Effect of nitrogen fertiliser applications on botanical composition

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Introduction

The diminishing returns associated with nitrogen (N) fertiliser use over time are well recognised, as are the detrimental effect to the environment of excess N fertiliser use (Eckard 1998). However, many Tasmanian dairy farmers apply continually high rates of N fertiliser (*e.g.* in excess of 500 kg/ha annually) to minimise risk associated with variable pasture dry matter (DM) yields, and this often occurs at the expense of white clover populations within the pasture (Frame 1990; Frame *et al.* 1998). The responses of botanical composition and perennial ryegrass DM yields to N fertiliser application rate were investigated in the current field plot study, to provide further information for farmers about the production-related effects of their N use.

Methods

The experiment was conducted between March 2010 and March 2012 at the Tasmanian Dairy Research Facility in north west Tasmania (41.08 S, 145.77 E, elevation 155 m). One hundred and sixty two 2 m x 3 m plots were sown with perennial ryegrass cv. Arrow (25 kg/ha). The plots were arranged in a randomised split plot design with four treatment factors (rain-fed and irrigated, 3 defoliation intervals, 3 defoliation heights and 3 N application rates). The N treatments of 0, 1.5 and 3.0 kg N/ha/day in this defoliation study (applied following every defoliation event), represented on-farm annual N application rates of 0, 250 kg N/ha and 500 kg N/ha (taking into account lack of recycling of N in defoliation study), and are the treatment focus of this paper. Herbage DM yield was measured at each defoliation event, with data then divided into four equal measurement periods and converted into daily growth rate values (kg DM/day). The four growth rate periods were as follows: April to September 2010 (Period 1), October 2010 to March 2011 (Period 2), April to September 2011 (Period 3), and October 2011 to March 2012 (Period 4). Botanical composition was visually assessed as the proportion of perennial ryegrass, white clover, broad-leaved weeds and other grasses present at four assessment dates (October 2010, February 2011, December 2011, and April 2012).

Table 1. Mean growth rate (kg DM/day) in response to nitrogen (N) applications of 0, 1.5 and 3.0 kg/ha/day, across the irrigation and defoliation treatments, over four periods of the study

Study period	Nitrogen applications (kg N/ha.day)			LSD (P<0.05)
	0	1.5	3	
Period 1	25.9	39.6	44.4	1.1
Period 2	48.3	59.2	63.6	2
Period 3	25.1	33	33.8	1.2
Period 4	53.4	57.1	55.9	1

Results and Discussion

During Period 1, increasing N fertiliser application from 0 to 1.5 kg N/ha/day resulted in a 35% increase in growth rate, and further increasing N fertiliser application to 3.0 kg N/ha/day resulted in a further 10% (Table 1). The growth rate advantage of applying N fertiliser above 1.5 kg N/ha decreased in the second year, with no effect in Period 3 and a detrimental effect of additional N in Period 4. During Period 4 there was only a 7% increase in growth rate between the 0 and 1.5 kg N/ha treatments.

The growth rate data infer that there were initially low levels of available soil N, which increased as a result of high N fertiliser applications. The growth rate response to high N fertiliser rates therefore decreased over time, indicating that reducing fertiliser application rates both maximises DM and economical responses.

The fact that there was so little difference in DM yield towards the end of the study between applying 0 N and 1.5 kg N/ha/day was surprising, but the botanical composition data explained some of this response (Fig. 1). When N fertiliser was not applied, the proportion of white clover increased to 53% and 61% under rain-fed and irrigated conditions respectively by February 2011, coinciding with a rapid decrease in the proportion of perennial ryegrass to 28% under both rain-fed and irrigated conditions. The proportion of perennial ryegrass also decreased over time under the 1.5 and 3.0 kg N/ha/day treatments, but not to the same extent, with perennial ryegrass maintaining a higher percentage of botanical composition than white clover throughout the study.

