How do soil water dynamics affect the spatial distribution of root exudates in the rhizosphere?

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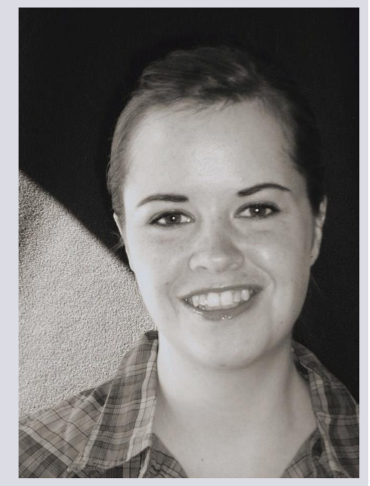
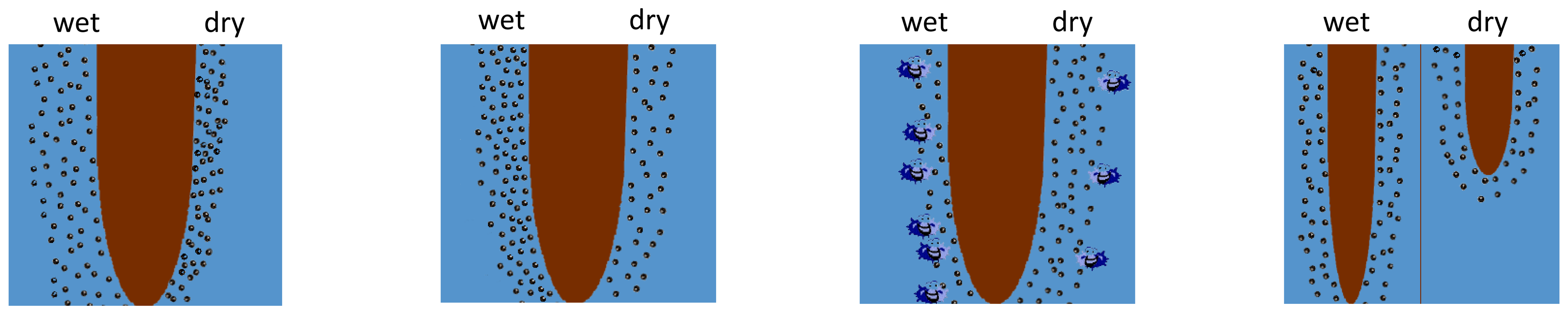


Introduction

The **spatial distribution** of root exudate in soil determines how **effectively** they can interact with the soil matrix and soil microorganisms. It is controlled by:

a) diffusion b) exudation rate c) micr. degradation d) root growth



Mucilage, exuded at the root tip, is believed to increase rhizopshere water content→ diffusion → total exudation

Objectives

1) To measure the spatial distribution of root exudates around the roots. Which root types and which locations are involved in exudation?
2) How do mucilage and soil water content affect the spatial distribution of root exudates?

