Traffic and Tillage effects on soil carbon dynamics and crop yield

Ana B. Prada Barrio[1], Paula A. Misiewicz[1], Edward Dickin[1], David R. White[1], Simon L. Jeffery[1], Diogenes L. Antille[2] and Richard J. Godwin[1]*

[1] Harper Adams University, Newport, UK;

[2] CSIRO Agriculture and Food, Canberra, Australia

* Presenting author (apradabarrio@harper-adams.ac.uk)

1. Objective

To determine the impact of traffic and tillage systems on soil organic carbon dynamics and carbon sequestration and their interaction with crop yields.

2. Method

The unique randomised block design field experiment was established in 2011 at Harper Adams University (United Kingdom). It consist of 36 plots (4 m wide and 80 m long) with three tillage (Deep, Low and Zero tillage) and three traffic treatments (Standard tyre pressure, Low tyre pressure and Controlled Traffic Farming -CTF) (Fig.1). It was drilled with winter barley *var.* Belfry (hybrid) in autumn 2020.

Large Marsh field at Harper Adams University

Photo source: Jonathan Gill at Harper Adams

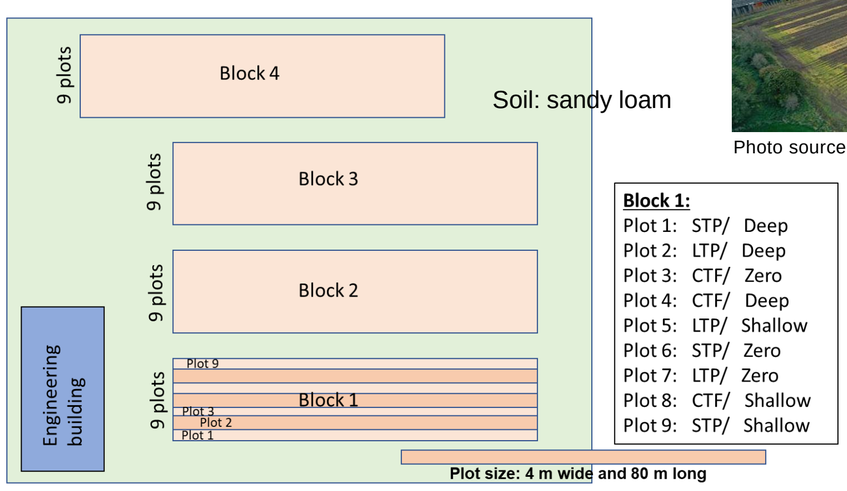

Fig. 1 Randomised block design

Hand-harvested yield data was obtained from individual crop rows that represented the trafficked and non-trafficked area of each plot for a length of 0.5 m. Subsequently whole plots were harvested with a combine (4 m header) and grain yields recorded.

Soil samples were collected following harvest at 0-10, 10-20 and 20-30 cm depth for soil organic matter (SOM) content and Total Soil Organic Carbon (SOC) analysis.

Further soil samples will be collected after the cover crop/ before the new crop, millet (sown spring 2022), and postharvest.

3. Key Results

The hand-harvest results showed significantly higher yields ($p<0.001$) on the non-trafficked area of the controlled traffic farming from the zero tillage treatment compared to the deep tillage, but not for the shallow tillage (Fig. 2).

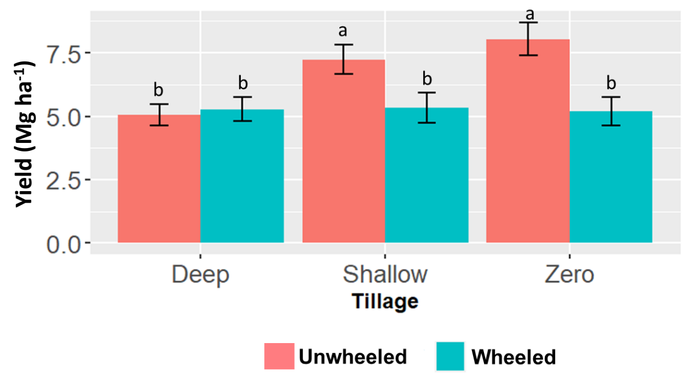

Fig. 2 The average hand harvest Yield in CTF treatments

The combine harvest results, based on whole plot areas, showed no significant differences in grain yield between treatments in 2021 (Fig. 3).

