Impacts of sub-surface drainage and "on-off" grazing in reducing wet soil pugging damage on southern Victorian dairy pastures – some soil effects

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Abstract

The effect on soil of subsurface drainage and “on-off” grazing management for winter wet dairy pastures was evaluated in a trial in south-west Victoria. “On-off” grazing of saturated soils caused a decline in soil strength with each successive grazing. By the 3rd grazing, the soils from pastures grazed for 2 hours were 400 kPa stronger than soils from pastures grazed for 8 hours. After an initial decline in soil strength, drained soils increased in strength with successive grazings being four times stronger than the undrained by the fifth grazing. This increase in soil strength coincided with an increase ($P<0.05$) in soil bulk density in the 0-5 cm horizon in the drained treatments for all grazing times compared to the undrained. Such bulk density increases may have contributed to the lower than expected pasture DM yield responses to subsurface drainage.

Key Words

Drainage, on-off grazing, pugging, wet soils, bulk density, soil strength

Introduction

Grazing waterlogged pastures during winter-spring is a major problem facing the dairy industry in southern Victoria. Grazing under such conditions causes damage to both pasture and soil (1). Recent New Zealand research has shown that pugging by cattle can reduce pasture productivity by 30-90%, last for up to two years (2) and cause considerable physical soil degradation (3). On farm strategies to reduce the occurrence and severity of wet soil damage include the "on-off" grazing system of limiting cow grazing time (4) and installation of subsurface drainage to remove excess water from the soil (5). This paper reports on the effects on soil of a study to evaluate these two strategies during 2001.

Methods

A grazing experiment in south-west Victoria (38?14'S, 142?55'E) investigated the effects of grazing wet soils using an incomplete combination of subsurface drainage, different lengths of "on-off" grazing by dairy cows and grazing at different soil moisture levels. Soil at the site was a basalt derived, fine sandy clay loam with a poorly drained medium clay B horizon at 30 cm depth. Subsurface tile drainage was installed to provide drained (D) and undrained (U) treatments. Plots were grazed for either 2 hours (SH), 4 hours (M), 8 hours (L) or 8 hours plus an additional 2 hours the following day (L+2). Soil water content (0-15 cm in the undrained) at grazing was either at or close to saturation (SA), at field capacity (FC), or dry (DY) (at least 6% below field capacity). Treatments were grazed (FC and DY treatments mechanically cut) five times each at 26 - 30 day intervals under wet soil conditions during late winter-spring. For the remainder of the year under DY conditions the treatments were grazed as per the farms normal grazing rotation. Prior to grazing soil strength was measured at 36 spots per plot using an Eijkelkamp cone penetrometer. Soil bulk density at 0-5, 5-10 and 10-15 cm depths was measured in 12 spots per plot before and at the end of the wet soil period. Data were analysed by analysis of variance using residual maximum likelihood (6).

Results

At all wet soil grazings soil water content was at or near SA in the undrained and at FC in the drained with the exception of October where it was at FC and 5% below FC respectively. Undrained treatments

experienced a marked decline in soil strength with each successive grazing under SA soil conditions (Figure 1). By the third grazing, undrained treatments L+2*SA and L*SA had lower (P<0.05) soil strengths than SH*SA and M*SA. After a temporary increase in soil strength in October due to lower soil water contents, the two longer grazing time treatments continued this trend in November. In contrast, the drained treatments maintained higher (P<0.001) soil strengths than the undrained treatments at all wet soil grazings. After an initial decline at the second grazing, the soil strength of the drained treatments increased with successive grazings to be higher at the last wet soil grazing than the first.

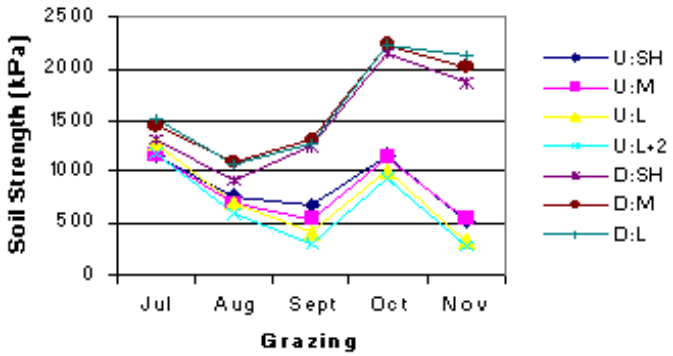

Figure 1. Soil strength (kPa) over 5 wet soil grazings over time due to drainage (U=undrained, D=Drained) and grazing time SH=2hrs, M=4hrs, L=8hrs, L+2=8+2hrs next day.

Table 1. Bulk density (BD)(Mg/m^3) of the 0-5 cm soil horizon of a range of drained and undrained treatments in December 2001.

Undrained BD		Drained BD	
SH*SA	1.219	SH*SA	1.335
M*SA	1.254	M*SA	1.363
L*SA	1.188	L*SA	1.418
L+2*SA	1.173	L*DY	1.210
L*FC	1.207		
L*DY	1.144		

l.s.d. (P=0.05) = 0.1080

No differences were found between any treatments for soil bulk density in the 5-10 and 10-15 cm depth soil horizons. However, in the 0-5 cm horizon the SA drained treatments had higher (*P*<0.05) bulk densities than their undrained equivalents at the same grazing length (Table 1). The longest of the drained SA treatments (L*SA) also had a higher (*P*<0.05) bulk density than the two shorter SA grazing times. Similarly, bulk densities of the three SA grazed drained treatments were higher (*P*<0.05) than the

drained treatment only grazed under dry conditions. There was also a non-significant trend for longer grazing time undrained treatments to have lower 0-5cm bulk densities.

Discussion and conclusion

The changes in soil strength over wet soil grazings illustrate the different ways that subsurface drainage and “on-off” grazing can reduce the severity of pugging damage when wet soils require grazing. By bringing the soil back to field capacity soon after rain, the soil remains comparatively strong preventing much of the pugging or plastic deformation that occurs when soils closer to saturation are grazed (7). The increases in soil strength and bulk density with successive grazings indicates that this benefit of drainage can lead to some compaction of the top soil as the air-filled macro-pores are compressed. This increase in soil bulk density may be a contributing factor to the lower than expected pasture dry matter (DM) yield increase for subsurface drainage in this study. In contrast, the lack of compaction in the undrained saturated treatments noted by several other workers (1,8), is likely to be a result of the macropores being full of water and thus resistant to compression. The data also indicate that “on-off” grazing is able to reduce the decline in soil strength with successive grazings resulting in a stronger soil at the following grazing.

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