The effects of soil compaction on the growth of wheat and subterranean clover

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Excessive cultivation, frequent traffic across the soil and grazing of livestock can all cause deterioration of soil structure and result in hardpans of compacted soil.

A survey in 1980 of farms in N.E. Victoria with crop productivity problems found readily detectable hardpans in 63% of affected paddocks. The main soils encountered were duplex soils with typical classifications of Dr 2.32 and Dr 2.33 (1). Bulk densities recorded ranged from 1.2 g cm^{-3} in surface (0-10 cm) soil and up to 2.18 g cm^{-3} in hardpans, although 1.7 - 1.8 g cm-3 was a more usual density for hardpans. We wanted to investigate whether soil compaction per se reduced plant growth.

Methods

In a field experiment, layers of soil were artificially compacted to simulate the effects of hardpans on the growth of wheat and subterranean clover. The soil type was Rutherglen brown loam, Db 2.12 (1). Compaction treatments were applied using a steel rammer at three depths (surface 10 cm and 20 cm), as well as the whole profile (0-20 cm).

There was no vertical constraint of compaction. Border plots were used between each treatment plot to offset any lateral effects. All plots were sown with an eight-row tyned cone seeder; sowing depth was 5 cm for wheat and 1 cm for clover.

Results and Discussion

Bulk densities of the plots were measured in the 0-10 cm layer only, just after sowing. Bulk density of the uncompacted treatment was difficult to measure accurately; a figure of 1.10 g cm^{3} is common in surrounding cultivated soils. The compacted treatments ranged from 1.40 g cm^{-3} to 1.66 g cm 3.

Physical resistance, measured with a Bush Penetrometer 18 weeks after sowing, showed that compaction treatments increased resistance from approximately 8 bars in the uncompacted soil to 25 bars in the compacted layer ($P<0.05$). Resistance was also increased for up to 15 cm below the compacted layers. Some compaction treatments had a significant effect on root growth. For example, in the 5-10 cm region of the 10 cm compaction treatment the concentration of wheat roots was significantly (P0.05) hiker (1.65 mg cm^{3}) than in the same region of the nil treatment (0.94 mg cm). In the 20 cm compaction treatment, root concentration at 15-20 cm was also significantly higher than for the nil treatment. There was a significant reduction in root growth from 10-25 cm in the 0-20 cm (profile) compaction treatment ($P<0.05$), compared to the control.

Top growth of the subterranean clover was significantly reduced ($P<0.05$) for the surface compaction treatment (mean plant weight 58.5 mg) and the profile (0-20 cm) treatment (63.5 mg), compared to the nil compaction treatment (149.2 mg). A marked reduction in top growth of wheat was also measured for these treatments but the differences were not significant.

These results indicated that soil compaction in the surface (0-20 cm) did reduce the growth of wheat and subterranean clover and that the symptoms of the affected plants - cupped reddened leaves on the clover, and stunting and yellowing of the wheat-were similar to those seen in many problem paddocks in N.E. Victoria.

1. Northcote, K.H. 1965. A Factual Key for the Recognition of Australian Soil. Divisional Report 3/65, Division of Soils CSIRO, Adelaide.