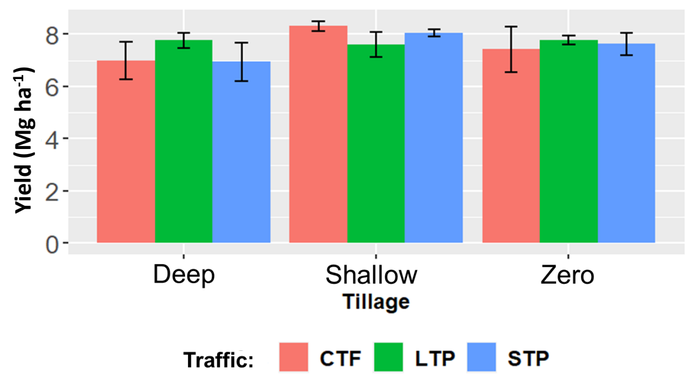

Fig. 3 The average yield from the combine harvest per tillage treatment

Deep tillage had significantly lower SOM content across traffic and tillage treatments at 0-10 cm (Fig.4).

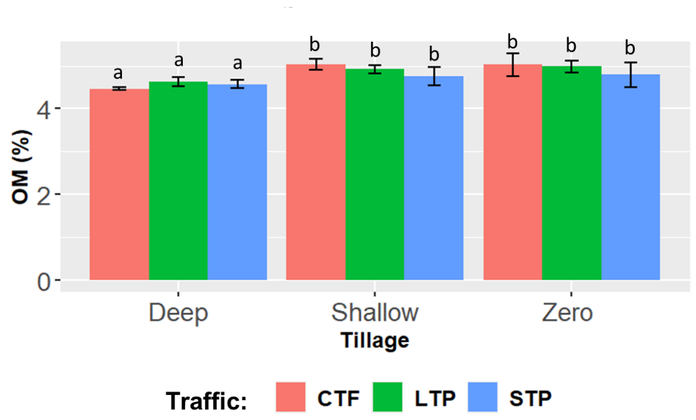

Fig. 4 The average soil organic matter content on 0-10 cm

When SOC stocks were calculated at equivalent soil mass (ESM), they were significantly higher on CTF with zero tillage, when compared to Deep and Shallow tillage treatments at 0-10 cm (Fig. 5). No other significant differences were found.

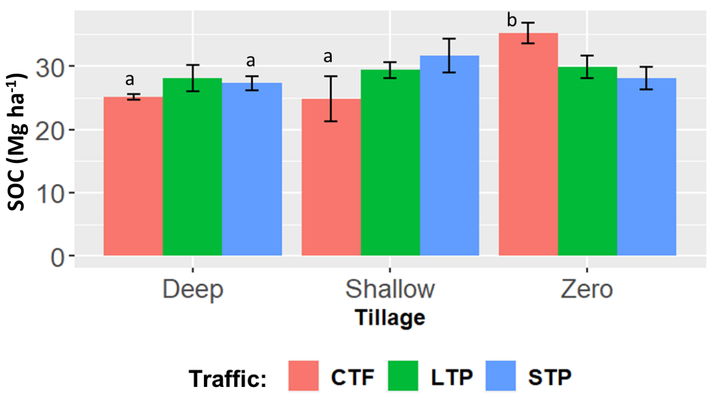

Fig. 5 The average SOC stocks calculated at ESM on 0-10 cm

4. Conclusions

While there were no significant differences in yield (Mg ha^{-1}), zero tillage delivered similar yields as the other treatments but has demonstrated the potential to increase SOM content and SOC stocks within the 0–10 cm layer in CTF treatments. This system also requires less fuel consumption and labour, resulting in further C savings.

This project will continue to investigate the environmental impacts of tillage and traffic systems on soil health and crop yields, with a particular focus on soil organic carbon dynamics.

5. Future Research

Millet crop (April '22 – Sept. '22). C4 plants will be established in spring where only C3 plants have grown.

Methodology:

- SOM and SOC stocks will be measured as before.
- δ13C isotope ratios will be applied across to different depths and different SOM fractions to investigate soil carbon dynamics.

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