

Remediation of a Tsunami affected saline and sodic soil by calcium carbonate and rice straw

ISHIBASHI, Sakuya^{1*}; NISHIMURA, Taku¹; HAMAMOTO, Shoichiro¹; IMOTO, Hiromi¹

¹Graduate School of Agricultural and Life Sciences, The University of Tokyo

Japanese government recommends leaching of soluble salts as well as adding calcium amendments for remediating saline and sodic soil after Tsunami by the earthquake on March 11, 2011,. Application of calcium carbonate (CaCO_3) is recommended for soils having pH lower than 6 and calcium sulfate (CaSO_4) is that for pH higher than 6. However, since CaCO_3 has low solubility to water, it has not been often used in reclamation of sodic soils (Shainberg et al, 1989).

Solubility of CaCO_3 is controlled by CO_2 - H_2O - CaCO_3 equilibrium in water. The concentration of calcium ion in CaCO_3 solution is affected by CO_2 concentration (partial pressure) of air phase. The higher partial pressure of CO_2 causes the higher concentration of Ca^{2+} . In general, addition of organic matter may enhance soil respiration and increase partial pressure of CO_2 in soil. This might potentially enhance solubility of CaCO_3 and increase Ca^{2+} concentration in soil solution.

Increase in Ca^{2+} concentration in soil decreases exchangeable sodium percentage (ESP) of the soil. Lower ESP may inhibit soil dispersion and help to keep aggregation. Stability of aggregates has a role on soil permeability, and it affects efficiency of leaching practice.

Objective of this study was to investigate the effect of changes in partial pressure of CO_2 by organic matter decomposition on dissolution of CaCO_3 , and subsequent Na^+ - Ca^{2+} ion exchange of a Tsunami affected soil.

Soil was collected at a former paddy field at Terashima, Miyagi, Japan, where was damaged by Tsunami at the Great East Japan Earthquake. EC (1:5) of the soil was 5.2dS m^{-1} . The soil was mixed with rice straw and/or CaCO_3 , and then packed into plastic columns of an inner diameter of 8.5cm and 20cm-high with the bulk density of 0.95g cm^{-3} . Amount of rice straw and CaCO_3 application was 10t ha^{-1} and 1t ha^{-1} , respectively. The soil columns were incubated for 23 days. During the incubation, 18mm of water was supplied for each three days. The temperature inside and around the columns, and soil water pressure were continuously monitored. The CO_2 concentration in soil air phase was measured at 5-days interval.

After the incubation, the columns were leached by 4 pore volumes of 4mmol L^{-1} KCl solution with. The leachate was collected for further analysis of EC, pH and concentration of cations. After the leaching, the soil columns were separated to 3cm thick layers. Each 3cm thick soil sample was used to measure EC, pH, soluble cations, and exchangeable cations of the soil.

In average, soil CO_2 concentration inside the column was high under the rice straw treatment regardless of CaCO_3 application. The CO_2 concentration rose at the periodical water application, and gradually decreased with time. Rise in CO_2 concentration could be due to the enhanced organic matter decomposition and the restricted CO_2 diffusion by higher soil water content following the water application.

Exchangeable cations of the column soil were measured after the leaching. Exchangeable Ca^{2+} slightly increased at whole layer of the four treatment. Increase in exchangeable K^+ coincided with decrease in exchangeable Na^+ , suggesting ion exchange between Na^+ and K^+ was a dominant reaction during the leaching.

In this experiment, the effect of organic matter and CaCO_3 application on remediation of the Tsunami affected saline and sodic soil was not clear. With fluctuating soil water content, soil CO_2 concentration was not always high during the column incubation experiment. It is expected that depression of soil CO_2 concentration with decrease in soil moisture after water application could not enhance dissolution of applied CaCO_3 .

Keywords: Tsunami affected soil, saline and sodic soil, rice straw, calcium carbonate