

Rotation and Manure Amendment Increase Soil Macro-Aggregates and Associated C and N Stocks in Flue-cured Tobacco Production

ZOU Congming, LI Yan, HUANG Wei, HU Xiaodong, JIN Yan
Yunnan Academy of Tobacco Agricultural Sciences, Kunming, China 650021

Abstract

- Flue-cured tobacco production in China is typically over-fertilized and mono-cropped. To understand how this agronomic management affects soil structure and organic matter, this study investigated the effect of rotation, fertilizer rate, and manure amendment on the proportion of water stable aggregates and aggregate-associated soil organic carbon (SOC) and total soil nitrogen (TSN) concentrations and stocks in tobacco production.
- Two tobacco management systems (Tobacco monoculture and Tobacco-rice rotation) with four fertilizer treatments (0, 75, and 112 kg N/ha, and 60 kg N/ha + Manure) were established in 1998. After 18 years, soil aggregation and aggregate-associated SOC and TSN were significantly affected by rotation and fertilizer management.
- Compared to tobacco monoculture and current fertilizer management, rotation and manure amendment increased macroaggregate (>250 μm) proportion and geometric mean diameter and decreased the proportion of microaggregates and silt-clay sized fractions (< 250 μm). Simultaneously, rotation and manure amendment increased macroaggregate-associated SOC and TSN stocks at the expense of the microaggregate and silt-clay size class and their associated SOC and TSN stocks.
- Rotation and/or manure treatment can maintain satisfactory physico-chemical soil properties through macroaggregate stabilization in tobacco production, which contributes to conserving SOC and TSN stocks.

Objective

This study aims to understand how agronomic management (including rotation and manure amendment) affect soil structure and organic matter in flue-cured tobacco production system

Materials and Methods

- This research was conducted at the Yunnan Academic of Tobacco Agricultural Sciences' Yanhe Research Farm near Yuxi, Yunnan, China (24°14'N 102°30'W). This study site was established in 1998.
- Field experiment design: This study included two factors: rotation style and N fertilizer management; Nitrogen fertilizer application had four levels: 0, 75, 112 kg N/ha, and a treatment with 60 kg N/ha with manure application; the current study had eight treatments: M-0, M-75, M-112, M-M-60 (Monocropping-Manure-60), R-0, R-75, R-112, and R-M-60 (Rotation-Manure-60).
- Aggregate size classes were physically separated with wet sieving to obtain four aggregate size fractions: i) > 2000 μm (large macroaggregates); ii) 250 to 2000 μm (small macroaggregates); iii) 53 to 250 μm (microaggregates); and iv) < 53 μm (silt and clay size class).

Results

- Figure 1. The proportions of soil in large macroaggregates, small macroaggregates, microaggregates, and the silt-clay size class due to the rotation by fertilizer interactions at the 0-10cm (upper) and 10-20cm (lower) soil layers.
- Figure 2&3. The SOC and TSN concentrations in whole-soil, large macroaggregates, small macroaggregates, microaggregates and the silt-clay size class for the rotation by fertilizer interactions at the 0-10cm (upper) and 10-20cm (lower) soil layers.
- Figure 4&5. The SOC stocks (SOCS) and TSN stocks (TSNS) of whole-soil, large macroaggregates, small macroaggregates, microaggregates and the silt-clay size class for the rotation by fertilizer interactions at the 0-10cm (upper) and 10-20cm (lower) soil layers.



Fig. 1. Effects on Soil Water Stable Aggregates

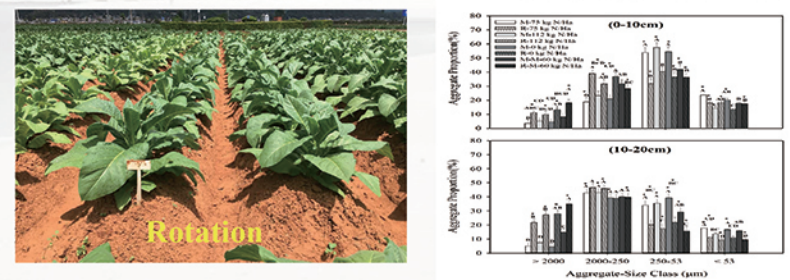


Fig. 2&3. Effects on Aggregate C and N Concentrations

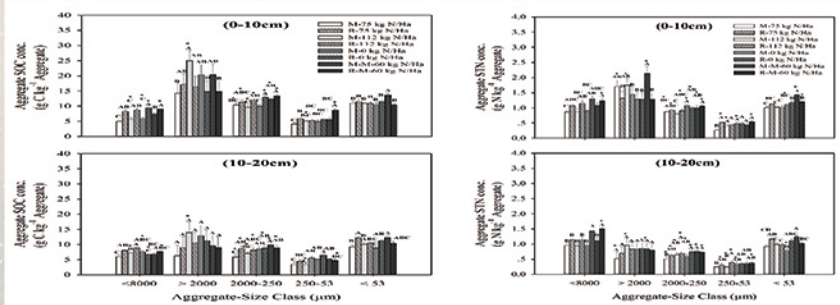
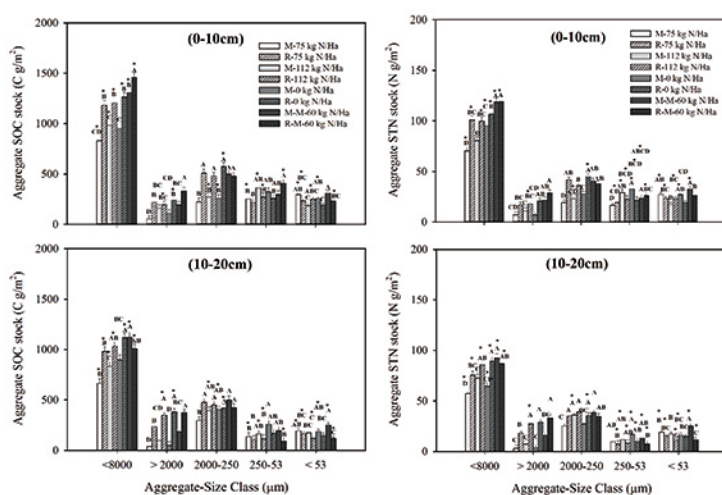


Fig. 4&5. Effects on Soil Aggregate Organic Carbon and Total Nitrogen Stocks



Conclusion

- Tobacco-rice rotation system with manure amendment resulted in significantly greater whole soil SOCS and TSNS and improved soil structure relative to tobacco monoculture and chemical fertilizer input only.
- The inclusion of the high biomass residue rice crop in rotation with flue-cured tobacco may be necessary to maintain/enhance soil quality and productivity. Tobacco-rice rotation, and manure amendment practices, could synergistically increase SOC and TSN, enhance soil structure, and promote soil quality.
- This study suggests that long-term monocropping and chemical fertilizer application not only reduce water stable large macroaggregates, but also decrease macroaggregate SOC and TSN and associated SOCS and TSNS.

Acknowledgments

This study was supported by the National Natural Science Foundation of China (No.41601330).

Geoderma
journal homepage: www.elsevier.com/locate/geoderma

Rotation and manure amendment increase soil macro-aggregates and associated carbon and nitrogen stocks in flue-cured tobacco production
Congming Zou^a, Yan Li^{a,b}, Wei Huang^a, Gaokun Zhao^a, Guorui Pu^a, Jisen Su^a, Mark S. Coyne^c, Yi Chen^a, Longchang Wang^a, Xiaodong Hu^a, Yan Jin^a