What the Tarp? Assessing Influence of Cover Crop Termination Practices on Soil Health and Fertility in Organic Vegetable Crop Production

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Introduction

Establishing and terminating cover crops is a common practice used by organic farmers to improve soil health and fertility, prevent soil erosion, and sustain the soil microbiome. A limited amount of research has focused on assessing the influence of a novel no-till cover crop termination method known as soil tarping on soil health and fertility. Our ongoing research project was directly informed by regional farmers' use of tarping as a tool for terminating cash or cover crops and controlling weeds without tillage. We investigated the effects of three different cover crop termination methods in a spring seeded oat-field pea mix including i) mowing & tilling, ii) mowing & tarping and iii) rolling & crimping on soil fertility and soil health parameters.

Methods

The soil type in our study area was Ruse-Ensign-Nykanen complex fine sandy loam. Prior to implementation of the treatments, a previously uncultivated field was roto-tilled and an oat and pea cover crop was drilled across the entire area in May 2023.

A fully-randomized block design containing four replicates of the following alternative cover crop termination methods was subsequently established on July 19, 2023 i) Mow-Till, ii) Mow-Tarp, and iii) Roll-Crimp. Plots were each 12 x 52 ft (Figure 1).

Aggregate soil samples were collected from each plot on 7/19/2023 and 8/7/2023 and sent to The Cornell Soil Health Laboratory where active carbon, Autoclave-Citrate Extractable Protein, total carbon, total nitrogen, and soil organic carbon parameters were tested.

The soil samples from each plot and treatment type were compared between pre- and post-treatment study periods. Linear mixed-effects models were used to estimate means for all soil health response variables where timing (as pre or post) and treatment were fixed-effects and plot was a random-effect. The Tukey method was used to for all pair-wise mean comparisons in R (Table 1).

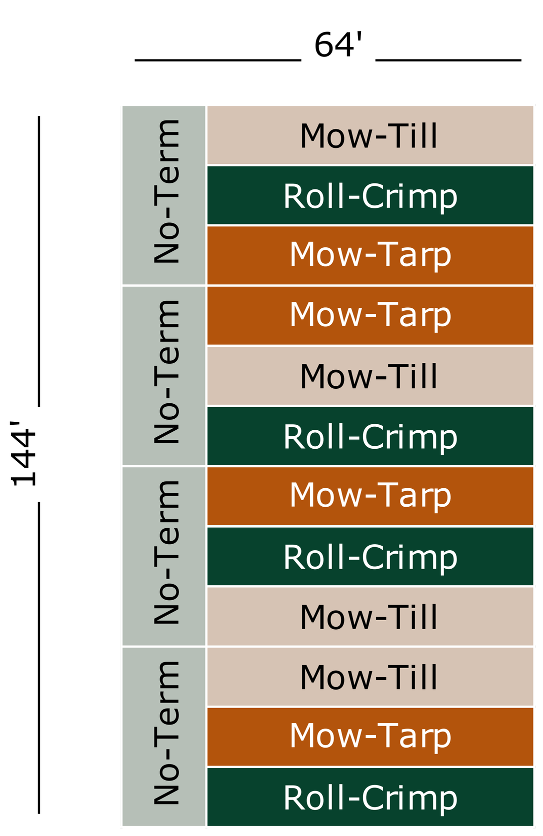

Figure 1. Study area at MOSA Certified Organic Upper Peninsula Research and Extension Center in Chatham, MI.