Results

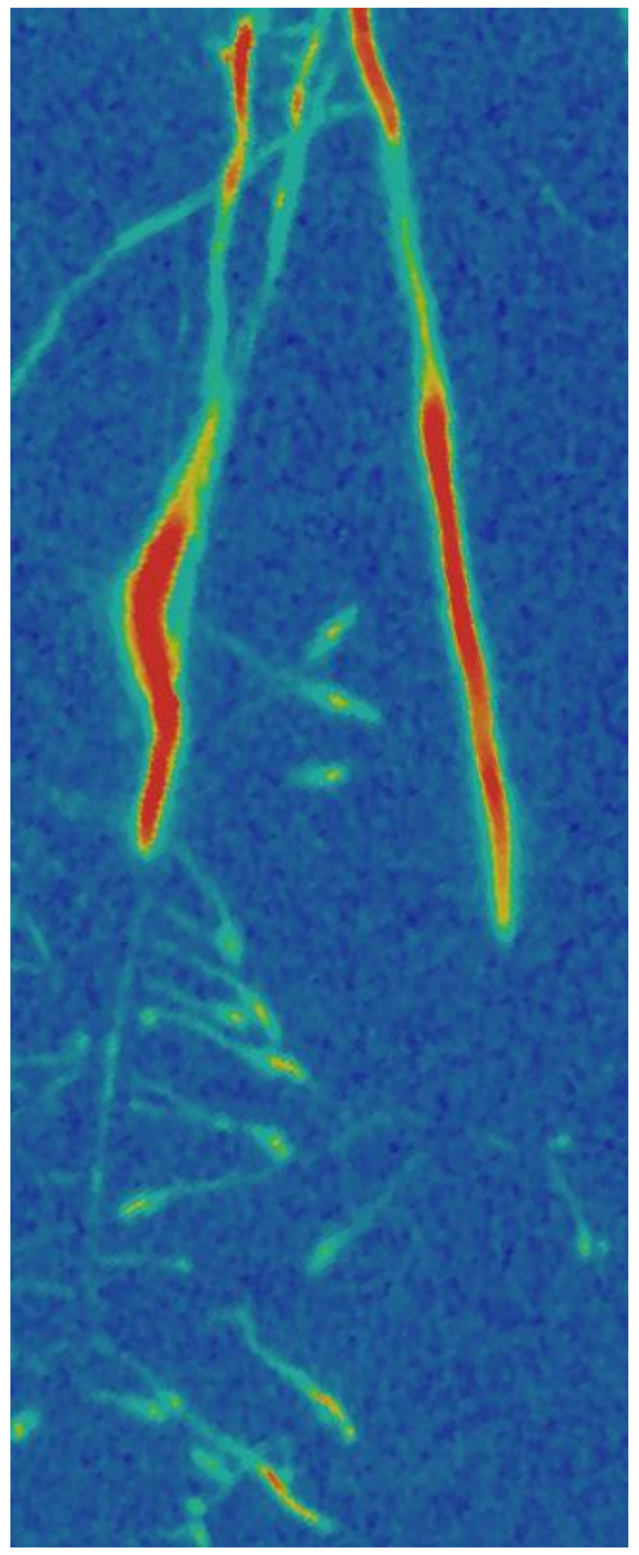


Fig. 1: ^{14}C activity around roots two days after labelling of plants. Highest activities were found around root tips (red color).

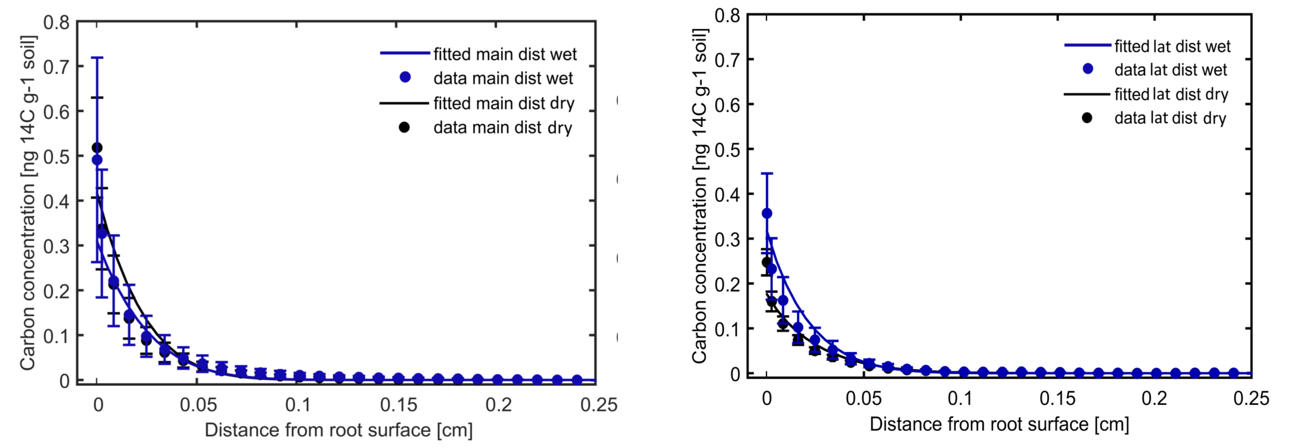


Figure 2: Measured (dots) and simulated (lines) radial profiles of ^{14}C concentration in the rhizosphere. Rhizosphere extension was independent of root type and water content.

