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CONTRIBUTION OF DAIRY COW MANURE TO SOIL FERTILITY AND NUTRIENT REDISTRIBUTION IN PASTURES

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Abstract

The effects of dairy cow manure on soil fertility were investigated at the site of the long-term phosphorus rate by stocking rate farmlet experiment at the Dairy Research Institute, Ellinbank, in Victoria. Manure increased extractable soil P (Olsen) in the 0 - 5 cm layer after 60 days to 61 mg/kg compared with values of 32 mg/kg in the control soils. Extractable soil K (Colwell) almost doubled under manure pads to 5 cm depth from 642 mg/kg in control soils to 1226 mg/kg in manure treated soils. The effects of grazing management on nutrient redistribution and pasture growth within strip-grazed paddocks was also investigated. While soil Olsen P was not different, Colwell K ($p<0.001$) and pasture height ($p<0.01$) were significantly greater at the front or gate-end of the paddocks compared with the back.

Keywords: phosphorus, potassium, grazing management, pasture, dung

Introduction

Dairy cows return significant quantities of nutrients to pastures through dung and urine. Up to 65% of the phosphorus (P) eaten in the diet is returned in faeces while approximately 11% and 79% of the consumed potassium (K) is returned in dung and urine respectively (Haynes and Williams, 1993). These nutrients contribute to soil fertility under and around the depositions, based on their mobility in soil (During and Weeda, 1973; During et al., 1973).

Grazing management affects the distribution of manure and therefore nutrients within paddocks (Gerrish et al., 1993; Peterson and Gerrish, 1995). The common practice of strip-grazing paddocks to ration feed on offer to dairy cows can potentially result in a build-up of nutrients near the front (gate-end) of the paddock. As cows are gradually given access to greater areas of the paddock, the front is grazed and visited more frequently than the back, unless back-fencing is practised. The greater return of manure and urine to the front of paddocks is likely to result in a build-up of nutrients in these areas.

This experiment was undertaken to investigate the effect of manure on soil chemical properties and to measure the effect of grazing management on soil nutrient distribution and pasture growth.

Materials and Methods

This study was undertaken at the Dairy Research Institute, Ellinbank, (38^o 15’S; 145^o 93’E) on the site of the long-term P rate by stocking rate (SR) farmlet experiment (Gourley, 1999). The soil type was a well-drained ferrosol, and the cows grazed perennial ryegrass (Lolium perenne L) and white clover (Trifolium repens L) pastures.

Manure experiment - Manure collected in the yards after cows were milked was used to create 21cm diameter pads in 3 replicate plots within each of 5 rotationally grazed paddocks. Soil samples (0-5cm and 5-10cm) were collected below the dung pads and compared with samples collected from control pads nearby. Soils were dried (40^{o}C), ground and sieved (<2mm) prior to analysis. Extractable P and K were measured according to the methods of Olsen et al. (1954) and Colwell (1963) respectively.

Grazing management experiment - Rectangular paddocks were sub-divided into six equal sections from the front (gate-end) to the back. Thirty soil samples (2.5cm x 10cm) were collected in a zig-zag fashion within each section, bulked, dried (40^{o}C), ground and sieved

(<2 mm) prior to analysis. Extractable P (Olsen et al., 1954) and K (Colwell, 1963) were measured. Pasture height within each sub-section was measured using an Ellinbank rising plate meter (Earle and McGowan, 1979).

Statistical analysis - Analysis of variance of the data with appropriately nested blocking structure was performed using Genstat, Rothamsted. REML was also used to analyse the within paddock nutrient distribution data as soil and pasture samples were only collected from front and back sections of selected paddocks.

