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Pattern of carbon allocation in the rhizosphere of rye grass (*Lolium perenne*) after defoliation

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Context

Defoliation causes drastic changes in the source-sink relationship between plant organs.

Plant C allocation is affected, but is C release to the rhizosphere stimulated or reduced?

Consequences on microbes and their feeders?

Objectives

To assess (1) if defoliation-induced changes in C allocation of field-grown *Lolium perenne* affect C availability, microbes and microbial feeders in plant rhizosphere, and (2) whether these effects depend on soil fertility.

Methods

The following indirect indicators of C rhizodeposition were determined:

1. Microbial C in rhizosphere soil (RS).
2. Microbial activity in RS [using ¹⁴C-glucose test; Nguyen and Guckert (2001) SBB 33:53-60].
3. Number of culturable bacteria in RS (bact r and k as Colony Forming Unit).
4. Community-level physiological profiles of microbes (Biolog® test after 72h incubation).
5. Abundance of microbial-feeding nematodes in RS.

Results

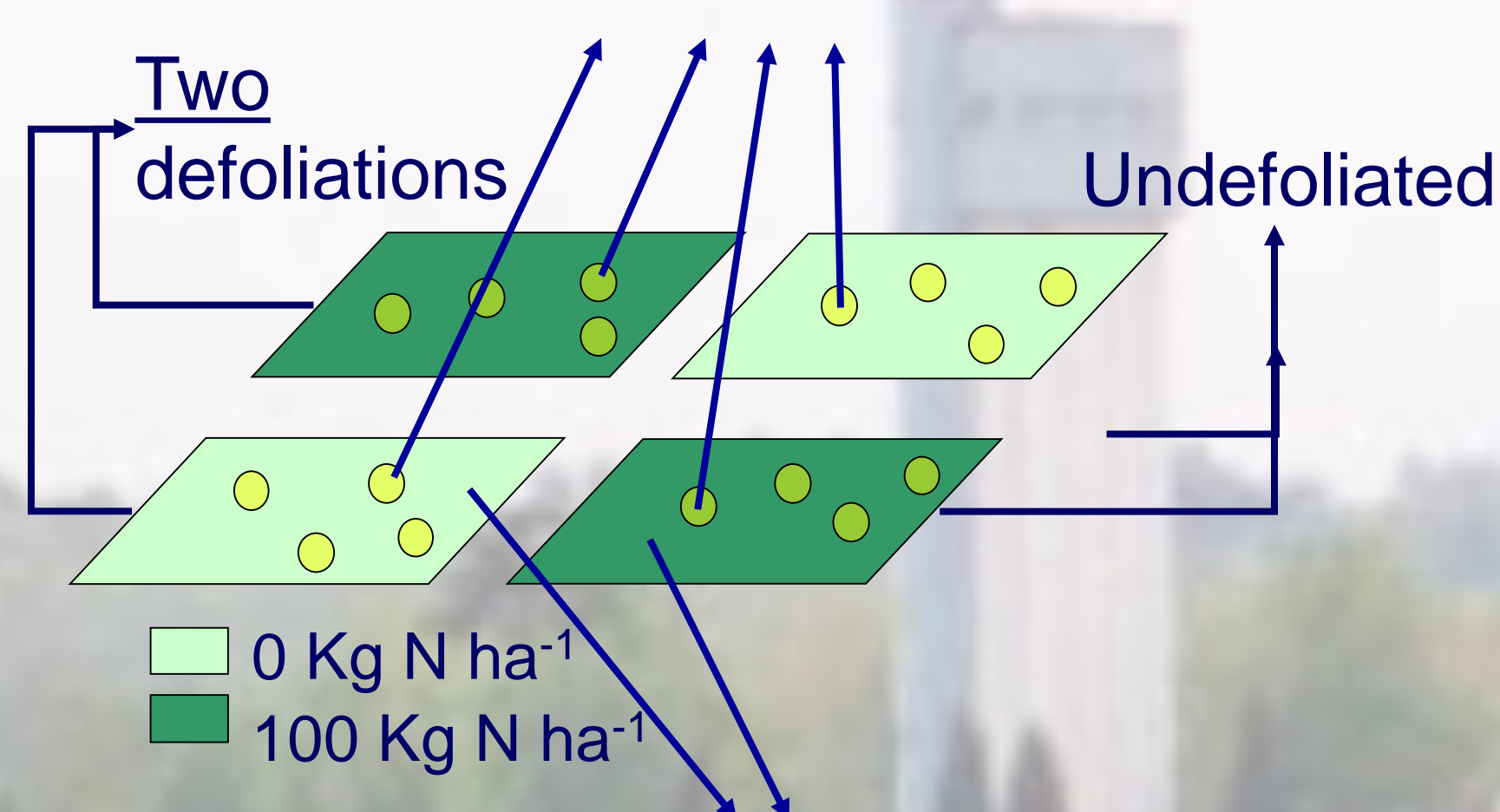
1. Defoliation reduced shoot C concentration and increased root carbohydrate concentration (Fig 1).

