Recovery of Tsunami-Affected Paddy Soil Using Calcium Materials for Sustainable Agriculture

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Many lives were lost and tremendous damage was caused by the Great East Japan Earthquake and tsunami disaster of March 11, 2011. The tsunami attacked the regions on Pacific coast and caused severe damage to the lowland farmlands by topsoil washout and salt injury. About 15,000 ha of paddy fields had been damaged in Miyagi Prefecture alone. It was found that water soluble salt content in the topsoil decreased to less than the acceptable limits by around 1000 mm of natural rainfall. In most of the tsunami-affected farmland, desalinization work was carried out by irrigation, resulting in sufficient removal of water-soluble salt content of the tsunami-affected soils. However, according to the monitoring surveys of the soil where the land consolidation projects had been completed, some fields had a poor nutrient balance. Some of the calcium (Ca) ion absorbed by negative charge sites of soils had been displaced by sodium (Na) ion derived from seawater and washed out by the desalinization process. As a result of the reactions in the soil, some of Na ion had remained in the exchange sites of soils and exchangeable Ca had been reduced. In soils with high concentration of exchangeable Na, crops sometimes show poor growth due to the excess uptake of Na (Na injury). In order to lower the risk of Na disorders and restore soil productivity, it is necessary to optimize the basic cation balance in the soils where desalinization has been implemented.

To solve the problem, we examined the effectiveness of applying calcium-silicate materials (steel-making slag fertilizers) in alleviating Na disorders using model desalinated tsunami-affected soil in 2013. An alluvial soil collected from normal paddy field was submerged by seawater and was then desalinated by flooding and draining repeatedly fresh water. The prepared soil showed EC of 0.42 dS m^{-1}, exchangeable Ca of 6.7 cmol(+) kg^{-1} and exchangeable Na percentage of 44 %. Rice cultivation experiment using *Hitomebore* was conducted in the paddy field with three replications. We stuffed a plastic frame of 0.076 m^2 with the prepared soil after four treatments (no application of material, steel-making slag fertilizer application of 200, 400 g m^{-2}, gypsum application corresponding to slag 200 g m^{-2} as application amount of Ca).

Gypsum and two slag treatments increased brown rice yields by 4, 10, 12 % than the control treatment, respectively, with significant difference for slag treatment of 400 g m^{-2}. steel-making slag fertilizers enriched concentrations of Ca, K and Si in the rice plants and reduced Na concentration at the maturity stage. It is known that Ca or Si applications can improve Na injury of rice. Supplementation of Ca decreases Na absorption and increases K adsorption (Khan et al., 1992; Song et al.) It is known that silicon application reduces Na uptake and improves rice growth (Yeo et al., 1999). It is concluded that the fertilizer made of steelmaking slag is effective in restoring the productivity of desalted tsunami-affected soils containing high amount of Na.