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Effect of tillage practices on the soil physical and chemical properties under on-farm conditions in Stark County, Ohio

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INTRODUCTION

- Soil management practices that enhance soil health are crucial for climate change mitigation and adaptation.
- Conservation tillage, including reduced or no-till systems, is widely recommended for enhancing soil carbon sequestration and improving soil health.
- The effect of tillage practices on soil properties depends on site-specific management practices.
- The on-farm study was conducted to evaluate the soil physical and chemical properties under different tillage practices in Stark County in northeastern Ohio.

MATERIAL AND METHODS

Study site

- Ten farms in Stark County, Northeast Ohio, with the same predominant soil type and slope were selected.
- Two undisturbed forest sites (one on the east side of the county and one on the west side of the county) adjacent to two of the selected farm sites served as reference sites
- The predominant soil type used in all study sites was a Canfield Silt Loam (2-6% slope).
- Crop rotation varied from corn (*Zea mays*) and soybean (Glycine max) to mixed forages and small grains.
- Farms follow different tillage practices:
  - Moldboard plowing (MP)
  - Vertical tillage (VT)
  - No-tillage (NT)
  - Long-term hay fields (HAY)

Soil sampling and analysis

- Five soil samples were collected from each field at 0-15 cm and 15-30 cm soil depth.
- Soil samples were collected with a soil auger to analyze for total carbon (TC) and major soil nutrients.
- Soil samples were collected in a core for soil bulk density and moisture retention measurement.

Fig.1 Soil sampling using the soil auger and soil core

Soil moisture retention

- Soil moisture was measured at five different pressures: 0, 3, 6, 33, and 1500 kPa
- Soil moisture content at 0, 3, and 6 kPa was measured using the tension table
- Soil moisture content at 33 and 1500 kPa was measured using the pressure plates

Fig.2 Processing of soil samples for soil moisture retention (a) soil saturation, (b) tension table (c) Pressure plate

RESULTS

Soil bulk density

- Soil bulk density (BD) was lower in woodland (WD) at 0-15 cm soil depth
- There was no effect of tillage intensity on soil BD at 0-15 cm soil depth
- At 15-30 cm soil depth, soil BD was significantly higher under NT than MP and VT fields

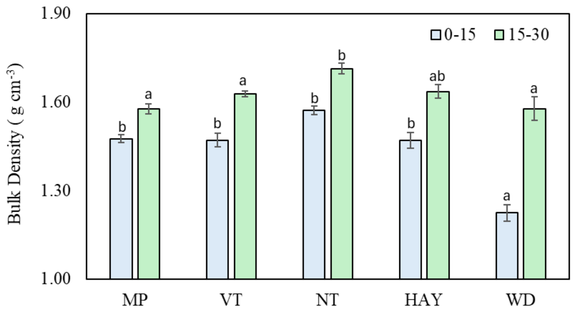

Fig.2 Effect of different management practices on soil bulk density at two different soil depths (0-15 and 15-30 cm). Different lowercase letters denote significant differences among the treatments within each soil depth ($p < 0.05$).

Soil macronutrients

- There was no difference in soil macronutrients among tillage treatments, except that the soil nitrogen was lowest in NT fields at 0-15 cm soil depth and highest in MP fields at 15-30 cm soil depth

Table 1. Effect of different management practices on soil macro nutrients: nitrogen(N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) at 0-15 and 15-30 cm soil depth. Different lowercase letters denote significant differences among the treatments within each soil depth ($p < 0.05$)

Treatments	N	P	K	Ca	Mg	S
	g kg^{-1}	mg kg^{-1}				
0-15 cm						
MP	1.6b	116a	162a	1435a	188a	11b
VT	1.6b	37a	129ab	1348a	182a	15ab
NT	1.4c	24ab	97ab	1556a	161a	16ab
HAY	2.1a	29ab	118a	1361a	196a	18a
WD	2.3a	12b	70b	445b	72b	21a
15-30 cm						
MP	1.2a	67a	99a	1415a	215a	10bc
VT	0.9b	9ab	49b	1263a	177a	10bc
NT	0.8b	7b	56ab	1220a	164a	12b
HAY	1.0ab	8ab	38b	935b	139b	7c
WD	0.9b	4b	37b	259c	50c	21a

Soil moisture retentions

- At saturation (0 Kpa), 3 and 6 kPa, the volumetric soil moisture content was higher under WD
- There was no significant difference in volumetric soil moisture content among the tillage treatments at any measured pressure

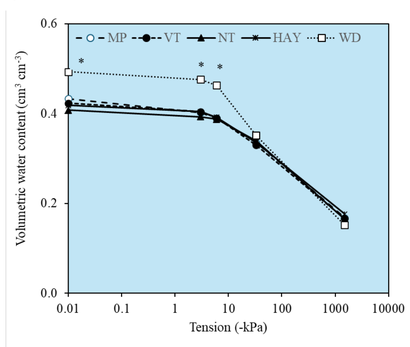

Fig.4 Soil water retention curves under different management practices. * indicate significant differences among the treatments ($p < 0.05$).

Total Carbon

- Total soil carbon (TC) was highest in hay fields and similar to TC in WD
- There was no difference in TC among tillage treatments at 0-15 cm soil depth
- TC was lowest in NT fields at 15-30 cm soil depth
- There was a significant positive correlation between TC, TN, and corn yield

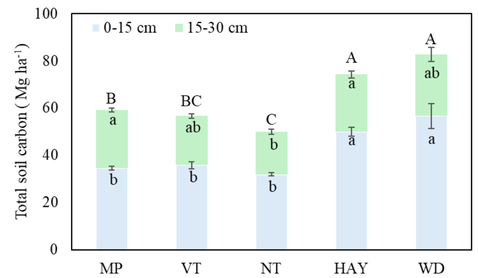

Fig.3 Effect of different management practices on soil carbon at two different soil depths (0-15 and 15-30 cm). Different lowercase letters denote significant differences among the treatments within each soil depth ($p < 0.05$). Different uppercase letters indicated the significant differences among the treatments for the whole soil profile (0-30 cm)

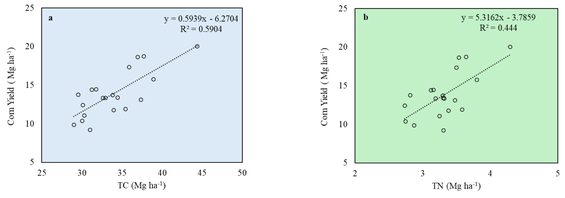

Fig.4. Correlation between corn yield and (a) TC and (b) TN at 0-15 cm soil depth

CONCLUSIONS

- NT reduced the TC and nitrogen content compared to MP at 0-30 cm, possibly due to manure application in the MP field.
- Future studies should aim to separate the individual effects of manure application and tillage practices on soil properties.

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