Mechanism of SOM threshold formation for crop production in Chinese Mollisols

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Introduction

Chinese Mollisols are distributed along a long but narrow regions with a greater difference in soil organ matter (SOM) ranging from 1% to 13%. This area is an important national commodity grain base of China. We moved five representative soils with different SOM from Heilongjiang province to a same location to leaving out the difference in topography, management as well as microclimate to study the relationship between SOM level and crop productivity.

The removed soil layer was 40 cm, 0 cm to 20 and 20 cm to 40 cm separately. Many scientists believe that there is a threshold between SOM and crop productivity, which means that for a specific soil crop yield will not increase with SOM increase continually, and sometimes decrease instead. The purpose of this study was to clarify this common belief in Chinese mollisols to answer if there is a threshold in Chinese mollisols and what mechanism involved.

Methods

The experiment was a two-factor design of five level SOM (SOM1 16.6, SOM2 51, SOM3 70, SOM4 80, SOM 5 108.9 g kg^{-1}) and five N application rates with three replicates in total of 75 plots. Other fertilizer management was routine.

The crop planted was spring wheat.

The following chemical and physical properties were determined: bulk density, water stable aggregates, infiltration rate, soil water content, soil temperature, total NPK and available NPK, ammonia N and nitrate N, pH, SOC, SOC mineralization rate, particulate organic matter (POM), soil microbial biomass C and N.

Results

1、The threshold of SOM on crop productivity

The result showed that there was a threshold on SOM to crop productivity in Chinese mollisols in northeast China. When SOM increased from SOM1 to SOM 4, the yield increased, while when SOM increased from SOM4 to SOM5, the wheat yield decreased.

2、The relationship between the formation of threshold with soil physical properties

When the SOM level increased from SOM1 to SOM4, soil bulk density decreased, but when SOM increased from SOM4 to SOM5, the bulk density increased. It means that there is no positive correlation between SOM and bulk density.

There was a significant difference between SOM level and soil water content during the whole growing season. The water content increased with the increase in SOM.

The soil temperature monitoring in the field indicated that, there was a significant difference between SOM level and top layer soil temperature during the whole growing season. The soil temperature decrease when SOM increase.

3、The relationship between the formation of threshold with soil chemical properties

The pH value decreased when SOM increased from SOM 1 to SOM4, but increased when SOM increased from SOM4 to SOM5.

Particulate soil organic matter in size from 53μ to 250μ and form 250μ to 2mm increase with SOM increase generally by weight, but the soil with SOM5 is lighter than with SOM4. The weight of particulate SOM in size smaller than 53μ decrease with SOM increase, but soil with SOM4 was lighter than soil with SOM5.

The soil with SOM5 had the lowest total water stable aggregate, while the SOM3 and SOM4 was much higher than SOM5.

Ammonia N decreased with SOM level increase during the whole growing season, while the nitrate N increased slightly.

Conclusion: the formation of the threshold is mainly due to the difference in soil bulk density which resulted in the difference in soil water content and therefore the difference soil temperature. Difference in particulate organic matter is the secondary factor in threshold formation which affects the supply of available N in ammonia and nitrate forms.