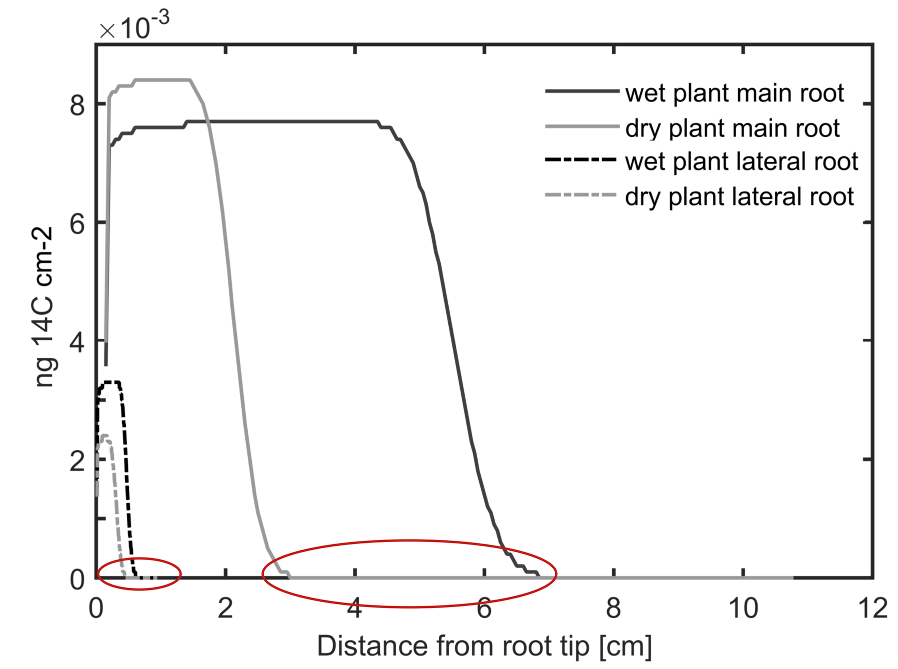


Figure 3: Modelled longitudinal distribution of root exudates. Exudation in wet soil was higher than in dry soil due to higher root elongation.

