Effects of trampling of a wet dairy pasture soil on nitrous oxide emissions and the efficacy of a nitrification inhibitor, dicyandiamide

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Introduction
Nitrous oxide (N2O) emitted from urine patches in grazed dairy pastures is a major contributor to the total greenhouse gas emissions in New Zealand. The nitrification inhibitor dicyandiamide (DCD) has been shown to reduce N2O emissions in grazed pasture systems. However, the N2O emission rates and efficacy of DCD are both subject to a range of soil and environmental conditions. During winter, pastures and winter-feed paddocks sustain substantial trampling damage by grazing stock, leading to soil compaction and may influence N2O emissions from the soil.

Objectives
Evaluate the effects of trampling of a wet dairy pasture soil on nitrous oxide emissions and the efficacy of a nitrification inhibitor, dicyandiamide. Relate these to soil porosity, permeability and structure.

Materials and methods
A factorial design experiment comprising the treatments: trampling (nil and trampled) and DCD (none and applied) was set up. Treatments were applied to 0.5 m diameter patches (Fig. 1A). A mechanical hoof mounted on a compressed air ram was used to simulate trampling (Fig.1B).

Trampling damage to the soil was assessed using the Visual Evaluation of Soil Quality (VESS). Porosities, bulk density and air permeability were measured on intact soil cores taken from 0-5 cm depth.

Hourly N2O fluxes were calculated based on 3 samples collected in a closed chamber 20 minutes apart for a total of 40 minutes (Fig. 1C).

Results
• Trampling destroyed the aggregate structure and reduced the porosity of the top 5 cm of the soil (Figure 2).
• Air permeability and pore continuity were decreased significantly (p<0.01 and p<0.05 respectively) by trampling.
• The N2O emission factor from animal urine-N was more than doubled by trampling (Table 1).
• DCD application significantly reduced N2O emissions in both trampled and untrampled treatments (Table 1).

Conclusions
Trampling significantly (p<0.05) increased N2O emissions. Most of the soil damage caused by trampling was confined to the top few cm of soil. The substantial increases in N2O emissions from trampling were attributed to increased water-filled pore space and reduction of air permeability due to soil aggregate destruction. DCD was very effective at mitigating the N2O emissions in both trampled and untrampled soils, and retained its effectiveness throughout the 10-week sampling period.

References