Carbon sequestration potential and nutrient cycling efficiency in a corn-soybean inter-cropping system under Conservation Agriculture

保全農業におけるトウモロコシ・大豆混作システムにおける炭素隔離ポテンシャルおよび栄養循環効率

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Abstract

Agricultural practices are essential for food production and the sustenance of human populations. However, conventional farming methods often lead to soil degradation, reduced fertility, and increased greenhouse gas emissions. Soil carbon sequestration and nutrient cycling are critical processes that can enhance soil health, improve agricultural productivity, and mitigate climate change (Lal, 2004). Despite their importance, these processes are not well understood, particularly in the context of different agricultural practices and environmental conditions (Smith et al., 2008). Conservation Agriculture, as defined by the FAO, is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of a permanent soil cover, and diversification of plant species for sustained agro-ecosystems and productivity (FAO, 2017).

Our experiment utilized a 2 x 3 Factorial design, incorporating two levels of agricultural practices: No-Tillage (NT) and Conventional Tillage (CT), and three levels of fertilizer application: Mulch (M), Organic (O), and Chemical (C). This arrangement resulted in six plot treatments: NT-M, NT-O, NT-C, CT-M, CT-O, and CT-C. The objective of this study was to test the hypothesis that Conservation Agriculture, represented by the No-tillage groups, is a potential solution to control soil degradation and mitigate greenhouse gas emissions.

The results indicated that NT-M plots emitted less CO_2 (0.3 mg m^{-2} hr^{-1} 10^{-2}) and absorbed more CH_4 (-0.02 mg m^{-2} hr^{-1} 10^{-2}) compared to other plots (Figure 1). There was no significant difference in H_2O vapor emissions among the treatments; however, CT-C plots emitted the least H_2O vapor (around 0 mg m^{-2} hr^{-1} 10^{-2}). In terms of soil properties, NT-O and NT-C showed higher values in soil organic carbon (SOC), and NT-C recorded higher volumetric water content (VWC) compared to other treatments, indicating that no-till practices tend to increase soil organic carbon and soil moisture retention capacity. These results demonstrate the carbon sequestration potential and improvement of soil properties in Conservation Agriculture. However, there was no statistically significant difference in crop growth parameters among the agricultural practices.

Keywords: Carbon sequestration, Nutrient cycling, Conservation Agriculture, Climate change
キーワード: 炭素隔離、栄養循環、保全農業、気候変動

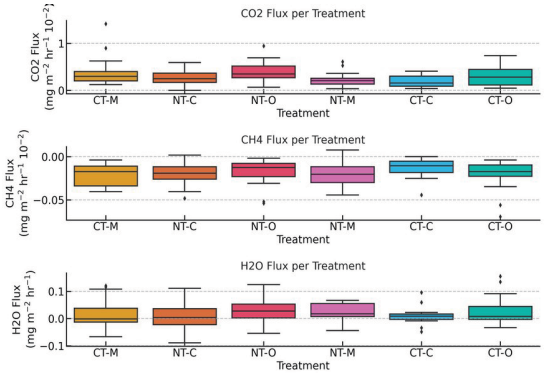

Figure 1. Variation of CO_2 flux (top), CH_4 flux (middle), and H_2O vapor flux (bottom) per treatment (NT-M, NT-O, NT-C, CT-M, CT-O, CT-C). The wider boxplots shows higher variation while the tight boxplots shows lower variation. The boxplots closer to zero suggest least gas emissions or absorption for the negative values.

References

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