

Assessing the Influence of Conservation Agriculture on Crop Growth and Development: Insights from an Experimental Study

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BACKGROUND

Globally, conventional farming practices are causing problems for many farmers in through increasing labour and fuel costs, and damage to soil health. In response, many farmers are instead taking up the practice of Conservation Agriculture (CA) which consists of:

Reduced soil disturbance



Permanent soil cover



Crop rotation



CA is associated with improved water and nutrient efficiency, a more sustainable relationship between the farmer and the soil structure, and a reduction in labour and fuel requirements.

OBJECTIVES

- Explore the impact of tillage and residue retention on
 - Soil properties
 - Crop growth and development
- Assess these changes over an eight-year period

METHODS

The treatments on the trial field consist of

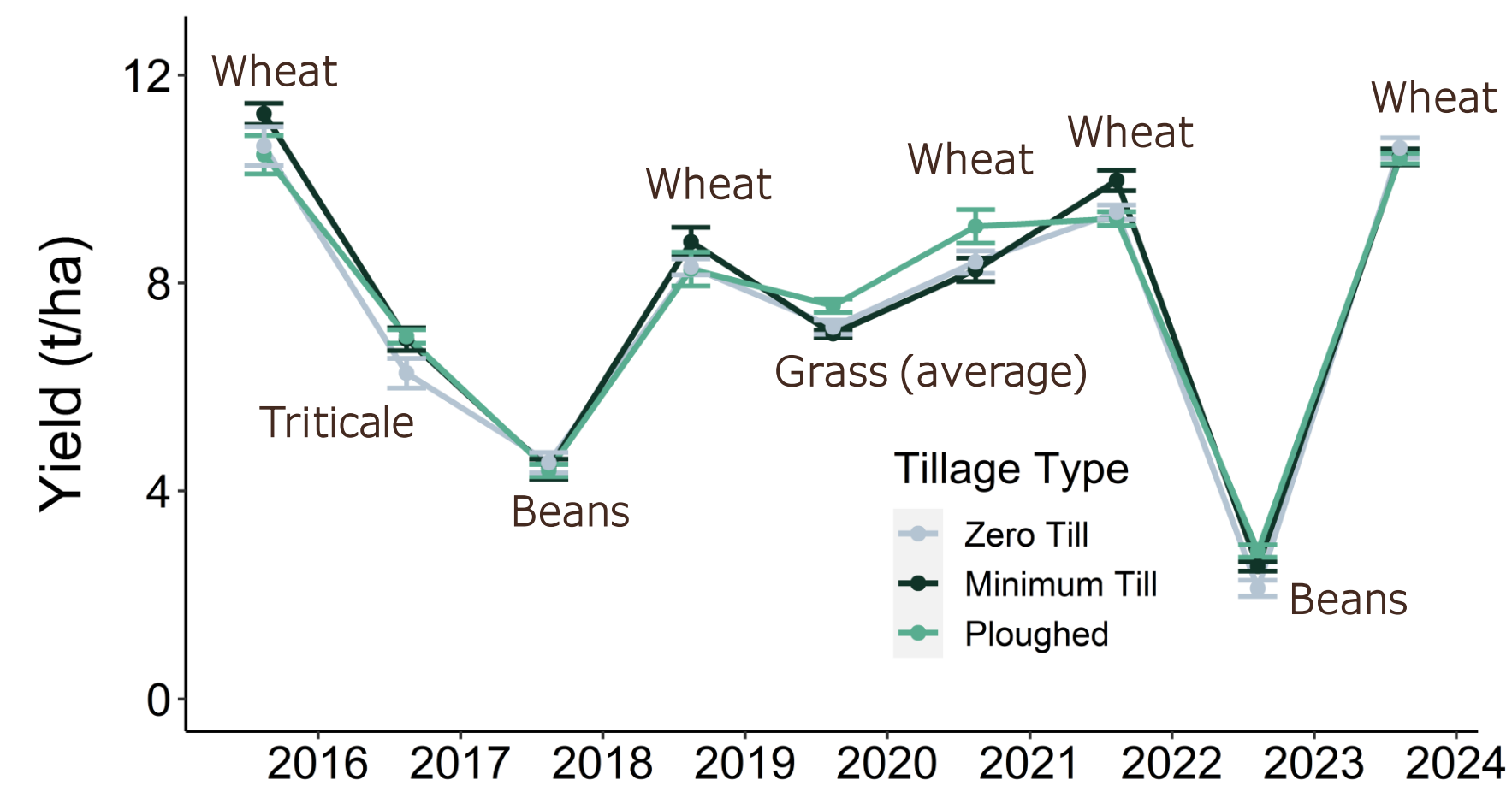
- ZT - Zero tillage (seed drilling only)
- MT - Minimum till (tine disks to 10 cm)
- PL - Ploughing (mouldboard ploughing to 25 cm).
- Residues (chopped straw from the previous crop)
- No residues.