Results

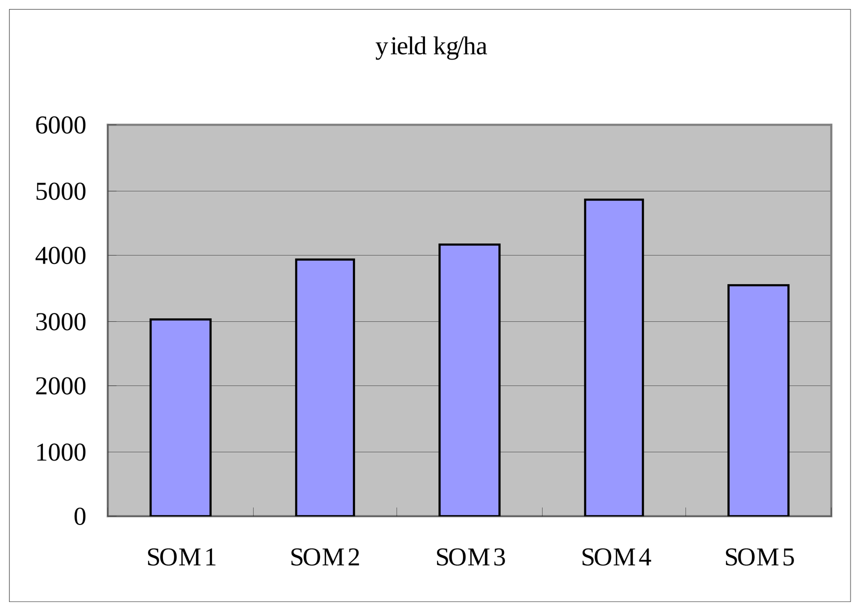

Fig. 1 Spring wheat yield on soils with different SOM level

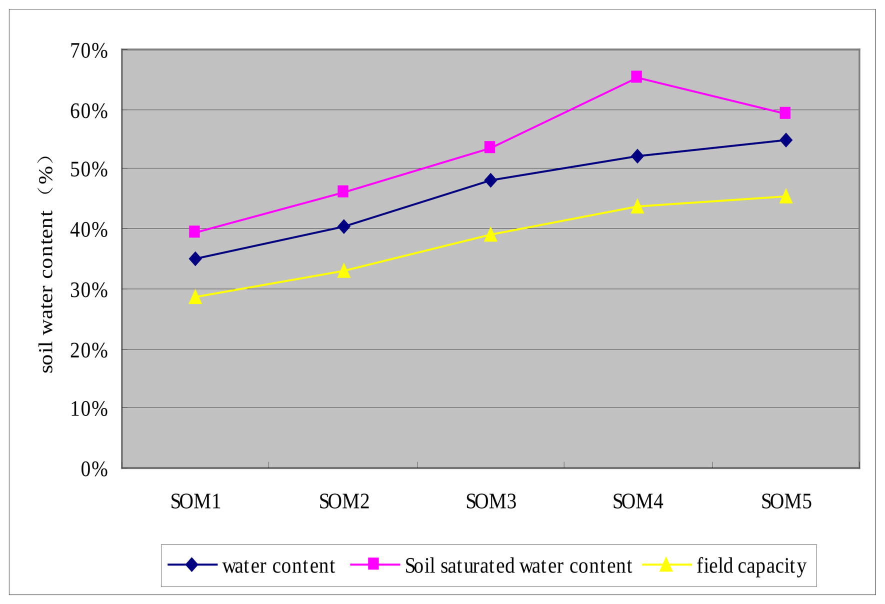

Fig. 2 Soil Water content with SOM level

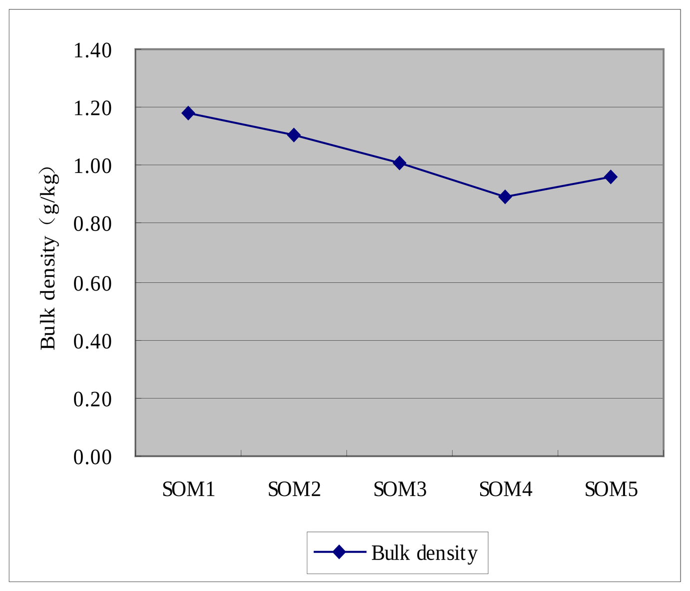