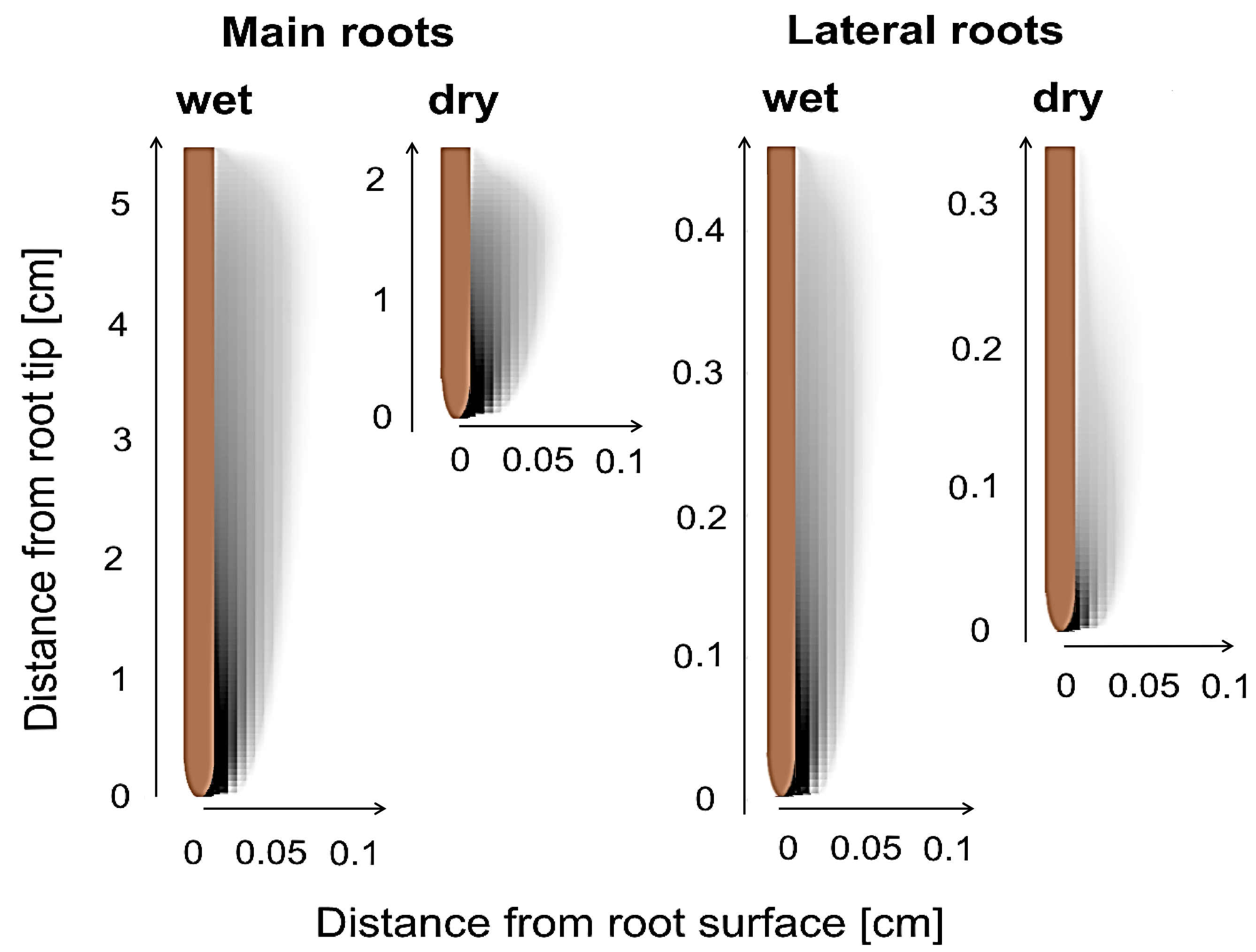


Figure 4: Modelled spatial distribution of root exudates. Total exudation was mainly affected by root type and root growth rate.

	main roots		lateral roots	
	Wet	dry	wet	Dry
Root elongation (cm d^{-1})	2.69 (1.24)	1.05 (0.52)	0.23 (0.07)	0.17 (0.02)
Diff. coeff. (model estimate)	4.1E-4	3.4E-4	3.8E-4	5.8E-4

Table 1: Root elongation (measured) and diffusion coefficient (modelled) for both treatments and root types.

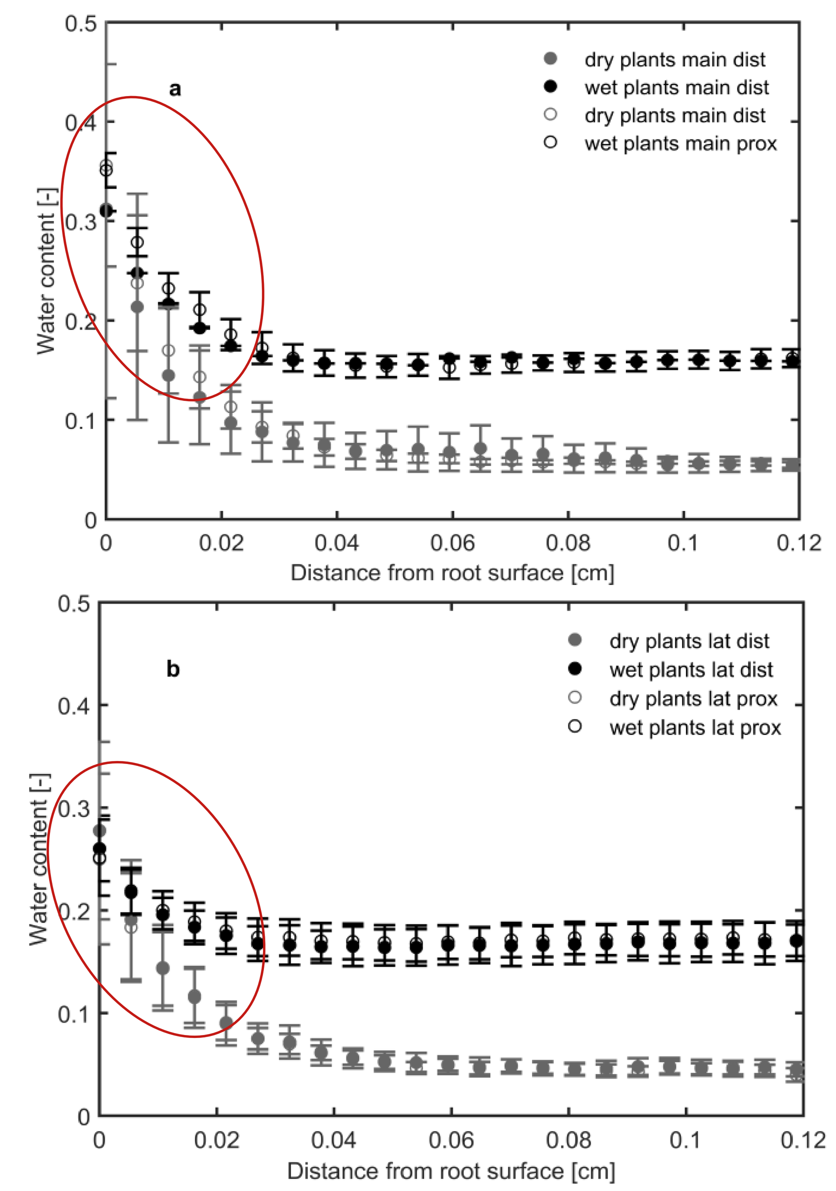
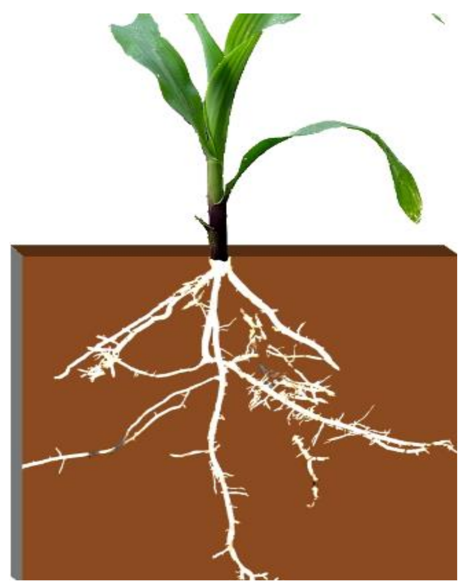


