N S
11.8.89	1.00	5.58	1.58	3.20		N S	0.08	0	0	0.06	N S
1.9.89	1.16	2.00	0.09	0.81		NS	0.76	0.25	0	0.32	NS
28.9.89	8.00	6.76	2.16	1.08		***	1.90	2.32	1.00	0.82	NS
19.10.89	4.08	3.58	1.42	0.96		*	3.50	2.16	1.08	0.78	*
4.12.89	17.84	3.42	0.26	2.74		***	2.34	1.66	0.50	0.84	NS
21.12.89	45.84	20.58	9.50	9.44		***	15.34	3.34	1.16	4.02	***
15.1.90	24.84	18.34	2.34	4.84		***	11.58	4.42	2.66	1.02	***
21.2.90	0.76	1.00	0	0.62		NS	3.76	1.76	1.92	1.26	NS
21.3.90	0	0	0	—		NS	0.34	0.16	0.08	0.20	NS

<sup>1</sup> Concord and other ryegrass tillers not differentiated

<sup>2</sup> Approximate standard error of treatment differences

The N concentrations in pasture **herbage** in early June 1989 were similar for all treatments (about 4.2% of DM). However, from late June until mid August pasture **herbage** from DD plots contained more N than that from other plots (4.6 vs 4.3% of DM). Concord **herbage** from DD plots also contained more N than that from US plots (4.5 vs 4.1% DM) over the same period. Treatment differences disappeared over spring, summer and autumn as the N concentration in pasture **herbage** declined to 2.5% of DM by March 1990. Pasture and Concord **herbage** from plots receiving N fertiliser contained a higher N concentration (4.3 and 4.0% of DM) than **herbage** from untreated plots (4.1 and 3.7% of DM) from early June until September, after which the effect disappeared.

#### Argentine stem weevil populations

Populations increased during spring and peaked in early summer (Table 3). The time of peak populations coincided with a rapid reduction of Concord (Table 2) and *Poa* spp. tillers from the sward. Populations were largest on the DD treatment and smallest on the EP treatment. N fertiliser had no effect.

## Discussion

The autumn introduction of the Italian ryegrass, Concord, increased feed production from ryegrass-based pastures during early lactation (July to September). The increase achieved by direct drilling was about 200 kg DM/ha lower than that measured by P.J. L'Huillier (pers comm.) in 1987 at a similar location, but was within the range of 1000-1500 kg DM/ha reported by Lancashire (1982).

There are no published data for comparisons of seasonal growth from established perennial ryegrass-based pastures and those that have been undersown with Italian ryegrass, although this is now common farmer practice. However, Edgcombe (1988) estimated a yield advantage during early lactation of about 800 kg DM/ha for an autumn-sown Ellett-Concord ryegrass mixture over Ellett perennial ryegrass sown alone. Although Edgcombe's

observations were made on newly established pastures, our estimate for an established perennial ryegrass pasture undersown with Concord ryegrass was similar (Table 2), but was only 45% of that achieved in the DD plots. This reflects the advantage of reducing competition before drilling new pasture species, and suggests short-term ryegrasses should be used as special purpose pastures to realise their growth potential.

N fertiliser responses were limited to winter-early spring. This confirms the finding of Feyter et al. (1985) that yield responses to winter (June, July) applications of N are concentrated into the early lactation period, when they can be of maximum benefit to production of milk solids on intensive dairy farms (Bryant & Trigg 1982). The treatment responses to N during late winter-early spring of an extra 490 (6.5 kg DM/kg N), 650 (8.7 kg DM/kg N) and 325 kg DM/ha (4.3 kg DM/kg N) for DD, US and EP pastures, respectively, are similar to those reported by O'Connor et al. (1989).

The autumn-early winter growth of pastures undersown with Concord and those direct-drilled after glyphosate application differed markedly, despite a higher Concord plant population, and as a consequence higher Concord tiller density (Table 2) in DD than in US plots. The abnormally dry autumn followed by a cold winter probably restricted the growth of Concord. This, combined with almost complete removal of resident grasses and a 50% reduction in white clover content after spraying, meant a slower than normal replacement of the DM lost in the DD plots. The June N concentrations in pasture **herbage** from all treatments were similar to published levels (Metson & Saunders 1978), so lack of available N per se probably did not restrict Concord growth in the DD plots. All plots were not grazed until 80 days from drilling, whereas in a moist autumn renewed or renovated pastures can be grazed about 40 days after drilling (Thorn et al. 1987).

Concord's promotion of feed production was limited to winter-early spring, since by February 1990 it had almost disappeared from the pasture. **Herbage** accumulation during summer and autumn on DD

and US plots did not decline below that on EP plots (Table 1) even though Concord content declined to very low levels (Table 2). The loss of Concord in these plots was replaced largely by an increase in the content of annual summer grass and weeds (dandelion, yarrow), and in the DD plots with a slow increase in the perennial ryegrass content to about 17% of DM by April 1990. The increased perennial ryegrass content was due to recovery of some resident plants after spraying with a low rate of glyphosate to reduce competition, and probably some germination of volunteer seed.

Concord (and other Italian ryegrasses) is susceptible to Argentine stem weevil and supports large population even though it contains an endophytic fungus (Prestidge unpubl. data). Argentine stem weevil populations on the present trial were low when compared to populations on endophyte-free perennial ryegrass, Italian and hybrid ryegrasses (Barker *et al.* 1981; 1984). The low insect population and replacement of Concord by other pasture species during summer-autumn did not precipitate a yield decline as has been previously reported (Thorn & Prestidge 1988). In the resident pasture where endophyte infection levels were high, populations of Argentine stem weevil were lowest and were most likely existing on weed grasses like *Poa annua* which are very favourable hosts (Barker *et al.* 1984).

N fertiliser had no apparent effect on Argentine stem weevil populations probably because it was applied in winter. Spring applications of N can increase adult Argentine stem weevil populations and consequent plant damage (Hunt *et al.* 1988). Winter temperatures and fungal pathogens in the Waikato region are likely to limit the-effect-of-winter applied nitrogen on Argentine stem weevil populations.

## Conclusions

1. Concord ryegrass improved feed production during early lactation (July to September) by 500-1100 kg DM/ha. Introducing Concord the previous autumn, did not affect summer-autumn yields.
2. Winter-applied N fertiliser increased pasture growth by 500 kg DM/ha during early lactation. The response from perennial ryegrass pastures to N fertiliser was similar to those where Concord had been introduced. N had no effect on Argentine stem weevil populations.
3. Farmlet studies are required to determine the impact of improved feed supply in early lactation on production of milk solids.

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