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Liming on acid soils enhances green house gas emission from agricultural land

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Liming is a common practice to improve acid soil in the world. Lime may raise soil pH and calcium derived from the applied lime would reduce Al toxicity to plant roots. However, atmospheric CO_2-water-Al equilibrium which is an important reaction to depress soil acidity may produce $CO_2$to atmosphere. IPCC (2007) and West and McBride (2005) estimated approximately 30% and 13% of applied carbon in the lime would emit to atmosphere as CO_2, respectively. However, changes in pH following liming may cause changes in microbiological activities and degradation of organic materials, thus soil respiration. However, this process has not yet discussed. In this study, we applied $Ca^{13}CO_3$to two different Japanese acid soils, Andisol and Ultisol and incubate the soil-$CaCO_3$mixture for 5weeks. During the incubation $^{13}CO_2$and $^{12}CO_2$emission from the mixture were measured periodically. Here, we assumed $^{13}CO_2$denotes CO_2through inorganic reactions following liming, while $^{12}CO_2$would represent $CO_2$from native soil organic matters and microbiological activity.

Kuroboku andisol from Tokyo had a pH of 5.2 and total carbon of 11.1% while Kunigami-mahji Ulitsol from Okinawa, here after Mahji ultisol, showed a pH of 4.3 and total carbon of 0.25%. These are typical organic and inorganic acid soil in Japan. Both soil was adjusted to be a 30 %(FC 30) or 70%(FC70) to its field capacity. This was equivalent to mass wetness of 0.31 and 0.75 for Andisol and 0.09 and 0.19 for Mahji ultisol, respectively. Amount of liming was determined by lime requirement test, and 0.01 kg/kg for Andisol and 0.004 kg/kg for Ultisol respectively. The soil-$CaCO_3$mixture was kept in a glass bottle with lid under constant temperature of 20 degree, and head space gas was sampled periodically. Total CO_2concentration was measured by TCD-GC and $^{13}CO_2$was determined GC-MS (GCMS-2010Plus, Shimadzu Inc.).

Liming had significant effect to raise soil pH. A few days after liming, Andisol and Mahji ultisol showed rise in pH to be 6.0 or higher. This level of pH is in general favorable for plant growth. For 5 weeks incubation, 21 to 23 % of the applied carbon to Andisol was emitted as CO_2. For the Ultisol, 5 to 14% of the applied carbon was transformed into CO_2. Andisol showed more soil organic matter derived $^{12}CO_2$than Ultisol. This was corresponding to the fact that Andisol had 40 times more total soil carbon than Mahji ultisol. It was interesting except FC30 of the Mahji ultisol, applying $CaCO_3$enhanced $^{12}CO_2$emission. This was remarkable for the Andisol since it had much soil organic matter. Less emission of $^{12}CO_2$from the FC30 Mahji ultisol could be due to smaller water content of the soil. The FC30 of Mahji ultisol had less soil water that $CaCO_3$could not wholly dissolve and be effective. Neither soil microbiological activity nor $CaCO_3$-water equilibrium was not vivid. This agreed a fact that the FC30 Mahji ultisol produced smallest amount of $^{13}CO_2$during the 5 weeks incubation.

Liming is an important practice to improve soil acidity. However, some, 13 to 30% according to previous papers, of the applied carbon with liming may emit to atmosphere as CO_2. Besides, improve in soil chemical condition may enhance microbiological activity and this would increase

soil organic matter derived CO_2emission.

Keywords: acid soil, liming, green house gas, carbon dioxide, soil amendment