Fig. 3 Bulk density with SOM level

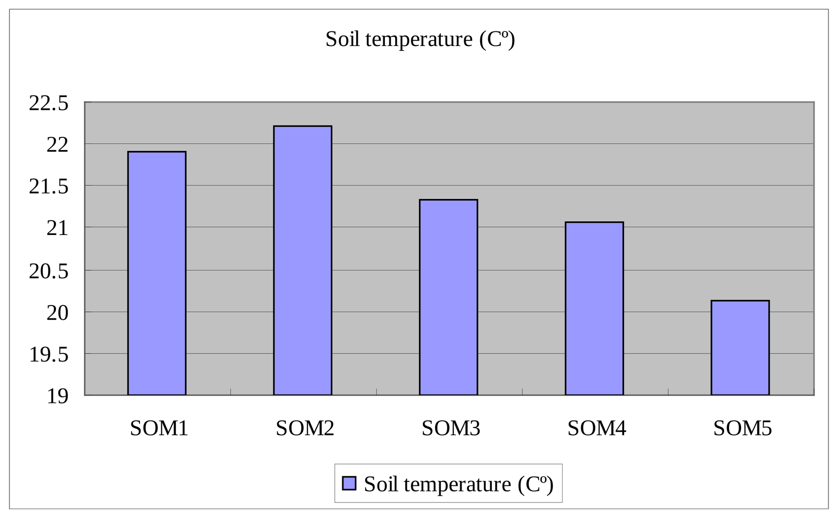

Fig. 4 Soil temperature with SOM level

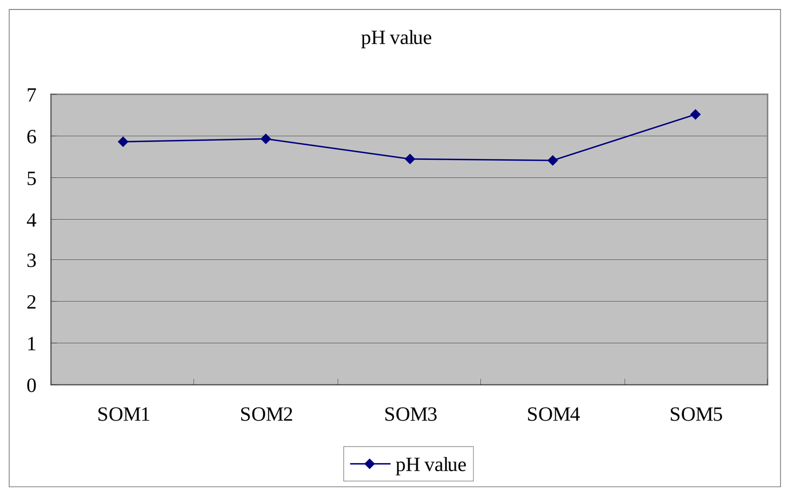

Fig. 5 Soil pH value with SOM level

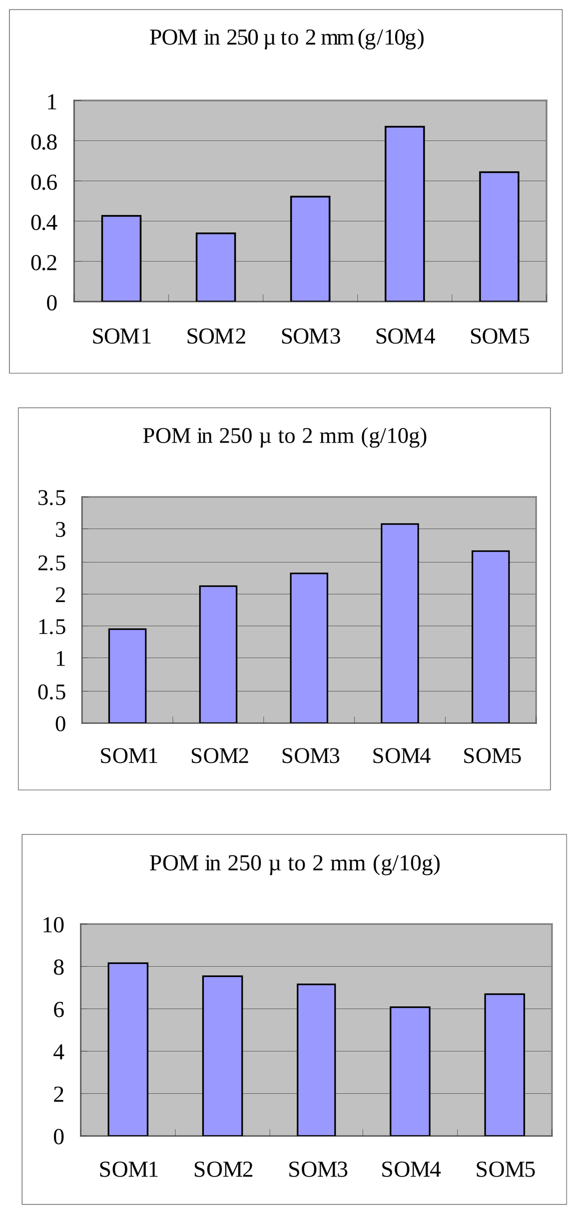

