SIX YEARS OF TILLAGE INFLUENCED SOIL CARBON FRACTIONS WITHIN CORN-SUGARBEET-SOYBEAN ROTATION IN SILTY CLAY SOIL OF NORTH DAKOTA

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INTRODUCTION

- In high clay soils, conservation tillage and N management may play crucial role in maintaining soil health.
- Different SOC fractions can provide early and sensitive indications on changes in SOC dynamics.

OBJECTIVES

- To determine the effect of tillage practices on SOC and its fractions within corn-sugarbeet-soybean cropping system.
- To determine the relationships among different SOC fractions.
- To determine the effect of N application on SOC fractions.

MATERIALS AND METHODS

Table 1: Experimental Sites (2011)

	Expt. 1 (Sugarbeet)	Expt. 2 (Soybean)	Expt. 3 (Corn)
Crop Rotations	S-C-SB-S-C-SB	C-SB-S-C-SB-S	C-SB-S-C
Expt. design	Split plot	RCBD	Split plot
Main plot	N (100 lb/acre) timing: • Full-N at preplant • Half-N early and half-N at V6 • Full N at V6	Tillage: • CT • NT • ST	N (150 lb/acre) timing: • Full-N at preplant • Full-N at V5-V6
Sub plot	Tillage: CT, NT,ST	None	Tillage: CT, NT, ST

- The soils are classified as Fine, smectitic, frigid Typic Epiaquerts.
- Sites are maintained under same tillage managements since 2005.

Table 2: Laboratory Analyses of Soil Samples

Properties	Methods	Citations
pH & EC	pH/Conductivity meter at 1:2.5 (w:v) soil to water ratio	Divito et al., 2011
BD	Gravimetric water content determined at 105°C for 24 hrs	Blake and Hartge, 1986
Texture	Hydrometer method by dispersing 40 g soil with 5 % NaHMP	Elliot et al., 1999
SOC	Dry combustion at 1000 ˚C in Carbon Analyzer	Cihacek and Jacobson, 2007
MBC	Chloroform fumigation and extracting the samples with 0.5 M K_2SO_4	Vance et al., 1987
CPOM-C	Burning coarse soil fraction (>53µm)-obtained after dispersing soil with 5 g L^{-1} NaHMP- in Muffle furnace at 550°C for 4 hrs	Sollins et al., 1999
$KMnO_4$-C	The absorbance of aliquot, obtained after reacting 5g soil with 0.02 M $KMnO_4$ for 2 mins, was measured spectrophotometrically at 550 nm	Weil et al., 2003
C_{min}	Soils incubated (50% WHC) with alkali traps (0.5 M NaOH) at 25°C for 30 day, and absorbed CO_2 determined by back-titration with 0.5 M HCl	Anderson, 1982

RESULTS

Table 3: Surface (0-15 cm) Soil Characteristics of Expt. Sites

Expts.	pH	EC (ds m^{-1})	BD (g cm^{-3})	Sand (g Kg^{-1})	Silt (g Kg^{-1})	Clay (g Kg^{-1})
Corn	7.58	0.26	1.18	26	458	516
Sugarbeet	7.66	0.11	1.14	21	467	513
Soybean	7.96	0.17	1.12	23	477	500

Table 5: Treatment Effects on Soil Properties in Corn

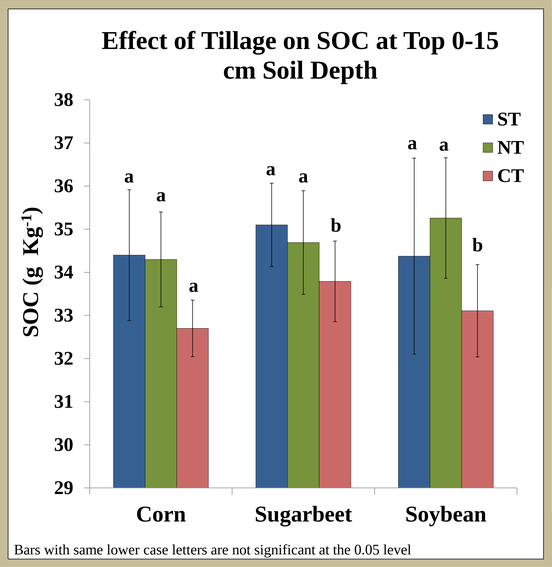
Variables	SOC (g Kg^{-1})	MBC (µg g^{-1})	CPOM-C (g Kg^{-1})	$KMnO_4$-C (mg Kg^{-1})	C_{min} (mg Kg^{-1})
N Timing	NS	NS	NS	NS	NS
Tillage	NS	NS	*	NS	NS
N Timing x Tillage	NS	NS	NS	NS	*

