論文の内容の要旨

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氏　　名　　郭　琳琳

指導教員名　　西村　拓

論文題目　Effects of tillage on behavior of carbon dioxide in an Andisol
（耕起方法が黒ボク土中の二酸化炭素ガスの挙動に及ぼす影響）

Soil respiration contributes to the production of carbon dioxide (CO_2) that is a major greenhouse gas. Tillage practices are considered to have a potential to restrict or enhance CO_2 flux from the soil. Andisol is an important soil for agricultural production in many areas of Japan, but the studies on the CO_2 behavior in Andisols under different tillage systems are limited. Behavior of soil CO_2 in an Andisol under different tillage systems was studied and reported in the present paper.

The undisturbed soil column incubation experiments were performed for a period of 150 days to conduct the study. Soil physical properties of five layers in soil columns were measured under no-tillage and tillage treatments. Tillage reduced soil dry bulk density and increased saturated hydraulic conductivity at the chiseled layer. No significant difference in soil temperature was observed between no-tillage and tillage treatments. Tillage modified the soil structure, and thus the water retention

characteristics and volumetric water content. Soil air-filled porosity and the gas diffusivity under no-tillage treatment were observed to be smaller than that under the tillage treatment during the incubation period. Four widely used soil gas diffusivity models were evaluated on prediction of soil gas diffusivities under no-tillage and tillage treatments. The Buckingham-Burdine-Campbell (BBC) model fit well with the measured values for both no-tillage and tillage treatments. Soil aggregates, especially macroaggregates (>1 mm) were destructed by tillage. The soil structure included pore structure and aggregation was distinctly influenced by the tillage.

Studies on effects of tillage on soil physical properties may provide necessary information for assessing the soil CO_2 flux under different tillage systems. After the first day, difference in the CO_2 flux between the no-tillage and tillage treatments was not as clear as that of the first day. The cumulative soil CO_2 flux under the tillage treatment for the incubation period tended to be higher than that under the no-tillage treatment. However, no significant differences in soil carbon stock and soil carbon associated with soil aggregates were seen between them, since the carbon loss of the 150 days of the incubation period was small to the carbon storage in the soil column. Long-term experiments are expected to conduct to study soil organic carbon stocks.

Soil CO_2 concentration was evaluated with the column incubation experiment, which was also used to estimate the CO_2 flux. Soil CO_2 concentration increased with the soil depth. During the incubation period, soil CO_2 concentration under the no-tillage treatment was clearly higher than that under the tillage treatment, except at the depth of 2.5 cm. Soil gas diffusivity under the tillage treatment at depths of 0–15 cm that estimated by the BBC model was greater than that under the no-tillage treatment. The CO_2 flux through the soil profile, calculated from the CO_2 concentration and gas diffusivity, decreased with depth. Linear relationship was observed between the estimated and measured CO_2 surface flux. The CO_2 production at depths of 0–15 cm

accounted for 70.5 % and 60.4 % of the whole CO_2 production of the 0–35 cm soil profile for no-tillage and tillage treatments. Soil CO_2 production was higher under the no-tillage treatment at depths of 0–5 cm in comparison to the tillage treatment, but contrary results were observed at depths of 5–35 cm. For the soil profile of 0–35 cm, the CO_2 production was increased by tillage.

The tillage depth and macropore in the soil were considered as important factors to affect the CO_2 behavior. Repacked soil column incubation experiments of 150 days were conducted to examine the contributions of the tillage depth and macropore on soil CO_2 behavior. Soil physical properties (i.e., soil gas diffusivity, dry bulk density and saturated hydraulic conductivity) were significantly affected by the depth of tillage at the chiseled layers. The CO_2 cumulative flux from the soil tended to show as deep tillage> conventional tillage> no-tillage. At deeper layers (20 cm and 30 cm), soil CO_2 concentration was lower under the deep tillage treatment than that under the conventional tillage, and the highest CO_2 concentration was observed under the no-tillage treatment. Similarly, no difference in soil total carbon was observed among the treatments.

Soil CO_2 concentration under the no-tillage- with macropore treatment was lower than that under the no-tillage- without macropore treatment, but the lowest CO_2 concentration was observed under the tillage treatment. The CO_2 cumulative flux from soils tended to show as tillage treatment> no-tillage- with macropore> no-tillage- without macropore. Although tillage destroyed the macropore in the soil, soil cumulative CO_2 flux tended to be increased and the CO_2 concentration tended to be decreased by tillage.

The column incubation keeps the soil structure the same with that in the field. With column incubation experiments, the behavior of CO_2 in the Andisol was well studied.