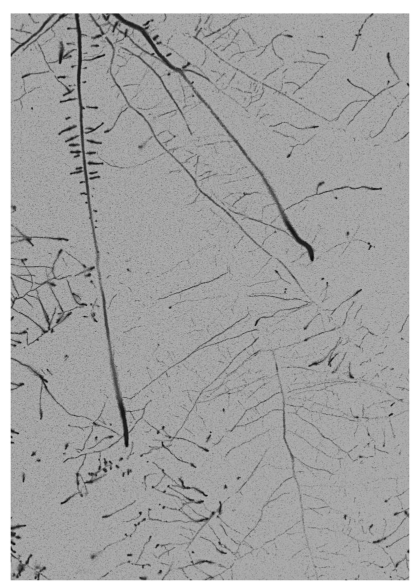
Figure 5: profiles of water content in the rhizosphere calculated from the neutron radiographs.

Material and Methods

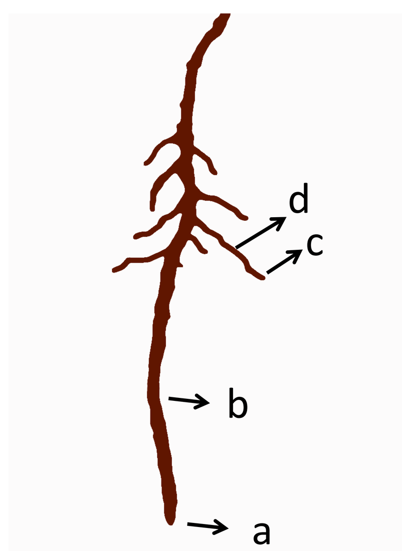


- Plants: 6 weeks old maize
- Treatments: wet (20% vol. wc) and dry soil (6% vol. wc)

Neutron radiography to monitor soil water content



^{14}C imaging to visualize rhizodeposits around roots



Selected root:
a) proximal parts of main roots
b) distal parts of main roots
c) proximal parts of lateral roots
d) distal parts of lateral roots

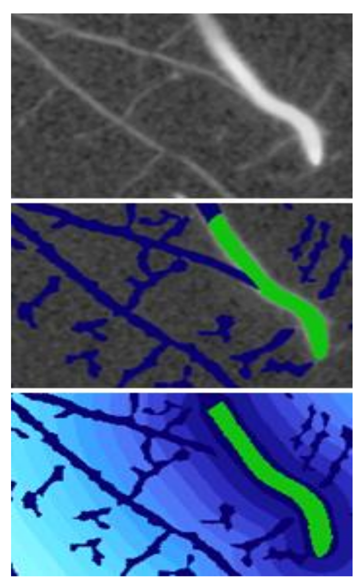


Image processing was done in MATLAB.

Modelling: Profiles of root exudates around the roots were inversely modelled by a diffusion equation including growth rate of roots.

Main findings

1) **Radial rhizosphere extension** was **independent** of soil water content and root type (Fig. 2).
2) **Root growth rate** increased longitudinal exudate distribution and total exudation (Fig. 3,4).
3) The **diffusion coefficient** was **independent** of bulk water content (Tab. 1).

Conclusions

- **Root growth** has a strong effect on exudate distribution and total exudation → it should be included in rhizosphere models.
- Rhizosphere water contents and diffusion coefficient were similar for both treatments → effect of **mucilage.**

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