*Significant at 0.10 level, NS: not significant

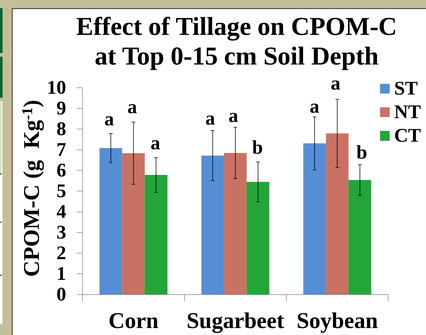
Table 4: Treatment Effects on Soil Properties in Sugarbeet

Variables	SOC (g Kg^{-1})	MBC (µg g^{-1})	CPOM-C (g Kg^{-1})	$KMnO_4$-C (mg Kg^{-1})	C_{min} (mg Kg^{-1})
N Timing	*	**	NS	NS	NS
Tillage	**	NS	**	**	NS
N Timing x Tillage	NS	NS	NS	NS	NS

*Significant at 0.10 level, **Significant at 0.05 level, NS: not significant



Bars with same lower case letters are not significant at the 0.05 level



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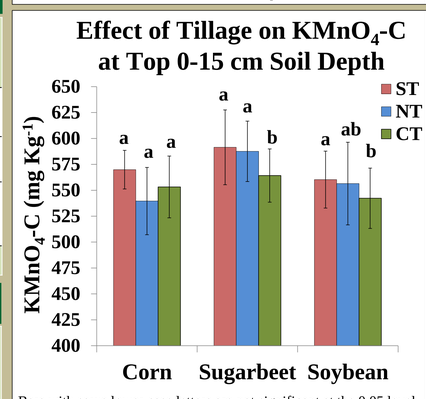

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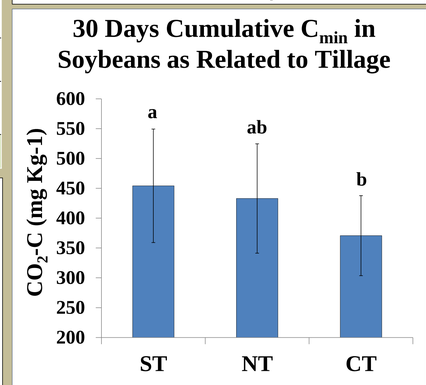

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Table 6: Pearson Correlation Coefficients Corn, N = 18

Variables	SOC	MBC	CPOM	$KMnO_4$-C	C_{min}
SOC		0.47	0.75	NS	0.58
MBC	0.47		NS	NS	0.82
CPOM	0.75	NS		NS	0.44
$KMnO_4$-C	NS	NS	NS		NS
C_{min}	0.58	0.82	0.44	NS	

Values are significant at the 0.05 level, NS: not significant

Table 7: Pearson Correlation Coefficients Sugarbeet, N = 36

Variables	SOC	MBC	CPOM	$KMnO_4$-C	C_{min}
SOC		NS	0.48	NS	0.34
MBC	NS		NS	NS	NS
CPOM	0.48	NS		NS	0.37
$KMnO_4$-C	NS	NS	NS		NS
Cmin	0.34	NS	0.37	NS	

Values are significant at the 0.05 level, NS: not significant

Table 8: Pearson Correlation Coefficients Soybean, N = 36

Variables	SOC	MBC	CPOM	$KMnO_4$-C	C_{min}
SOC		NS	0.36	NS	0.45
MBC	NS		NS	NS	NS
CPOM	0.36	NS		0.32	0.69
$KMnO_4$-C	NS	NS	0.32		NS
C_{min}	0.45	NS	0.69	NS	

Values are significant at the 0.05 level, NS: not significant

CONCLUSIONS

- Conservation tillage (NT and ST) significantly increased SOC, CPOM-C, $KMnO_4$-C, and C_{min} than CT.
- Significant positive correlations were found among SOC, CPOM-C and C_{min}.
- CPOM-C and C_{min} are significant indicators of tillage effect on SOC change in silty clay soils.
- N timing did not have any significant ($p<0.05$) influence on SOC and its fractions, except MBC in Sugarbeet (Experiment1).

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Abbreviations: SOC: soil organic carbon; CT: conventional tillage; ST: strip tillage; NT: no tillage; SB: sugarbeet; S: soybean; C: corn; RCBD: randomized complete block design; V5: 5th leaf stage; V6: 6th leaf stage; EC: electrical conductivity; BD: bulk density; MBC: microbial biomass carbon; CPOM-C: coarse particulate organic matter; NaHMP: sodium hexametaphosphate; KMnO4-C: potassium permanganate oxidizable carbon; C_{min}: mineralizable carbon; WHC: water holding capacity.