The influence of conservation agriculture on soil biophysical properties, crop growth and yield in the UK

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Introduction

Conventional farming practices can be costly in both labour and fuel while also being associated with soil erosion and nutrient loss. Conservation agriculture (CA) is a practice that consists of reduced soil disturbance, permanent soil cover, and crop rotation. This study investigates the effects reduced tillage and residue retention, on soil structure, soil biological activity, crop growth, development, and yield.

Materials and Methods

The experiment was carried out using a split-plot design with residue retention on the main plot and tillage technique (zero-tillage, minimum-tillage or conventional-tillage) on the sub-plot. There were four replicate blocks.

Soil biophysical measurements

Soil property measurements were made approximately every two months throughout the growing season including soil moisture content, bulk density, organic matter and penetration resistance.

Crop growth and development measurements

Crop measurements of chlorophyll content and spectral ratios were made approximately every 100 degree-days. Biomass harvests of 0.72 m^2 were carried out throughout the growing season at growth stages 31, 37, 39, 61, and the day before harvest to assess green area, dry biomass, and seed development.

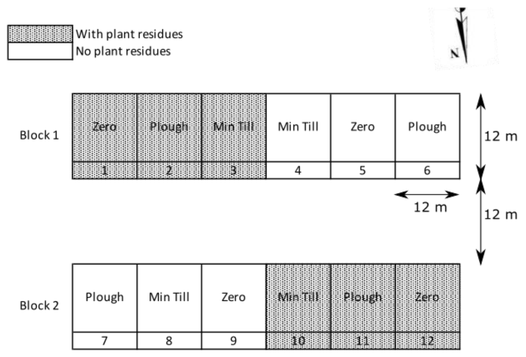

Fig 1. **Plan for the current trial, begun in 2014**

Results and Discussion

Changes seen in crop growth and development

The yield from the minimum till plots was significantly higher (P=0.005) than either ploughing or zero tillage. Residues had no significant impact on the yield (Fig. 2). The key changes in the components of yield are the shoot number (Fig. 3) and the 1000 grain weight (Fig. 4).

Changes seen in soil properties

The soil under conservation tillage became more tightly packed as seen through higher bulk density and penetrometer resistances throughout the season (P<0.001, P<0.001). Additionally, the soil moisture content was highest throughout the season, though especially at the beginning, in the zero till plots, followed by minimum, then ploughed (Fig. 5, p<0.001).

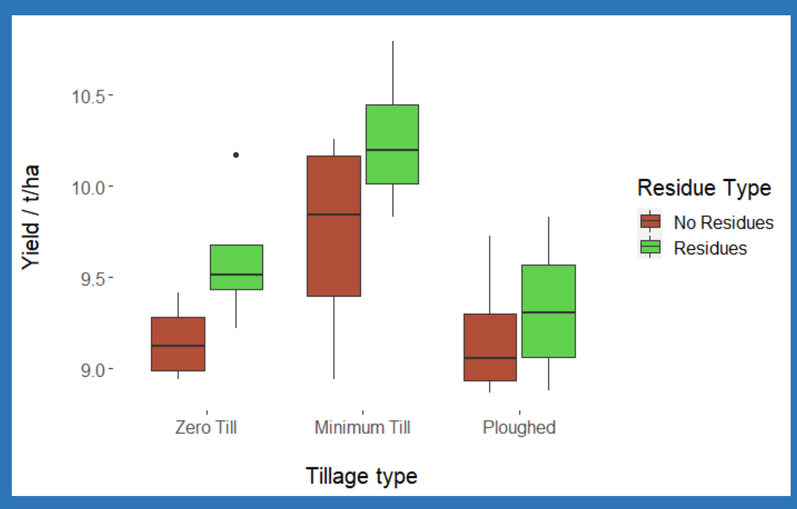

Fig 2. **The average final yields of wheat under different tillage and residue conditions.**

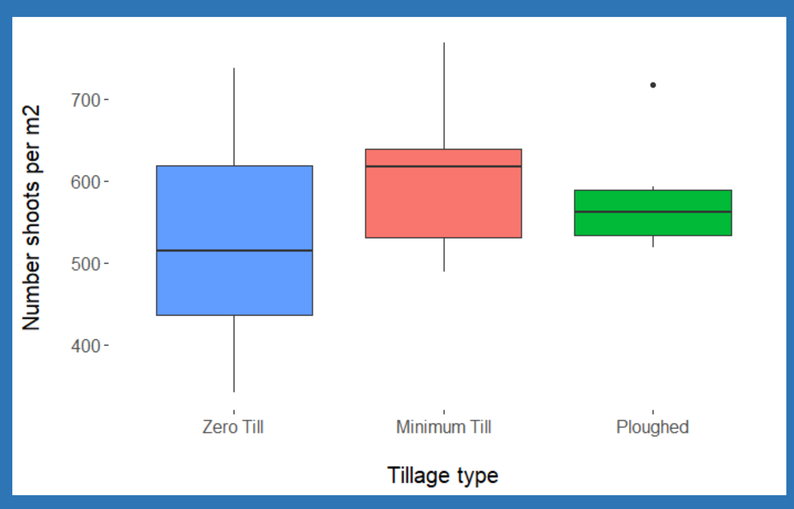

Fig 3. **Number of shoots per m^2 under different tillage conditions**

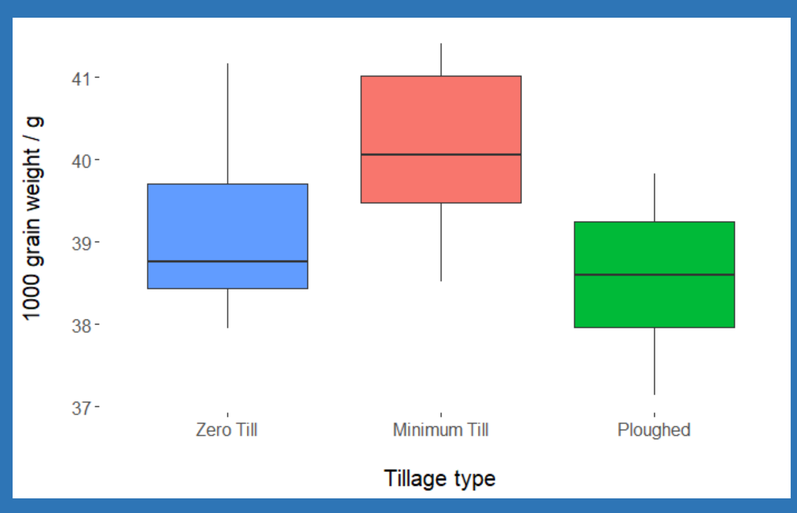

Fig 4. **1000 grain weight in grams under different tillage conditions**

Fig 5. **The soil moisture content (%) of the soil throughout the year under different tillage conditions**

The grain number per ear is determined by the survival of florets during growth stages 51-59, and the grain size from 59 onwards. In 2021 this occurred in the beginning of June which was both warm (17°C) and dry (0.6 mm rain). It could be predicted that low soil moisture retention in a key growth period during dry weather could lead to less floret survival and lower grain filling and thus a lower grain number.

Conclusions

- **The yield was highest in plots that had been minimum tilled than either zero tillage or ploughing (P=0.005), although residues had no impact.**
- **The disparity in yield was likely driven by dry conditions during the grain production and grain filling periods in June where higher soil moisture levels under conservation tillage allowed higher dry matter production and less plant stress.**
- **The zero tillage plots suffered from large bare patches driving down overall yield despite the high production levels of the remaining plants.**

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