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REDUCED N LOSSES

DUE TO SUBSTRATE INDUCED IMMOBILIZATION

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Introduction

Plant residues with a low C-N-ratio like from oilseed rape (OSR) and faba beans enable fast mineralization after harvest. Due to low N uptake by typical subsequent crops, e.g. winter wheat (WW), surplus N might cause groundwater pollution and GHG emissions. Soil mineral nitrogen (SMN) can be immobilized by the microbiome via conversion into organic forms and therefore kept from loss (Trinsoutrot et al., 2000). We tested the application of different organic substrates (Tab. 1) as an option to promote microbial immobilization, delay mineral N release and improve synchronization of N availability and N uptake by following crops.

Material & Methods

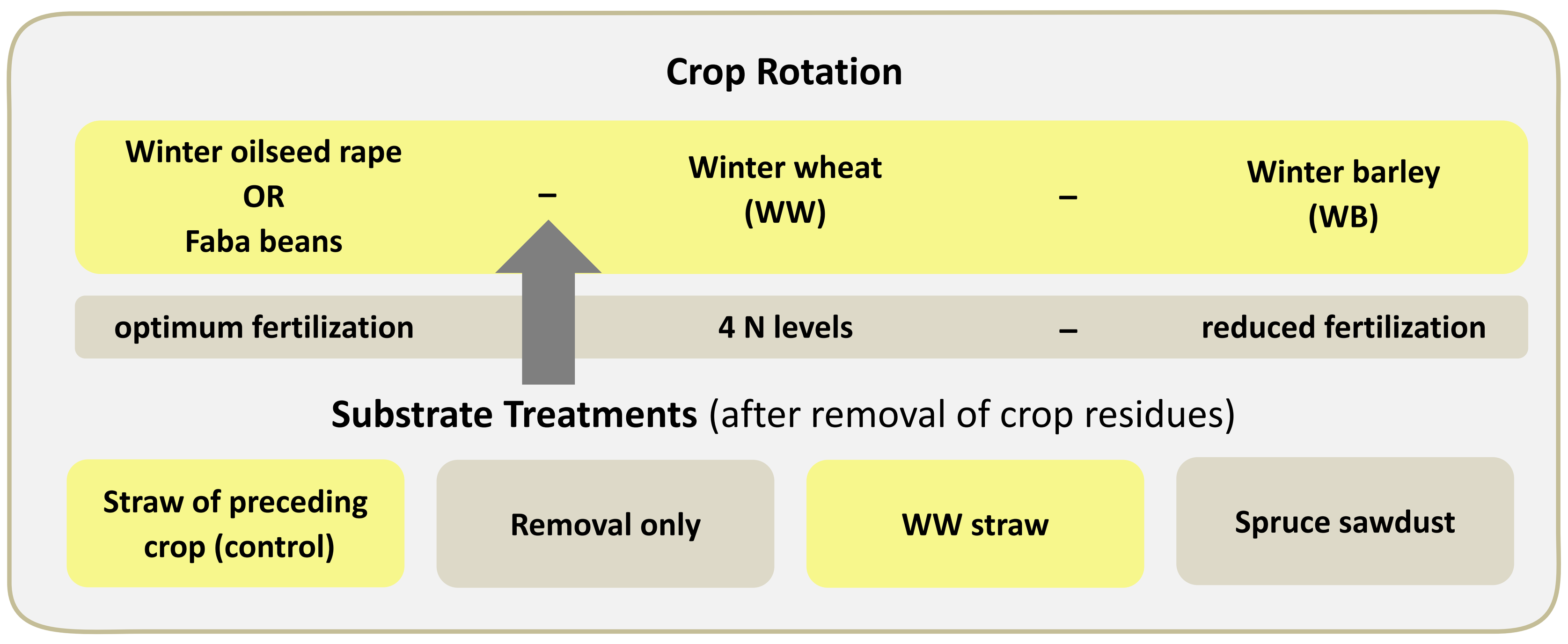

Fig. 1: Scheme of the field experiment

Measurements:

- SMN dynamics
- N_2O quantification with closed chambers (August to March in WW)
- Yield parameters (all crops)

Tab. 1: Substrate properties (analysis of 2015)

Substrate	C/N	added C [t ha⁻¹]	added N [kg ha⁻¹]
Rapeseed straw	84	4.1	59
Faba bean straw	53	2.2	41
Wheat straw	101	3.7	37
Spruce sawdust	791	4.1	5

Data analysis was done with mixed models in R. For N leaching calculation we used a process-oriented plant-soil-atmosphere model developed in our working group, parameterized with the actual field data (HUME, Kage and Stützel, 1999).