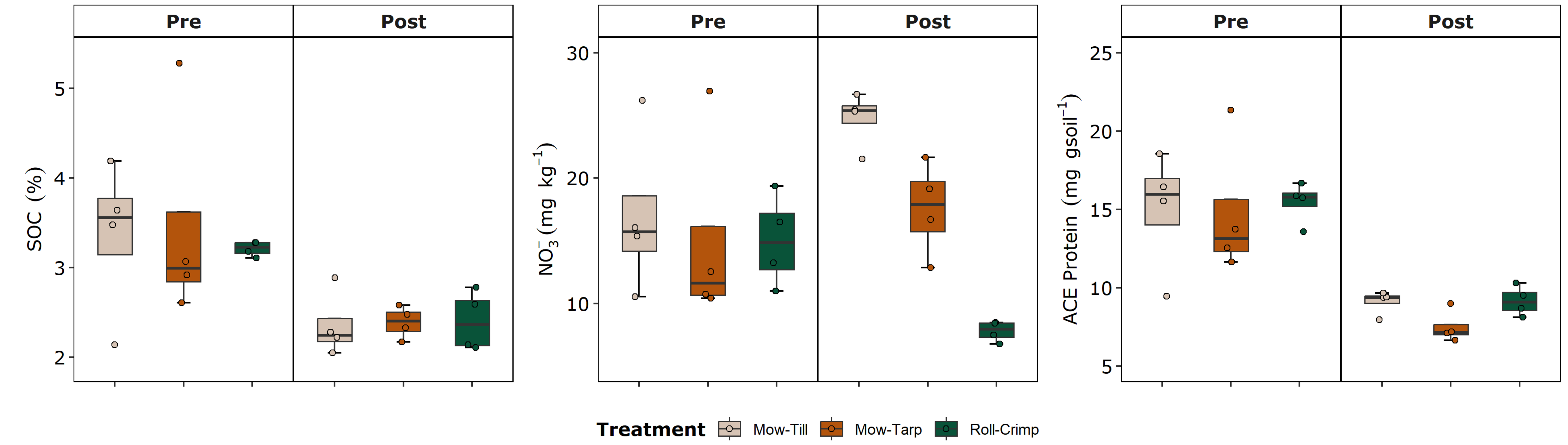

Figure 2. Soil organic carbon (SOC; left) , soil nitrate (NO_3^-; middle), and Autoclave-Citrate Extractable Protein (ACE Protein; right) observations (points) for each treatment during pre- and post-treatment study period. Boxplot lines represent median, 25%, and 75% quartiles, while whiskers represent quartiles ± 1.5 · interquartile range.

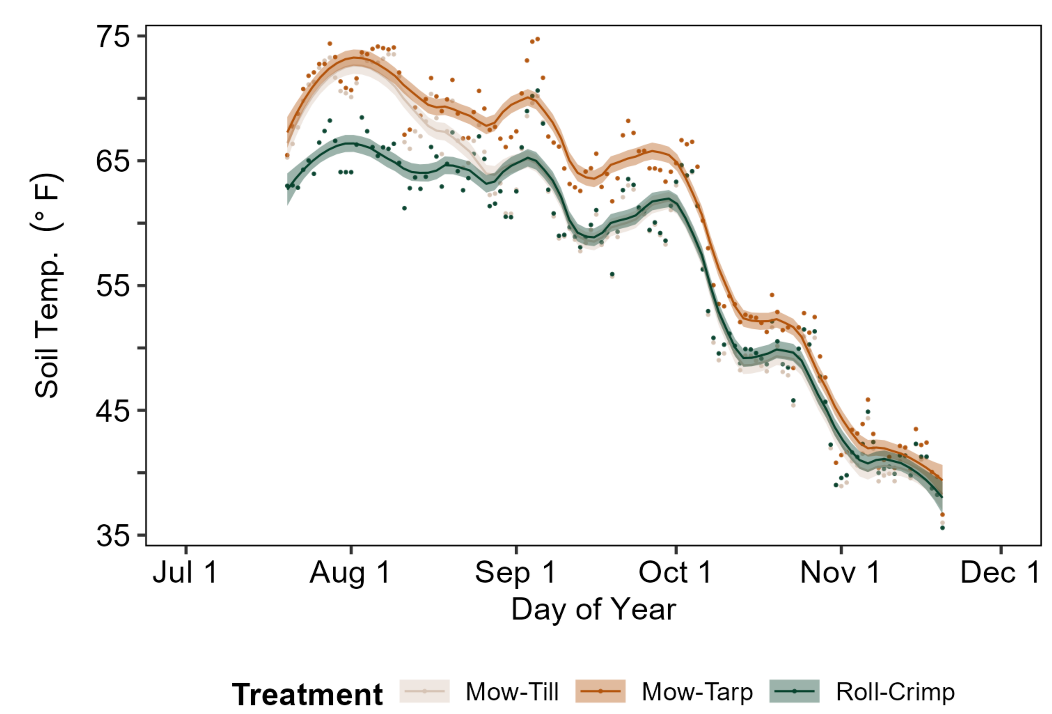

Figure 3. Mean daily soil temperature (°F) observations for each treatment throughout the study period.

