TILLAGE IMPACT ON SOIL ORGANIC MATTER, NITROGEN, AND PHOSPHORUS FROM 1990 TO 2014

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ABSTRACT

- The impact of continuous tillage on soil properties (soil health), and crop production potential continues to be an area of interest to the public
- While some studies show crop yields are not different for no-till (NT) and conventional till (CT) systems (Cook and Trlica, 2017), others have shown that yield and economic differences are important for different soil types and locations (Al-Kaisi et al., 2015)
- Soil organic matter (SOM) is one of the most important soil chemical properties that can be affected by tillage practices
- SOM levels increase under continuous no-till (NT) practice, but drop when conventional tillage (CT) is used
- To contribute to the existing wealth of cropping systems research, this study aimed at providing an understanding of how soil tillage, and N fertilization might be affecting SOM, and soil P availability in a North Dakota soil

OBJECTIVES

- Determine the impact of tillage on SOM content
- Determine if N fertility affects SOM under different tillage practices
- Verify if any changes in soil residual N and P levels vary by tillage practices

METHODS

- Long-term tillage trial began in 1987 at the NDSU Carrington Research Extension Center, ND
- Trial evaluates three, 4-year crop rotations, as a main plot; each crop within rotations is grown every year
- Three tillage practices: CT, MT, and NT, imposed in each block
- N treatments are applied annually (perpendicular to the direction of fertilization and planting, Fig 1) and include:
  - Urea, at flat N rates of 0, 50, 100 lbs/ac
  - Composted manure (MAN) applied at 200 lbs N once at start of every 4-year rotation cycle
- Soil is sampled annually after harvest. N and P are analyzed annually; SOM is once every 4 years

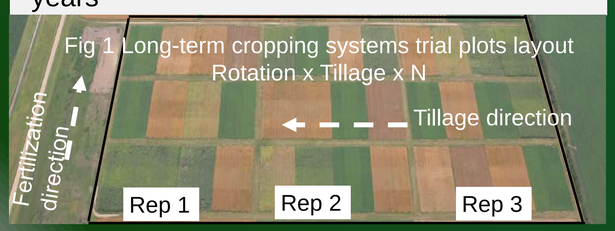


Fig 1 Long-term cropping systems trial plots layout
Rotation x Tillage x N

FINDINGS

- From figure 2, it is evident that SOM varied with no consistent pattern of either increasing or decreasing over time
- Plots that received composted manure over the years have maintained higher SOM than all other treatments with or without urea
- No-till plots consistently showed higher SOM content than CT for six out of seven four-year cycle averages (Fig 3)
- Over the 24-year period, SOM increased by 6.1% under no-till (from 3.3 to 3.5%), and dropped by 1.9% under conventional till
- N fertilization with urea enhanced SOM buildup for both tillage practices (Fig 4)
- Soil available P has been on the decline since 2002 (Fig 5) . This is true for both CT and no-till However, more P remains available for NT plots
- Differences in soil available N are small between tillage practices. However, the general trend is, higher available N under CT, in the order CT>MT>NT
- Urea applied under NT, led to consistently greater or equal SOM content compared to CT plots that received composted manure

Fig 2. Influence of tillage, N fertility and SOM averaged across rotations in a 24-year period

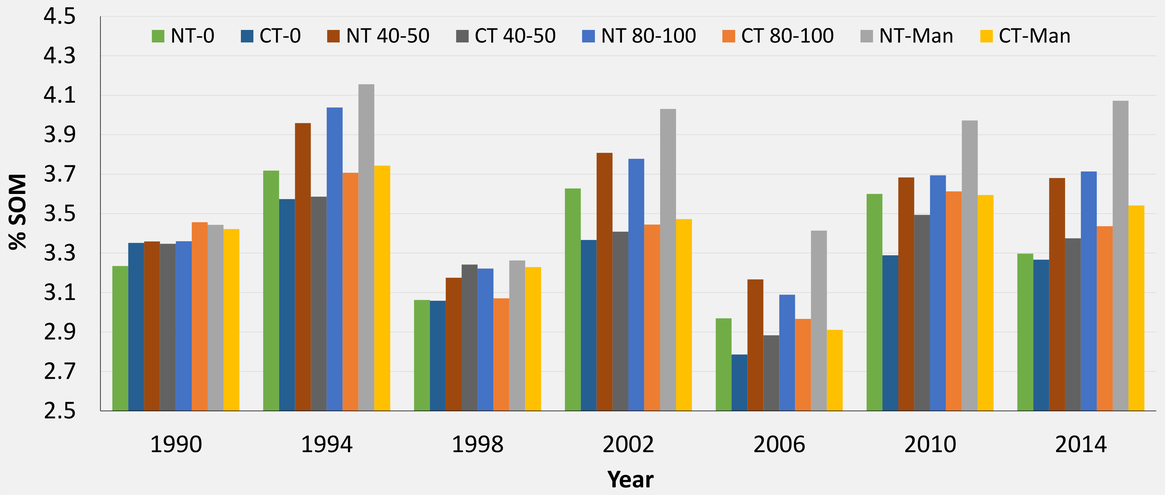


Fig 3. SOM in no-till and conventional till soil at the end of every 4-year cycle

