

**QUANTIFICATION OF THE BELOWGROUND INPUTS OF  
ORGANIC CARBON BY THE ANNUAL PASTURE LEGUME  
BARREL MEDIC (*MEDICAGO TRUNCATULA* GAERTN.)**

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## ABSTRACT

In the cropping soils of southern Australia, pasture phases based on the annual legume barrel medic (*Medicago truncatula* Gaertn.) provide significant inputs of organic matter and lead to improvements in soil structure and fertility. This thesis aimed to quantify the belowground input of carbon by barrel medic and the effect of defoliation on this input. This aids the development of simulation models of soil organic carbon, and has practical implications regarding rotation choice and grazing management.

The major belowground input of carbon in annual species is found as root production. Measurement of total root biomass production, using a technique that accounted for root death and decomposition, found that it was 1.6 to 2.9 times the maximum live root biomass. In a year of very low rainfall, root production was a lot less than in a year of average rainfall. However, the ratio of total root production to total shoot production was higher. In both years, the total root biomass production and root:shoot ratio of barrel medic were greater than faba beans but similar to barley grass.

Total root biomass production of a frequently defoliated barrel medic pasture was estimated using a  $^{13}\text{C}$  dilution technique where swards were pulse labelled with  $^{13}\text{C}$ . Root biomass production following labelling was estimated from the subsequent dilution in  $^{13}\text{C}$  enrichment during the remainder of the season. Although live root biomass of cut pasture was less than that of uncut pasture, total root biomass production was similar.  $^{13}\text{C}$  allocation data showed that this was due to greater allocation of carbon belowground by cut plants. It was concluded there must be greater turnover of root material under cut pasture.

The effect of defoliation on the amount of carbon released to the soil through rhizodeposition was estimated by growing plants in pots in a labelled atmosphere in a growth cabinet. Plants were grown in a  $^{14}\text{C}$ -labelled  $\text{CO}_2$  atmosphere, defoliated and then grown in a  $^{13}\text{C}$ -labelled  $\text{CO}_2$  atmosphere. Distribution of  $^{14}\text{C}$  and  $^{13}\text{C}$  in the plants was compared with uncut plants. Defoliation did not have a significant effect on belowground allocation of carbon. The proportion of labelled carbon allocated belowground was 24 and 28 % for cut and uncut plants respectively. Total input of carbon into the soil was estimated to be 1.70 (cut) and 1.65 (uncut) times the amount of carbon recovered in root biomass.

Applying these correction factors to results from the field experiments, total annual belowground input of carbon ranged from 700 to 1880 kg C/ha. As a proportion of carbon in above ground production, carbon input belowground ranged from 0.40 to 0.77. Defoliation at the frequency and level imposed in these experiments had no adverse effect on total belowground inputs of carbon.

## DECLARATION

*I declare that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.*

*I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.*

Michael Crawford

Date



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## PUBLICATIONS ARISING FROM THIS THESIS

### Book chapters (refereed)

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