While there was only a 7% difference in DM yields in the last 6 months between applying 0 N and 1.5 kg N/ha/day, there was a considerable difference in

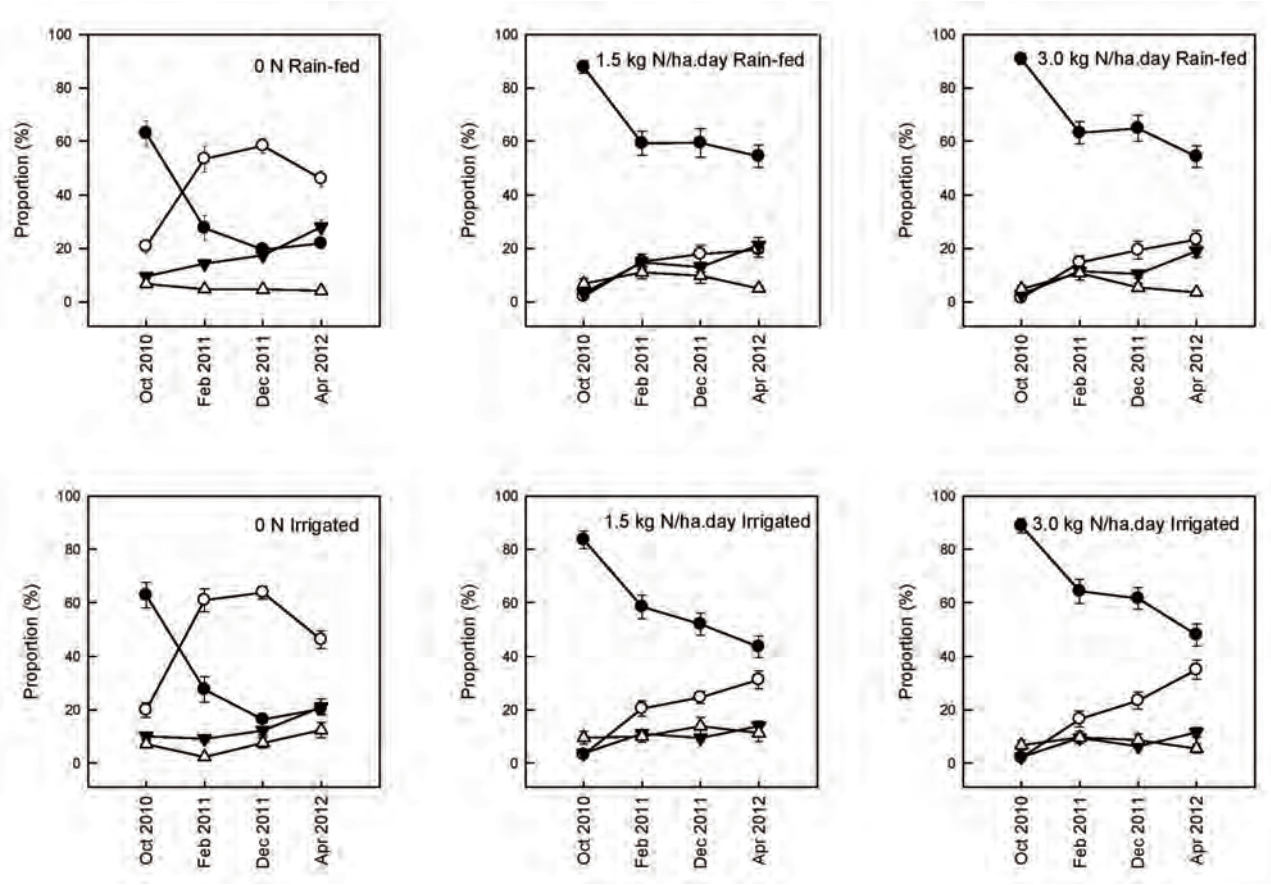

Figure 1. Proportion (%) of perennial ryegrass (●), white clover (○), broad leaved weeds (▼) and grass weeds (△) in rain-fed and irrigated plots over four visual assessments, under three nitrogen (N) treatments (0, 1.5 and 3.0 kg N/ha/day). Error bars represent standard error of the means.

botanical composition. It is well known that increasing annual applications of N fertiliser in a clover-grass mixed sward generally increases overall DM production at the expense of the clover component (Frame 1990; Frame *et al*. 1998). The current study provides new data on the ability of white clover to establish and contribute to overall DM when minimal N fertiliser is applied.

Conclusions

This research confirmed the diminishing returns associated with using high levels of N fertiliser, with the economical response to high rates of N fertiliser application decreasing over time. However, the relationship between N fertiliser application and white clover content in a mixed sward was also highlighted. While the effect of high N fertiliser application on reducing white clover content in dairy pastures has been observed on many Tasmanian dairy farms, the effect of nil N fertiliser application on greatly increasing white clover content, while maintaining overall DM in this study, was of interest.

References

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