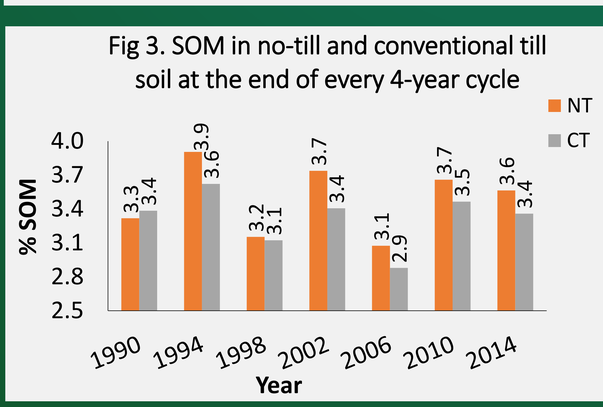


Fig 4. Tillage by N effect on SOM, averaged across crop rotations and years

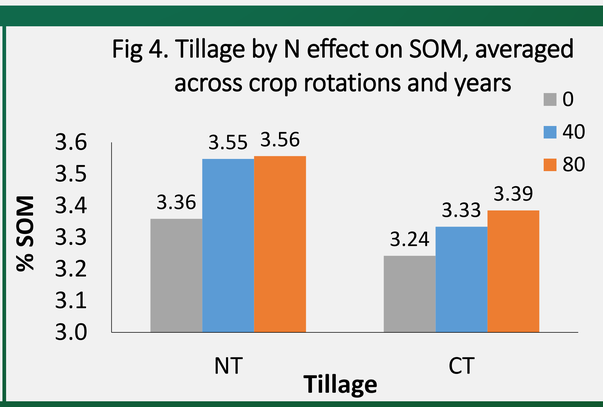


Fig 5. P content by tillage every four years, averaged across depths

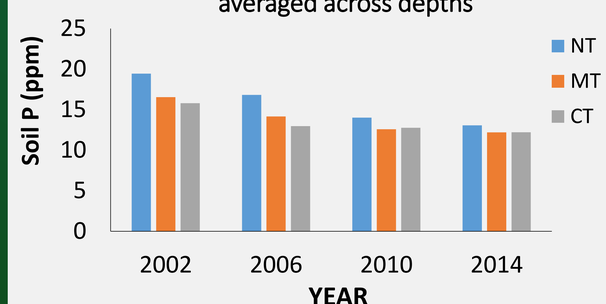
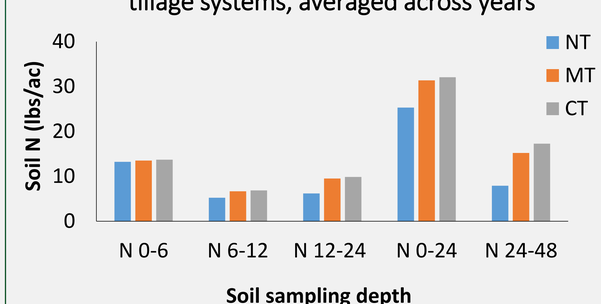


Fig 6. Soil N content by depth under three tillage systems, averaged across years



DISCUSSIONS

- Differences in SOM for each fourth year of soil analysis suggest that several factors, are interacting and in tandem influence changes in SOM build up
- Higher SOM content when N is applied under NT is consistent with many other studies. However, since there is no consistency in a gradual buildup of SOM, rather declining in some years, it is paramount for producers or landowners to ensure that proper soil management is a priority to enhance SOM buildup, and minimize SOM loss
- The declining soil P also shows the need for supplemental P to replenish what is taken up by crops. It can be argued that with low soil nutrients, and at the low rate of N applied over the years, less biomass was produced and therefore low carbon input back into the soil
- The declining P content observed over the years in the soil is occurring because the field was not fertilized regularly with P
- Given that urea application enhanced SOM under NT than for CT soils that received composted manure, was quite telling of the impact that tillage has on SOM breakdown and loss

CONCLUSIONS

- SOM improved with NT, and declined under CT
- Adequate N to enhance crop yield seems to have a positive effect on SOM accumulation
- This study also revealed that, when N is applied under NT, SOM content was consistently greater or equal to the SOM for CT plots that received composted manure

REFERENCES

- Al-Kaisi, M.M. S.V. Archontoulis, D. Kwaw-Mensah, and F. Miguez. 2015. Tillage and crop rotation effects on corn agronomic response and economic return at seven Iowa locations. Agron. J. 107:1411–1424
- Cook, R.L., and A. Trlica. 2016. Tillage and fertilizer effects on crop yield and soil properties over 45 years in Southern Illinois. Agron. J. 108:415-426

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