Effects of soil fertility and compaction on root standing mass and production

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Introduction

How can we increase or maintain soil carbon (C) under pasture, to improve soil function and offset greenhouse gas emissions? Roots are a major source of soil C inputs, so manipulating root growth will be an important approach. Root growth is affected by soil fertility, irrigation, compaction and pasture species. But there are not enough quantitative data on the effects of these factors on root mass and production.

Objective

Quantify the effects of soil fertility (N, P) and soil compaction on root mass and production under a ryegrass+white clover pasture over a full year

Methods

Two small plot experiments measuring root mass and production in ryegrass+white clover Manawatu dairy pastures:

1. 2008-09: Comparing moderate (Olsen P = 24) and high (Olsen P = 50 + 400 kgN $ha^{-1}y^{-1}$) fertility in summer-irrigated pasture.
2. 2011-12: Factorial experiment including high and moderate P with high and no compaction. Compaction applied by rolling between 20-40% soil moisture.

Standing root mass measured in 25 mm Ø cores to 150 mm depth

New root production measured in 40 mm Ø refilled cores to 150 mm depth over 40-60 day periods (Fig 1a, b)

Fig 1a. Ingrowth core for root production measurement

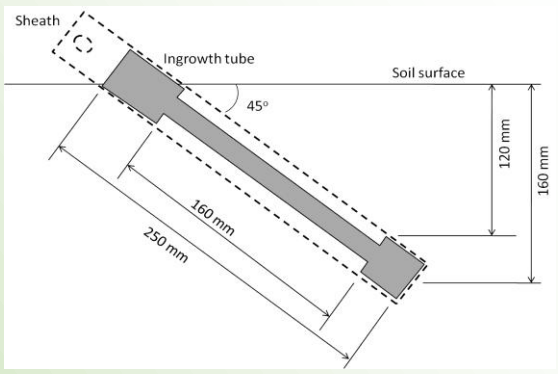


Fig1b. Soil refilled into ingrowth cores inserted under pasture

Results: Experiment 1

- For most of the year, no significant difference in root mass or root production between high and moderate fertility (Fig 2a, b)
- During spring, lower root mass and higher new root production at high P and N fertility (Fig 2a, b)
- Root production low due to method of re-used cavities and non-local soil (Fig 2b)

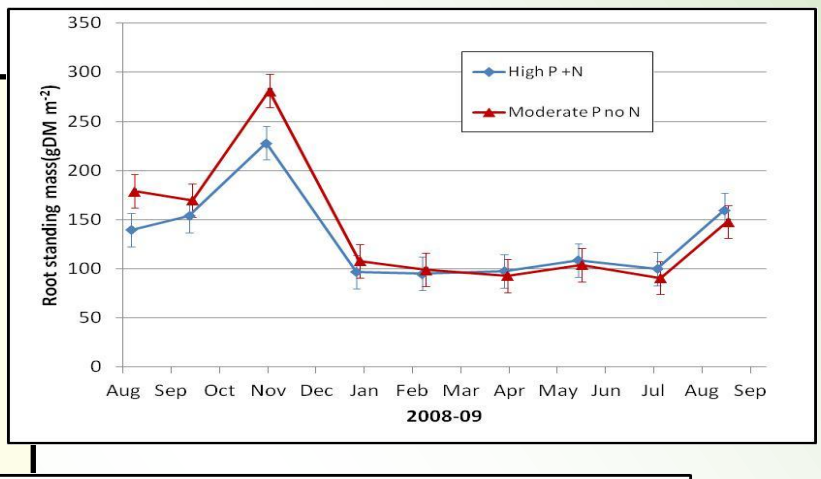


Fig 2a. Root standing mass to 150 mm depth in Experiment 1

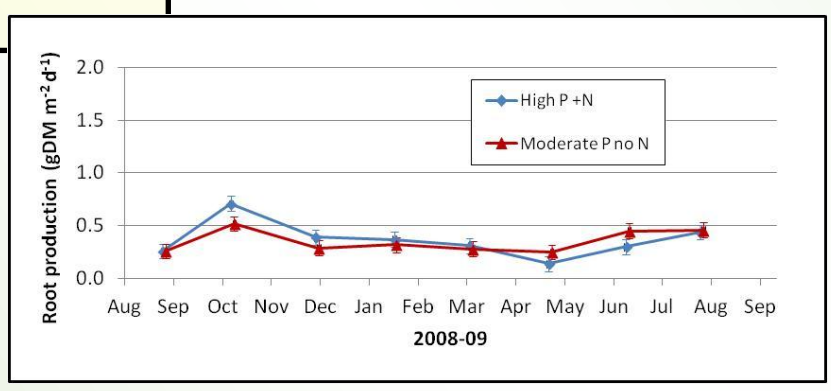
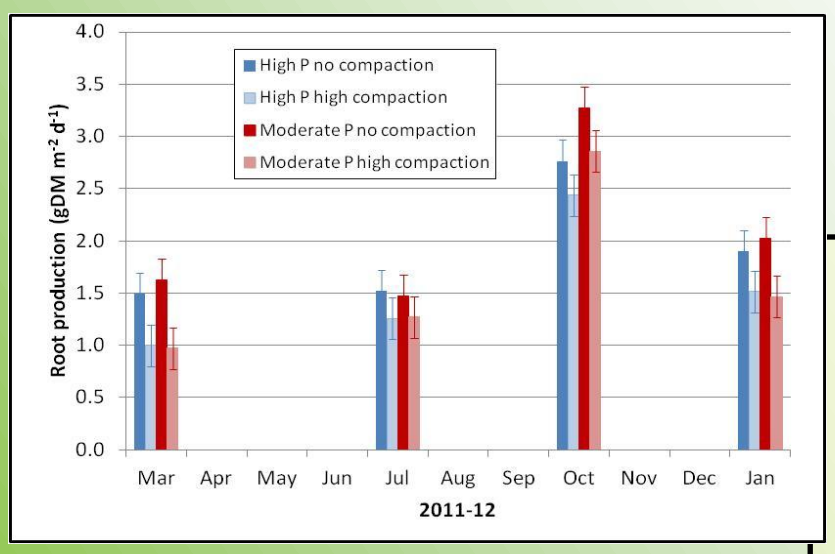


Fig 2b. Root production to 150 mm depth in Experiment 1

Fig 3. Root production to 150 mm depth in Experiment 2 (bars represent SEM)



Results: Experiment 2

- Root production 4 times higher compared to Experiment 1, using fresh cavities and local soil (Fig 3)
- Root production reduced by ~20% in all four seasons under compaction (Fig 3)
- No significant effect of P level on root production (Fig 3)

Conclusions

- Effect of fertility in reducing root mass and increasing root production consistent with resource allocation theory
- Fertility effects on root production more strongly affected by N than P in this system
- Consistent effect of compaction to diminish root production

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