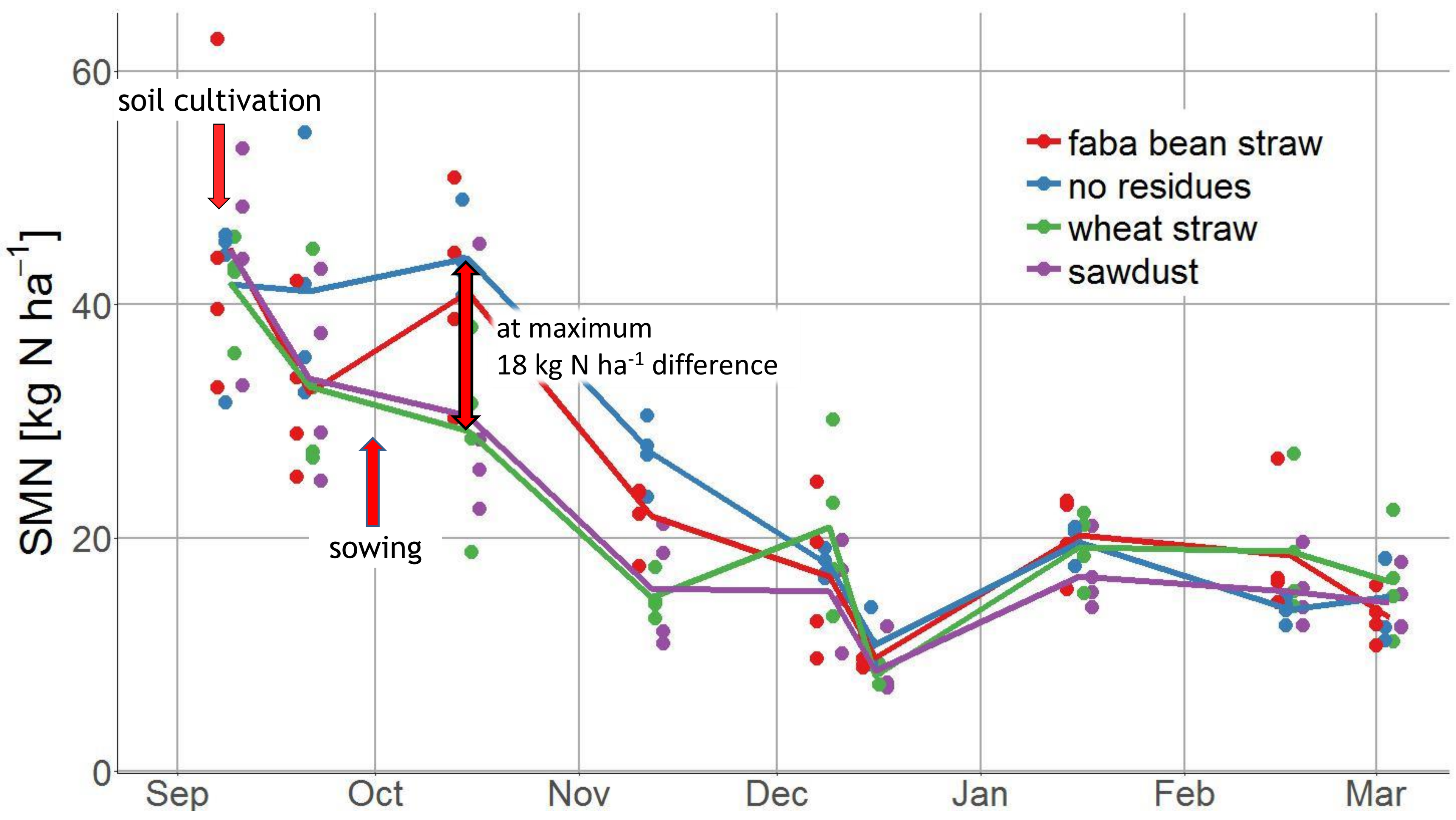

Fig. 2: Examplary SMN contents in 0 – 30 cm depth in the faba bean rotation, September 2015 – March 2016

Results

SMN dynamics

- On average of rotations and years SMN was 13 kg N ha^{-1} lower after application of wheat straw and sawdust compared to the treament without any residues (Fig. 2)
- Calculated N leaching was on average 21 kg N ha^{-1} higher without any residues compared to wheat straw and saw dust treatments

Yield

- Winter wheat: maximum yield lower after application of wheat straw (on average 2 dt ha^{-1}) compared to the other treatments
- Winter barley (fertilized with 50 kg N ha^{-1}): average grain N uptake is 7% lower after the treatment without residues prior to winter wheat compared to the control (Fig. 3)

N_2O emissions

- Cumulated emissions were low to moderate (0.59 kg N ha^{-1} in average)
- Correlation between flux rates and soil temperature (ρ = 0.4) and soil moisture (ρ = -0.12) at $p < 0.01$
- There was no significant effect of the substrates on N_2O emissions

