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Nitrogen use efficiency of crops in a newly arranged agricultural landscape: effects of field size, crop synergy and soil heterogeneity.

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Introduction

- Over-application of N (mineral and organic fertilizer) leads to environmental degradation via leaching as nitrate (NO_{3-}) and gaseous emissions of nitrous oxide (N_2O) or ammonia (NH_3).
- A novel field experiment (patchCROP) is designed by breaking down the characteristic large, sole-cropped fields into site-specific patch-based multi-cropping landscapes in Brandenburg, Germany (Grahmann et al., 2021).
- The aim of patchCROP is to redesign agricultural production systems while maintaining crop yields and minimizing nutrient losses and enhancing biodiversity and ecosystem services.

Objectives

Within this scope, the objectives are:

- To understand the spatial variability of biomass N of different crops from the edge to the centre of the smaller field arrangements, called patches.

Materials & Methods

Study site

- A large 70 ha field was divided into 30 smaller fields of ~0.5 ha (72m x 72m) considering soil heterogeneity, defined as patches.
- Four patches were selected for this study (Table 1).
- Creation of non-fertilized (0-N) and fertilized(+N) micro-plots (1.8 m^2) for calculating end-of-season NUE and to understand if the spatial variability of biomass N varies due to small scale soil heterogeneity.
- Sampling was conducted at twelve locations along a transect from the edge to the centre (Figure 1).
- Sampling has been conducted over two cropping cycles in 2021 & 2022.

Table 1: Arrangements of crops within four patches for consecutive seasons.

Year	Patch 73	Patch 74	Patch 89	Patch 95
20-2021	Rapeseed	W. Wheat	W. Rye	W. oat
21-2022	W. Barley	Rapeseed	Sunflower	Maize

Collected Data

- Soil (0-30, 30-60, 60-90 cm) for N_{min} and moisture and biomass for biomass N.
- Sampling at three different crop stages (stem elongation, flowering and harvest).
- Soil texture (% sand, silt, clay) up to 25 cm by GEOPHILUS (Lueck & Ruehlmann 2013)
- Slope and aspect from 1m digital elevation model (DEM): downloaded from https://data.geobasis-bb.de/geobasis/daten/dgm/

Figure 1: Sampling locations along a transect from the edge towards the centre of the patch. Image: UAV mounted Parrot Sequoia+ Multispectral Camera 31.05.2021

Preliminary results

Two-sample t-test showed significant difference (p 0.001**) in biomass N between 0-N and +N plots.

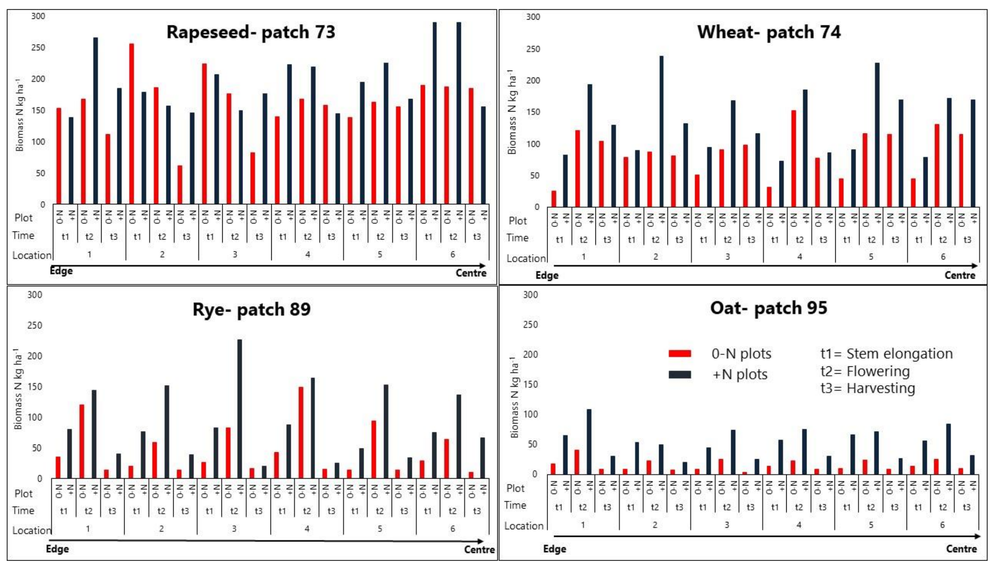

Figure 2: Distribution of biomass N in four patches, sampling was done in three different crop stages.

One-way ANOVA was conducted separately for 0-N and +N plots, considering location (edge-centre) as a factor. No significant spatial variability (from edge to the centre) was found for biomass N. Additionally, multiple linear regression was run to understand soil factors influencing the availability of biomass N in each patch (Figure 3). Elevation has a statistically significant effect on biomass N in rapeseed (p 0.0149*), wheat (p 0.0006**) and oat (p 0.004**). Additionally, soil moisture (0-30cm) has also shown significant effect in wheat (p 0.001**) and rye (p 0.0170*).

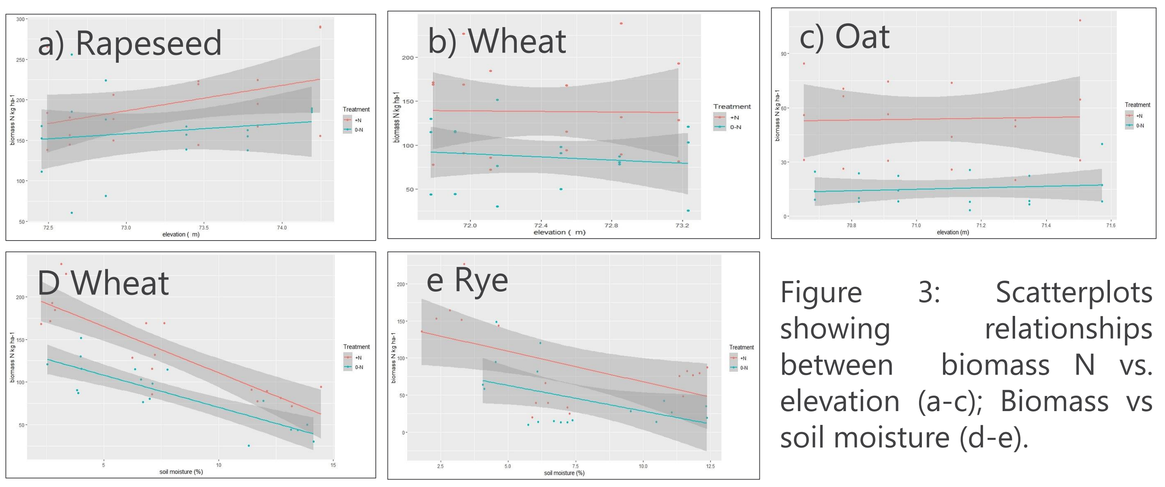

Figure 3: Scatterplots showing relationships between biomass N vs. elevation (a-c); Biomass vs soil moisture (d-e).

Way forward:

- Field sampling and data processing, 2021/22 season
- Calculation of Nitrogen use efficiency (NUE)
- More robust statistical analysis (linear mixed effect model) to understand the dynamics of Nitrogen in newly arranged cropping systems

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