Table 1. Soil sample summary, including number of observation (n), mean (± standard error) for nitrate (NO_3^-; mg kg^{-1}), inorganic nitrogen (IN; $NO_3^- + NH_4^+$; mg kg^{-1}), soil organic carbon (SOC; %), and ACE Protein (mg g^{-1}) during the pre- and post-treatment study period.

Timing	Treatment	n	NO_3^-	MCT NO_3^-	IN	MCT IN	SOC	MCT SOC	Protein	MCT Protein
Pre	Mow-Till	4	17.0 (±3.29)	a	23.3 (±3.47)	a	3.36 (±0.43)	a	14.99 (±1.95)	a
	Mow-Tarp	4	15.2 (±3.95)	a	21.6 (±4.44)	a	3.47 (±0.61)	a	14.81 (±2.21)	a
	Roll-Crimp	4	15.0 (±1.83)	a	21.1 (±2.07)	a	3.21 (±0.04)	a	15.46 (±0.66)	a
Post	Mow-Till	4	24.7 (±1.12)	b	30.3 (±1.26)	b	2.36 (±0.18)	a^w	9.11 (±0.38)	a^w
	Mow-Tarp	4	17.6 (±1.88)	b	23.1 (±2.03)	b	2.39 (±0.09)	a^w	7.50 (±0.51)	a^w
	Roll-Crimp	4	7.80 (±0.41)	a^w	13.4 (±0.34)	a^w	2.40 (±0.17)	a	9.16 (±0.48)	a^w

Significant between-treatment mean differences are indicated by (a) and (b), where within-treatment mean differences indicated by (^{w}) at p<0.1.

Results

NO_3^- moderately significantly ($p<0.1$) increased by 8.66 (mg kg^{-1}) in Mow-Till plots, whereas NO_3^- significantly ($p<0.05$) decreased by 6.96 (mg kg^{-1}) in Roll-Crimp plots in post- compared to the pre-treatment timing (Figure 2; Table 1).

Soil organic carbon (SOC) moderately significantly decreased ($p<0.1$) by 0.333 (%) and 0.335 (%) in the mow-till and Mow-Tarp treatments when the post- was compared to the pre-treatment timing, respectively. However no significant SOC difference was detected between the post- and pre-treatment periods within the Roll-Crimp plots (Table 1).

The 7.31 (mg g^{-1}) mean ACE Protein level decrease detected in Mow-Tarp was the greatest within treatment comparison among all termination methods, however ACE Protein levels were significantly lower in all treatments during the post-treatment period when compare to pre-treatment (Table 1).

Discussion

Soil NO_3^- levels were moderately significantly greater ($p<0.1$) in the Mow-Till and significantly lower ($p<0.05$) in the Roll-Crimp when the post-treatment study period was compared to pre-treatment indicating that additions of cover crop nitrogen residues were rapidly converted to inorganic nitrogen within the first three weeks following termination. Whereas inorganic forms of nitrogen were likely scavenged by microbes and/or taken up by vegetative regrowth during the first three weeks following the Roll-Crimp termination.

Mow-Till and Mow-Tarp SOC levels were moderately significantly lower ($p<0.1$) during the post-treatment study period when compared to pre-treatment indicating more soil carbon was mineralized or decomposed during the first three weeks following termination when compared to the Roll-Crimp. These findings are consistent with the mean daily soil temperatures which were 5.6 (°F) and 6.4 (°F) warmer in the Mow-Till and Mow-Tarp when compared to the Roll-Crimp during the first three weeks following termination (Figure 3).

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