Soil compaction related to root growth of cover crops and N dynamics

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Introduction

According to the EU Nitrate Directive, agriculture in Flanders needs to reduce nitrogen (N) leaching to ground and surface waters. Apart from adjusting fertilization management, one of the measures to reach this goal is to sow cover crops in autumn. These crops prevent N-leaching during winter months. Arable land in Flanders is subject to compaction due to the use of heavy machinery under wet conditions.

Objective

To investigate the impact of compaction on the below and aboveground cover crop growth and the efficiency to take up N throughout the growing season.

Material and methods

Experimental set-up

- Location field plot: Merelbeke, near Ghent, Belgium
- Locations within field plot (Fig. 1):
  - headland (block A)
  - normal conditions (block B)
  - wet conditions (block C)
- Treatments:
  - bare
  - Italian ryegrass (*Lolium multiflorum* Lam.)
  - white mustard (*Sinapis alba* L.)
- Number of replicates per block: 3
- Soil type: anthric Albeluvisol, sandy loam, %C: 1.0-1.1%
- Sowing date: August 29th 2008

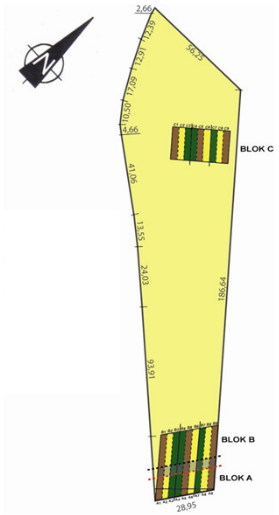

Figure 1: Experimental set-up (brown: bare plots; yellow: white mustard; green: Italian ryegrass). Plot size: 3mx10m (A) or 3mx15m (B and C).

Measurements

- Aboveground biomass parameters (Oct, Nov, Feb)
  - dry matter yield
  - N-uptake
- Rooting parameters (Oct, Nov, Feb)
  - rooting depth (cm)
  - root length (cm)
  - root mass (g)
  - root length density (cm cm^{-3})
  - root density (mg cm^{-3})
- Soil compaction (March 2009)
  - penetrologger
  - kopecky rings: 15-20, 35-40, 50-55 cm
- Soil mineral N (Oct, Nov, Feb)
  - 0-90 cm or 0-210 cm; per 30 cm

Results

Soil compaction

Penetration resistance (Fig. 2) was significantly higher on the headland (A) than in B and C for the 15-30 cm soil layer and significantly higher in A and B than in C for the 30-45 cm soil layer.

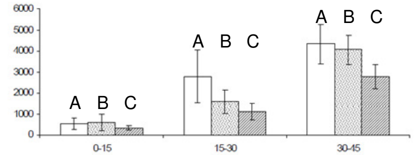

Figure 2: Average maximum soil resistance (Y-axis; kPa) within each block (A, B, C) for three soil depths (X-axis; cm); with standard deviations.

Soil compaction and aboveground dry matter yield

Aboveground biomass was very variable on the headland. Therefore, locations with low yield (Alow) were sampled separately from locations with normal yield (Anormal). Although it was our hypothesis, these yield differences could not be attributed to differences in soil compaction.

Soil compaction and root parameters

Increased soil compaction restricted rooting depth to 30-40 cm on the headland in contrast to 50-60 cm in B and C. No location effects were detected for the other root parameters.

Cover crop type and N-uptake

N-uptake in October was higher for white mustard than for ryegrass because of the fast early crop development. This difference had disappeared in November.

Soil mineral N

Mineral N content (Fig. 3) in the 0-90 cm soil profile (residual N) did not differ between both crop types in November. Except for in Alow, the cover crop plots had a significant lower residual N than the bare plots, showing their efficiency to take up N during autumn or winter.

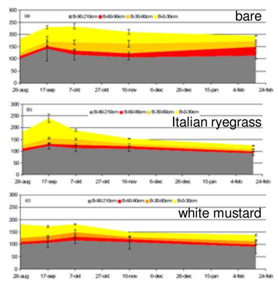

Figure 3: Time evolution (X-axis) of mineral N (kg/ha; Y-axis) in different soil layers measured in block B.

Mineralisation

Mineralisation in the bare plots between the end of August and October, was lower in A than in B and C. This could be explained by the higher soil compaction in A which limits mineralisation.

Conclusions

Growing cover crops has positive effects on the N-uptake in autumn or winter and prevents N leaching. In this study, soil compaction had an effect on rooting depth and probably also mineralisation. However, no clear effects on aboveground yield, N-uptake and soil mineral N in cover crop plots could be observed.

Reference

Coorevits, L. 2009. Bewortеling van groenbedekkers in functie van bodemverdichting – Consequenties voor de stikstofdynamiek. MSc Thesis, K.U.Leuven, 124p.

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