Results and Discussion

Soil Olsen P increased significantly in the 0 to 5 cm layer 60 days ($p<0.001$) after the manure pads were created (Figure 1). The Olsen P at 5 - 10 cm also appeared to be increasing but this was not statistically significant. Increases in soil P under dung have been reported (During and Weeda, 1973; Williams and Haynes, 1995), but the low mobility of P resulted in its accumulation in the upper layers of soil (Gerrish et al., 1993). Colwell K under manure pads almost doubled in the 0 - 5 cm layer after 60 days, with little increase occurring in the 5 - 10 cm layer. Gerrish et al. (1993) reported 4 to 10 fold increases in soil K due to animal returns in camp areas, although most of this K is likely to come from urine which contains greater amounts of K than dung (Haynes and Williams, 1993).

The changes in soil fertility observed under manure pads suggest that nutrient re-distribution may occur in paddocks as a result of grazing management. Strip-grazing is commonly practised to ration pasture feed to dairy cows. While the grazed strips should be back-fenced, providing access to water troughs limits its use. As a result the cows visit the front or gate-end of the paddocks more often than the back, depositing faeces and urine in these areas.

Soil Olsen P levels were similar at the front and the back of strip-grazed paddocks. However, Colwell K was significantly ($p<0.001$) greater at the front of the paddocks (Figure 2), as was pasture height ($p<0.01$). The high P-fixing capacity of the ferrosols in this study is likely to have reduced changes in soil P levels in 10 cm cores, although the Olsen P levels in the 0 to 5 cm layer may have increased, as was observed in the previous experiment. Grazing management had a much greater impact on soil K in this experiment. Gerrish et al. (1993) suggested that changes in soil K observed in grazed pastures were due to the large amounts of K recycled by the animals and its relative mobility in soil. The greater soil K levels and increased pasture growth at the front of the paddocks suggest the potential for luxury uptake of K (During et al., 1973) which may be detrimental to animal health (Lewis and Sparrow, 1991). The fertility gradient particularly of soil K from the front to the back of paddocks may need to be considered when applying fertilizers.

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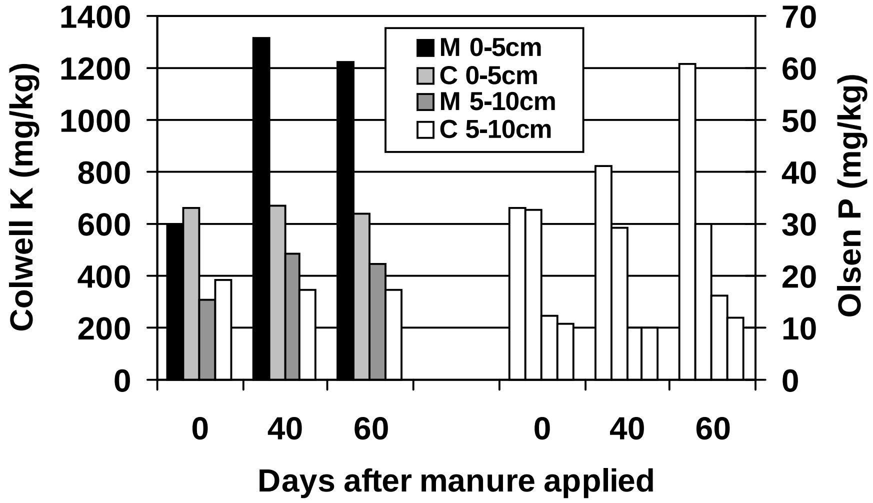

Figure 1 - Olsen P and Colwell K (mg/kg) in dairy pasture soils under manure (M) and control (C) pads at 0 – 5 cm and 5 – 10 cm depths.

Table 1 - Olsen P, Colwell K (mg/kg) and Pasture height (cm) at the front (gate-end) and the back of strip-grazed dairy paddocks.

	Olsen P (mg/kg)	Colwell K (mg/kg)	Pasture Height (cm)
Front of paddock	24.10	554.8	14.57
Back of paddock	25.26	446.4	12.65
SED*	1.196	26.76	0.6464

*Standard error of differences