Nitrogen Response Efficiencies from Grazed Dairy Pastures under Dry Conditions

Frank R. McKenzie
Department of Natural Resources and Environment, Australia

J. L. Jacobs
Department of Natural Resources and Environment, Australia

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F.R. McKenzie and J.L. Jacobs

Department of Natural Resources and Environment, 78 Henna Street, Warrnambool, Vic 3280, Australia Email: frank.mackenzie@nre.vic.gov.au

Abstract

Experiments were conducted within a long-term nitrogen (N) fertiliser experiment under grazing. The objective was to examine N response efficiencies (kg dry matter (DM)/kg N) and herbage crude protein (CP) content to fertiliser N applied under dry soil conditions (gravimetric soil moisture content of 17% at 10cm; soil field capacity = 38% and wilting point = 11%) during autumn (April 1999) and late spring (November 1999) in southeastern Australia. Visually, N treated plots were greener in colour than control (no N) plots. No differences were recorded in primary or residual DM yields, N response efficiencies, and pasture growth rates between N fertilised plots and control plots for both autumn and late spring applications. Fertiliser N, however, had increased herbage CP content six weeks after application in autumn, but had no effect on primary (autumn and late spring applications) or residual CP content in late spring. It was concluded that N fertiliser applications under dry soil conditions are economically and environmently questionable.

Keywords: Perennial ryegrass, urea, soil moisture, dry matter yield, crude protein

Introduction

Increased stocking rates on dairy farms in southeastern Australia and tighter calving patterns have increased demand for additional feed from pasture. Nitrogen (N) fertiliser can increase dry matter (DM) yields from pasture to help meet the needs for additional feed. It has become common practise to use N fertiliser with the onset of autumn rain (usually in April) through to late spring (November) on many dairy farms in southeastern Australia. However, it is at these times (autumn and late spring) that available soil moisture may limit the economic response to N fertiliser, and thereby increase the risk of N loss to the environment. This study aimed to establish the pasture DM yield response (kg DM/ha), N response efficiency (kg DM/kgN), pasture growth rate (kg DM/ha/day) and herbage crude protein (CP) content to N applied as urea, during autumn and late spring under dry soil conditions.

Materials and methods

This study was conducted on a dairy farm with an annual precipitation of 790mm near Terang (38^{o}14'S, 142^{o}55'E) in southwest Victoria, Australia. The soil was a poorly drained sandy clay loam with a field capacity of 38% and wilting point of 11% (top 10cm), soil pH_{water} 5.4, and nutrients phosphorus, potassium and sulphur non-limiting. The pasture was dominated by perennial ryegrass (75%) and white clover (15%). Urea (46% N) at 0 and 50 kg N/ha was applied to grazed plots (30m x 30m) with a residual pasture mass of 1400 kg DM/ha on 8 April 1999 (autumn application) and again at 0 and 30 kg N/ha on 5 November 1999 (late spring application). Plots were replicated three times. For the autumn N application, gravimetric soil moisture content at 10cm was 17%, and ranged from 12 to 25% over the following six weeks. In late spring, gravimetric soil moisture content at 10cm was also 17%, but ranged from 12 to 36% over the following eight weeks. Primary and residual DM yield responses were taken three and six weeks (autumn application), and four and eight weeks (late spring application) after applying urea. At each harvest a 1.1m by 20m strip was cut from respective plots using a sickle bar mower and weighed. A sub-sample was taken to determine the DM of the pasture and for herbage CP analysis (Near Infrared Spectroscopy calibrated using the methods of Shenk and Westerhaus 1991). Residual DM yield estimates were taken from the same areas as the primary yield estimates after having animals restricted from grazing these areas to avoid the confounding effects of nutrient returns. Statistical analyses were undertaken using ‘paired t-tests’.

Results

Visually, N treated plots were greener in colour than control (no N) plots. There were however, no differences ($P \geq 0.05$) in primary or residual DM yields, N response efficiencies, and pasture growth rates between treatments for both autumn and late spring applications (Table 1). Fertiliser N, however, significantly ($P<0.05$) increased residual herbage CP content six weeks after application in autumn, but had no effect on primary CP content in autumn, or primary and residual CP content in late spring (Table 1).

Discussion

There are many ways of expressing efficiency (both economic and environmental) of N use, the most common being the apparent recovery of applied N and its conversion to DM yield. In this study, N treated plots were visually greener in colour than control plots, indicating an apparent uptake of N. This ‘greening-up’ effect is one of the most common pasture responses to applied N (Whitehead 1995), but as the results of the present study indicate, may be misleading. While residual herbage CP levels were boosted with the autumn N application (indicating plant uptake of N), there was no DM yield advantage to applying N fertiliser. The data also indicate that for the late spring N application, there was no measurable uptake of fertiliser N. These applications can therefore be questioned economically. Furthermore it is likely that fertiliser N applications under dry soil conditions would contribute to higher N losses to the environment than if soil moisture conditions for pasture growth were more favourable (Whitehead 1995).

The effect of soil moisture on the N responsiveness of pasture, apart from the dissolving or leaching influence on N fertiliser, is largely through the indirect effect of soil moisture on pasture growth potential (Eckard 1998). If soil moisture limits pasture growth, then N responsiveness is likewise affected (Whitehead 1995). More efficient uptake of N fertiliser has been measured in this environment when actively growing pastures (with higher soil moisture content) have been targeted for applications of N fertiliser (McKenzie *et al*. 1998; 1999).

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Table 1. Primary and residual dry matter yields (kg DM/ha), nitrogen response efficiencies (kg DM/kgN), pasture growth rates (kg DM/ha/day) and crude protein (%DM) for nitrogen fertiliser applied under dry soil conditions during autumn and late spring

	Autumn							
	Primary response				Residual response			
Treatment (kg N/ha)	DM yield (kg DM/ha)	N response (kgDM/ kgN)	Growth rate (kgDM/ha /day)	CP (%DM)	DM yield (kg DM/ha)	N response (kgDM/ kgN)	Growth rate (kgDM/ha /day)	CP (%DM)
0	181	0.0	8.6	17.3	260	0.0	6.2	17.5
50	233	1.0	11.1	18.3	360	2.0	8.6	21.2
Difference	NS	NS	NS	NS	NS	NS	NS	*
	Late spring							
0	1342	0.0	38.3	12.7	241	0.0	6.7	14.1
30	1333	-0.3	38.1	11.3	208	-1.1	5.8	14.7
Difference	NS	NS	NS	NS	NS	NS	NS	NS

NS = non significant ($P \geq 0.05$); * = significant ($P<0.05$)