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Effects of water control on flux of greenhouse gases at rice paddy field

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Global warming is one of the important issues because that impact on human life is very severe. Japan set out 25% reduction of greenhouse gases (GHG) emission below 1990 levels by 2020 at the Summit on Climate Change in 2009. Global warming potentials (GWP) in a 100-yr time horizon were calculated by taking conversion factors that 1 mg methane (CH_4) and nitrous oxide (N_2O) are equivalent to 23 and 296 mg carbon dioxide (CO_2), respectively (IPCC, 2001). All GWP results were expressed as mg CO_2 equivalent per kg soil (air dry) per hour. Rice paddies are considered to be a major source of anthropogenic methane emission (Jacobson, 2005). Especially, there exist a big proportion of the paddy field throughout Asian region include Japan. We should control GHG emission from paddy field. Yu and Patrick (2004) reported that there exist suitable oxidation-reduction potential (ORP) range that makes the minimum emission of CO_2 and CH_4 and N_2O. Water management of paddy field would be one of the most important tools that can control the emission of GHG from paddy field. In this study, we investigated the effect of water management on the GHG flux in paddy field.

We used six 2*2*2 m size lysimeters installed in Ikuta Campus of Meiji University to observe the GHG flux in paddy field. We set 3 types of water management practices (1) continuous flooding, (2) mid-season drainage, (3) low water level. We set water level 20 cm under the surface to study the effect of low water level on GHG flux from the rice field. We plant one japonica rice cultivar Kinuhikari per hill and set the 20 cm of interplanting. As GHG, we had observed the CH_4, CO_2, N_2O gas flux (mg m^{-2} h^{-1}) once a week during rice growing season (June 11st /2010 to September 17th /2010) using the closed chamber method. Each GHG flux was measured at rice glowing area with 30*60*106 cm chamber and at bare area with 25.6 cm i.d. 50cm hight cylindrical chamber. When the flux at rice glowing area was measured, we set six Kinuhikari into the chamber. The concentration of GHG was analyzed with GC-FID and GC-ECD. ORP was measured with putting reference electrode and platinum electrode into the soil.

As a result, high GHG flux was observed at rice glowing area and there were a very low GHGs flux at bare area. High emission of CH_4 was observed from constant flooding paddy fields by contrast of the low water level sites as for rice glowing area. CO_2 greatly sank into rice glowing area regardless of the difference of water management at rice glowing area. NO_2 flux is small compared to other GHG and both of the emission and sink had been observed at rice growing area. At bare area, observed GHG flux value was very small, but CH_4 was seemed to sink into the field, CO_2 and NO_2 tended to emit from the field.

The reason why the emission of CH_4 from low level water site was smaller than from constant flooding paddy fields would be that anaerobic methane producing bacteria's activity was inert in aerobic low level water sites. Hou et al. (2000) reported methane is produced in the strict anaerobic environment by obligate anaerobic microorganisms either through CO_2 reduction or transmethylation of acetic acid. Observed CH_4 emission and sink of CO2 in this study support their results. Almost all GHG flux was observed at rice glowing area might conclude that aerenchyma worked as an important GHG passage root. The photosynthesis of rice would be thought a major reason of large CO_2 sink because our flux measurement made in the daytime. ORP value at low water level site was minus through this test time. It might be caused by the pore water around electrodes. ORP at continuous flooding and mid-season drainage sites were observed under -200 mV through almost of this test time and could not be set the suitable range (+180 to -150 mV) proposed by Yu and Patrick (2004). We will try to observe the annual GHG flux change with set the suitable ORP level.

Keywords: water management, paddy field, global warming, greenhouse gases, gas flux