Changes in plant C allocation after defoliation

3. Defoliation reduced the abundance of fungivorous and herbivorous nematodes in the rhizosphere soil (Fig 2).

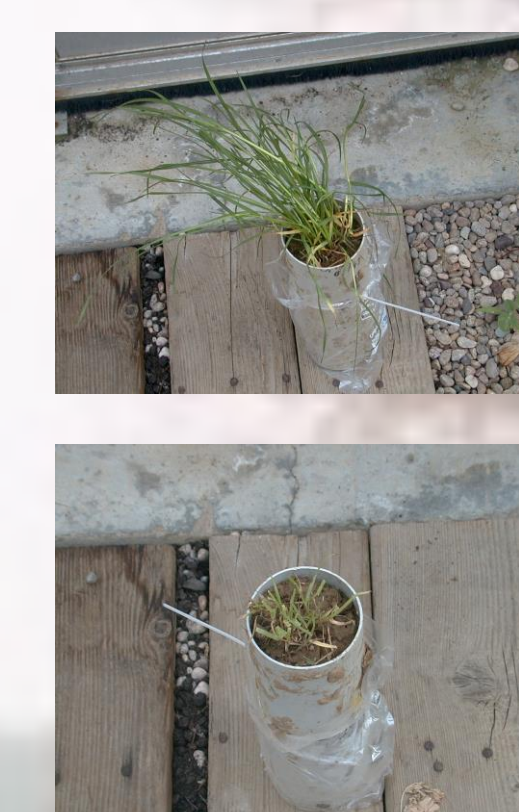
Longer-term effects of first defoliation likely mediated by changes in root growth and abundance of mycorrhizal fungi

Soil cores with growing rye-grass plants excavated 2 and 4 days after the last defoliation.



Samples of rhizosphere soil 6 days after the last defoliation for analysing the abundance of microbial-feeding nematodes.