Fig. 6 Soil pH value with SOM level

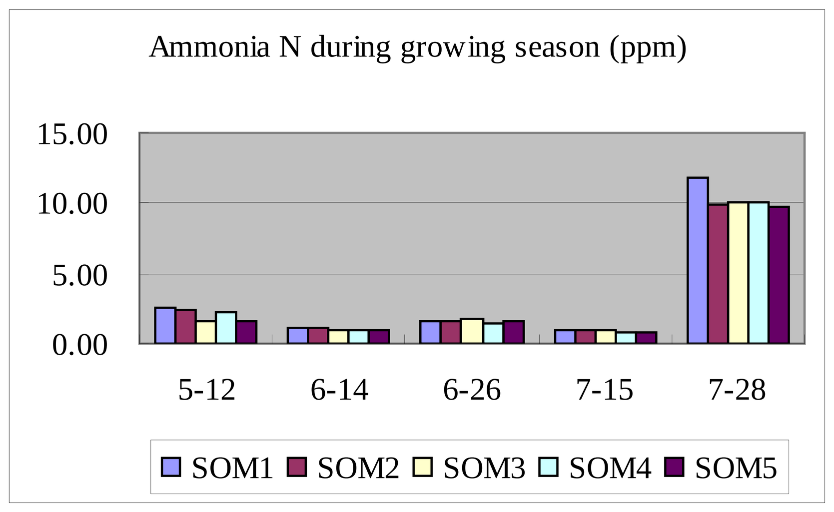

Fig. 8 Ammonia N with SOM level

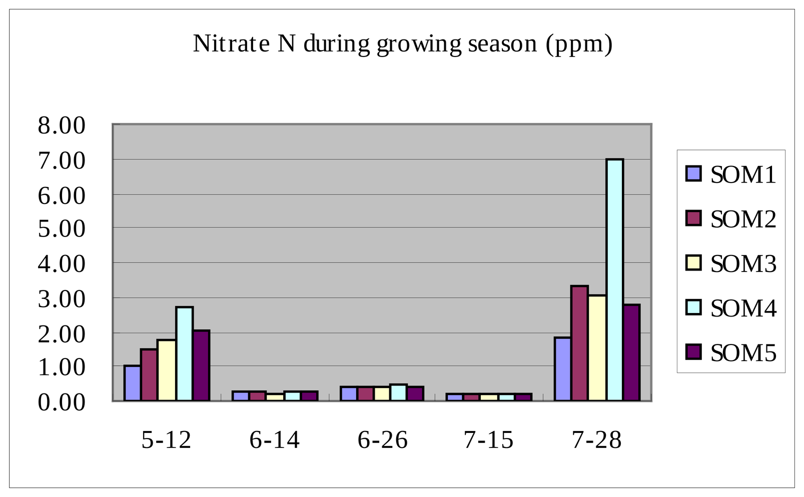

Fig. 9 Nitrate N with SOM level

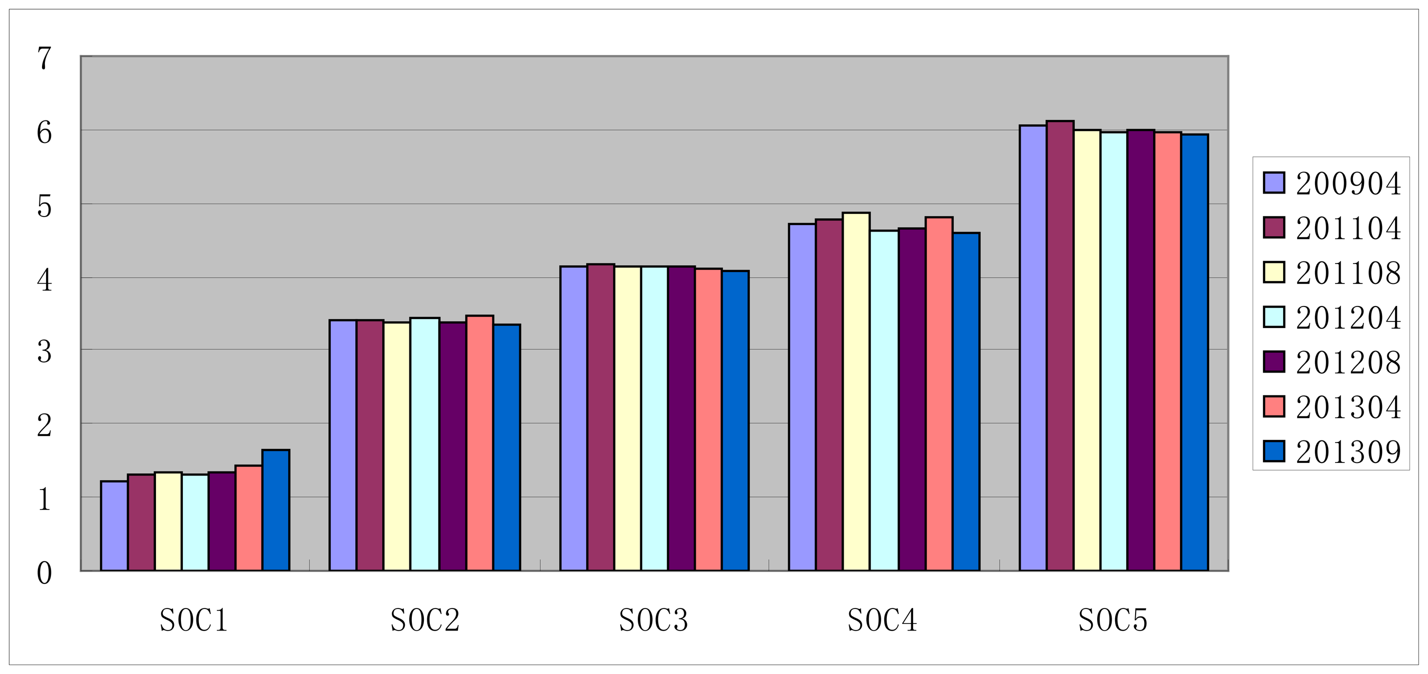

Fig. 10 SOC changes with time in soils with different SOM level