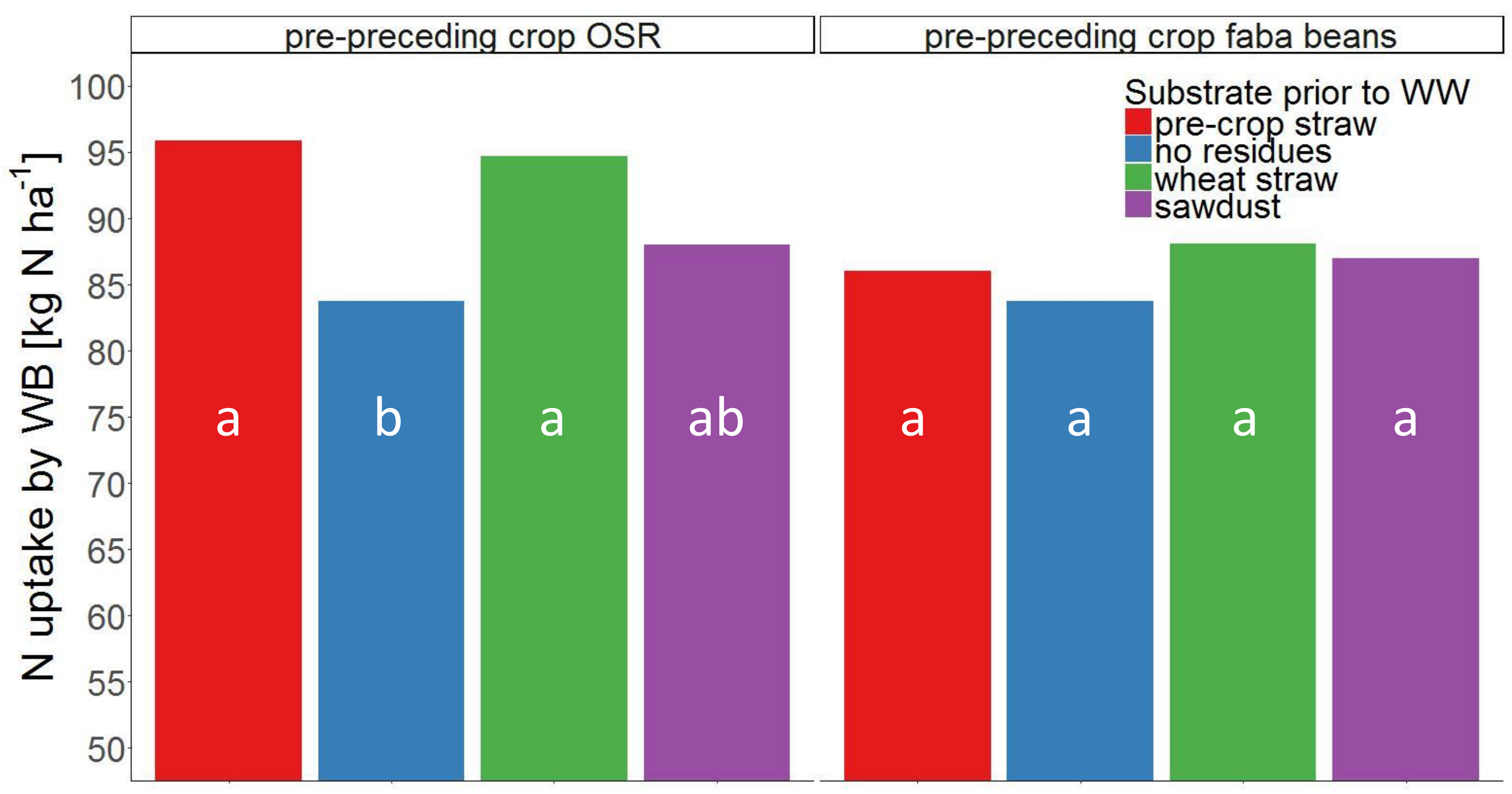

Fig. 3: Grain N uptake by winter barley in the second year after the substrate treatment; letters indicate significant differences per rotation ($p < 0.05$)

Discussion

The SMN dynamics suggest nitrogen immobilization after treatments with substrates with a low C-N-ratio. Though, this does not explain the reduction of the calculated maximum wheat yield in the WW straw treatment. Pathogen transfer by wheat residues may be an explanation that need further investigation. Also, a non-compensable N deficiency in the early stages of plant development could reduce the final yield.

In the second year after the treatment, delayed release after N retention by OSR residues and wheat straw had a positive effect on the yields of winter barley (in average +7%). Besides a pre-preceding crop effect (OSR promoting WB), there was no significant interaction between pre-preceding crop and substrate treatment.

The already low N_2O emissions of autumn and winter are rather affected by climatic conditions (soil temperature and moisture) than by substrate addition.

The trial will be maintained three further years, enabling observation of long-term effects and repeated treatments. Sensitivity analysis will help to enlighten the mechanisms of the substrate effects. After final validation the model will be used for evaluation of spatial and temporal scenarios.

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References

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