This trial has been running since 2014 and so these plots are in their 10th year of treatment, cycling through a cereal-based crop rotation with detailed measurements as presented here beginning in 2020.

RESULTS

Annual yields under different tillage types since 2014



No tillage type significantly outperforms another throughout the years (though some are significantly higher yielding in a specific year), nor is there a trend toward one preferred tillage type for this farm.

Soil structure assessments from the 0-10 cm range

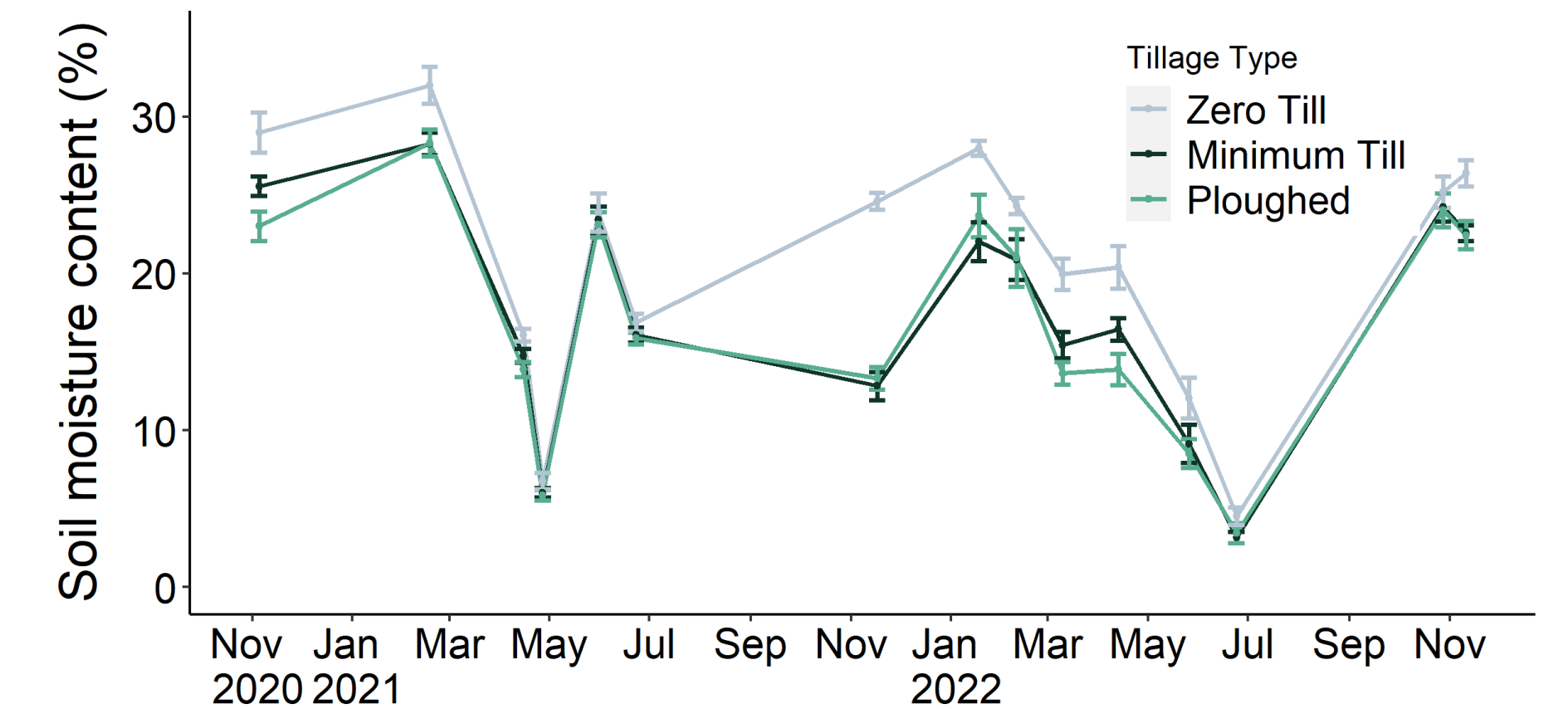
Tillage Type	Average Bulk Density (g/cm ³)	Average Penetration Resistance (kPa)
Zero Till	1.09	832
Minimum Till	1.01	596
Ploughed	1.08	491

The soil can be seen to significantly increase in bulk density ($P=0.007$) and penetration resistance ($P<0.001$) under reduced tillage in the top 10 cm. However, due to the sandy loam soil, these values are not high enough to be associated with restricted root growth (~ 1.7 g/cm³ and ~ 1800 kPa) and so are unlikely to be the cause of the poor establishment under reduced tillage. Instead, poor drilling was seen at the beginning of the season in the reduced tillage plots where the general-purpose Horsch Sprinter winged tine drill did not perform as well on the denser soil.