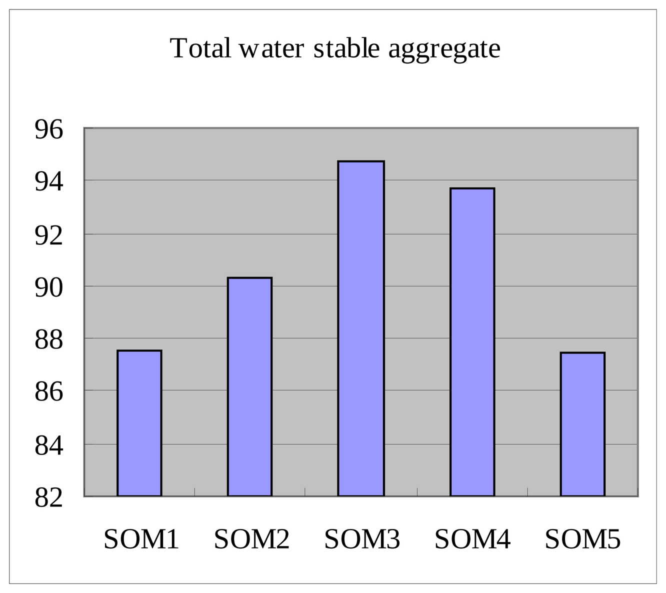

Fig. 7 Total water stable aggregate with SOM level (>5mm, 5-2mm, 2-1mm, 1-0.5mm, 0.5-0.25mm, 0.25mm>)

Acknowledgments

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