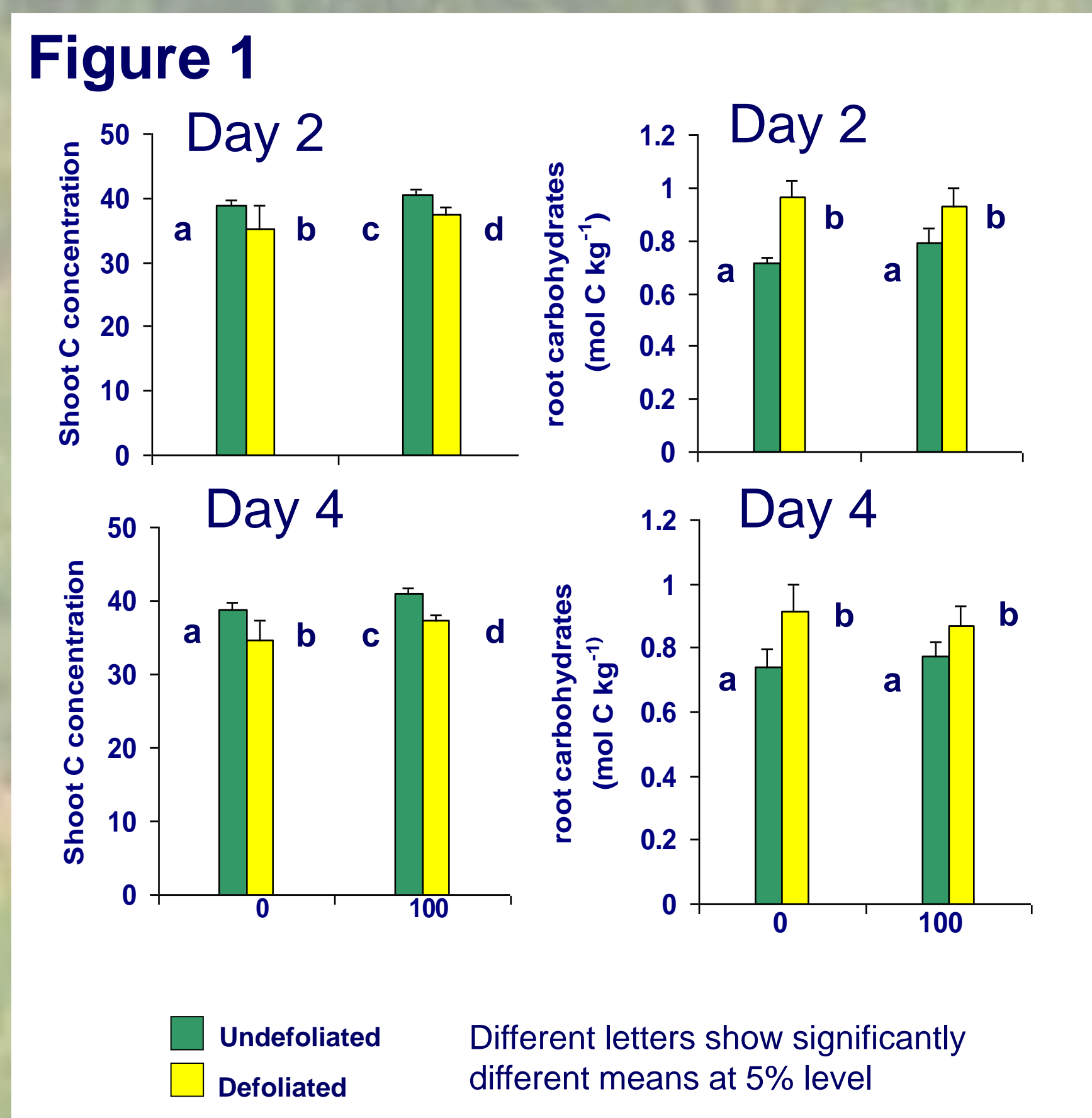
Undefoliated plant



Defoliated plant



Plant and microbial analyses



2. Defoliation did not affect

1) microbial C content, 2) microbial activity, 3) number of culturable bacteria, 4) catabolic activity of bacteria (Table 1) or 5) the abundance of bacterial-feeding nematodes in the rhizosphere soil (Fig. 2).

No changes in C release to rhizosphere shortly after defoliation

Cut	N supply (g.m ⁻²)	Microbial C		Microbial activity		CFU		Biolog®	
		RS (mgC kg ⁻¹)	¹⁴ CO ₂ / ¹⁴ Cfe	log r Day	log k Day	Total area			
Day 2	- 0	388 (76.3)	0.56 (0.052)	8.2 (0.66)	unavailable data	3831 (617.3)			
	- 100	329 (38.8)	0.61 (0.031)	8.5 (0.57)		4316 (588.8)			
	+ 0	345 (56.3)	0.69 (0.014)	8.3 (0.79)		4097 (657.3)			
	+ 100	344 (46.5)	0.54 (0.058)	8.0 (0.71)		4099 (575.6)			
Day 4	- 0	274 (21.7)	0.59 (0.131)	8.5 (0.17)	8.6 (0.26)	1884 (1131)			
	- 100	312 (25.5)	0.63 (0.056)	8.6 (0.29)	8.6 (0.23)	1805 (395.6)			
	+ 0	288 (42.0)	0.66 (0.067)	8.4 (0.26)	8.4 (0.37)	1607 (538.6)			
	+ 100	297 (28.5)	0.69 (0.039)	8.3 (0.40)	8.3 (0.33)	2369 (826.2)			
Statistics		F value	P	F value	P	F value	P	F value	P
Date		11.09	0.185	1.98	0.393	2.42	0.172	64.8	<0.0001
Nitrogen		0.03	0.888	0.17	0.748	2.35	0.134	1.17	0.284
Cut		0.06	0.839	2.74	0.345	0.02	0.961	2.09	0.163
N°C		0.06	0.839	2.76	0.344	2.53	0.120	0.21	0.650
D*N°C		0.71	0.423	1.80	0.215	1.19	0.282	1.50	0.260

Table 1. Microbial activity expressed as ¹⁴CO₂/¹⁴Cfe: ¹⁴C respired proportionally to the size of the microbial compartment; Culturable cells for bact r (2 days of growth) and bact k (10 days of growth) in log units; Biolog® test: Total area under the kinetic curve after 72h of incubation: relative utilization of single carbon sources by micro-organisms.

Conclusions

1. Despite increasing C allocation to roots, defoliation did not appear to increase C exudation to the rhizosphere.
2. Instead, effects of defoliation on rhizosphere organisms appeared to be longer-term and mediated by root and mycorrhizal fungal growth.