CONCLUSIONS

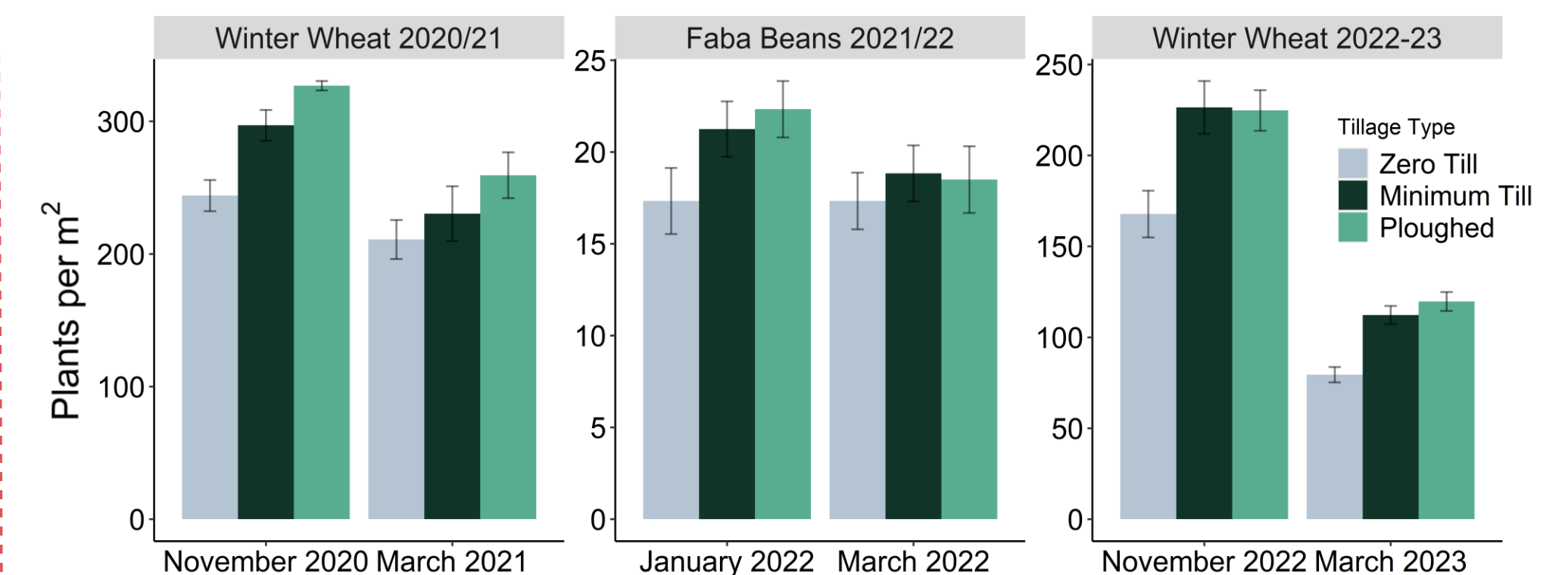
- Neither CA practices, nor conventional tillage practices result in a consistent improvement in yield.
- While CA practices are associated with increased soil density, in the loose sandy soil of this trial these effects are not strongly seen.
- The main impact of the tillage type on the yield on this soil type is at emergence where reduced crop establishment is seen, likely as a result of poor drilling.
- Where CA practices are seen to outperform conventional is later in the season with compensatory growth seen in increased wheat grain number and size and improved bean pod numbers, likely due to increased soil moisture.

Soil moisture in the top 5 cm of the soil



The soil moisture content is significantly higher in the top 5 cm of the soil under zero tillage than under either minimum tillage or ploughing ($P=0.001$) though this difference becomes less pronounced throughout the season.

The establishment rate measured at emergence and in Spring



Reduced tillage sees a significant reduction in the establishment rate as compared to the ploughed plots ($P=0.001$) and is lower again under zero tillage than minimum ($P=0.002$). This trend continues into the final harvest where the stems per m² are still significantly lower in the zero tillage plots ($P>0.001$).