The effects of dairy cow weight on selected soil physical properties related to compaction

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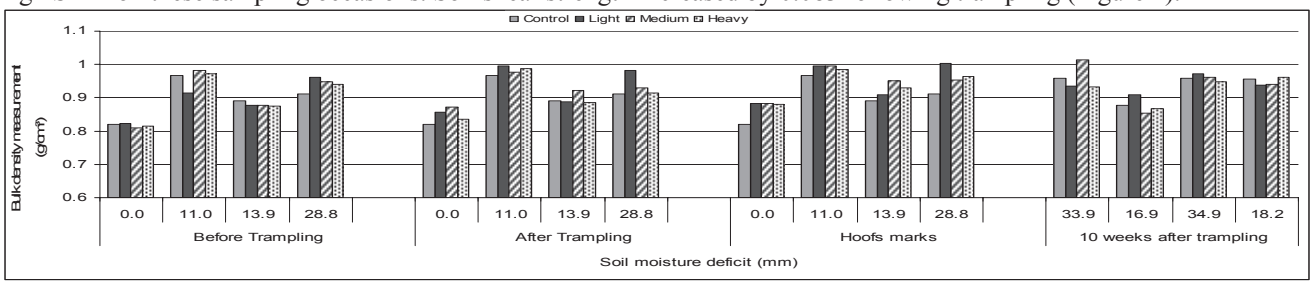
Introduction Compaction occurs as a result of traffic on the soil surface, e.g. tractors, machinery, cattle trampling. In grazing systems, animal treading can affect soil physical properties and in some circumstances, such as critical soil water contents can result in soil compaction and reduction or loss of soil porosity. Excessive compaction has damaging consequences for agriculture and the environment, such as reduced plant growth, reduced infiltration rates and increased runoff potentials (Gifford *et al*., 1977). Changes in soil bulk density can be used to determine the occurrence of compaction as a result of surface activities. An increase in bulk density following treading is an indication of compaction. The objective of this study was to investigate the effect of treading by dairy cows of different weights on soil physical properties on a free draining soil at a range of soil moisture deficits (SMD).

Materials and methods An experiment was undertaken at Teagasc Moorepark, Fermoy, Co. Cork on a free draining soil type. The experiment was a 4 x 4 factorial arrangement, with four replicates per treatment. The treatments were SMD (SMD = 0.0, 11.0, 13.9 and 28.8 mm) and four dairy cow weights representative of Holstein Friesian (545 kg +/- 20 kg), Jersey X Friesian (478 kg +/- 20 kg), Jersey (389 kg +/- 20 kg) or no cow (0 kg). Soil moisture deficit was estimated using the model developed by Schulte *et al.*, 2005. At the target SMD, 2 cows per treatment were walked up and down the assigned plots five times in each direction. The size of the front left hoof on each cow was measured and taken to represent that of the four hooves on the cow. Bulk density, total porosity, gravimetric and volumetric water content, penetration resistance and soil shear strength were measured, using standard methods, before and after treading. Data relating to bulk density and soil shear strength are presented here. Bulk density measurements were repeated 10 weeks after the trampling event to assess soil recovery.

Results There was a significant effect (<0.001) of SMD and trampling on bulk density (Figure 1). The effect of cow weight was approaching significant (0.0599). Bulk density increased by 0.024 following trampling, and was 0.048 greater in the hoof marks. Ten weeks after trampling the soil bulk density was 0.04 higher than before trampling, this is explained by the high SMD on these sampling occasions. Soil shear strength increased by 0.083 following trampling (Figure 2).



a **b** **c** **d**

Figure 1 The effect of four cow weights (0, 389, 478, 545 kg) on soil bulk density at four SMDs (0.0, 11.0, 13.9, 28.8 mm) before trampling (a), after trampling in non-hoof marks area (b), after trampling in hoof mark areas (c) and 10 weeks after trampling (d).

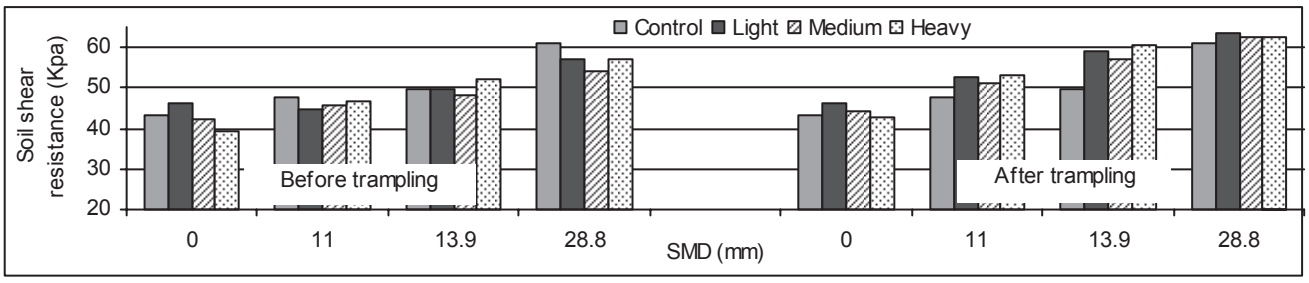


Figure 2 The effect of three cow weights on soil shear strength at four SMDs (0.0, 11.0, 13.9, 28.8 mm) immediately before and after trampling.

Conclusions Bulk density and soil shear strength increase significantly with increasing SMD. Soil bulk density and soil shear strength were similar for all cow weights at the four SMDs. No significant differences between the three cow weights on bulk density and soil shear strength measurements were found.

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