Effects of Moisture Content on Soil Water and Ion Movements in the Vicinity of Soybean Roots

*Rui Nakasone[1], Shoichiro Hamamoto[1], Naoto Nihei[2], Taku Nishimura[1]

1. Graduate School of Agricultural and Life Sciences, the University of Tokyo, 2. Fukusima University

Radioactive cesium was emitted from the disabled Fukushima Dai-ichi Nuclear Power Plant on March, 2011, and diffused into the environment, including agricultural area in eastern Japan. As one of most effective countermeasure to reduce Cs uptake by crops, additional potassium (K) fertilization at applying basal fertilizer is recommended. It is generally known that with increasing exchangeable K in soils the soil-to-plant transfer factor (TF) of Cs decreases. However, it is also reported that the TF is variable under lower exchangeable K. Further understandings of Cs uptake by roots, governed by mass transport in the vicinity of roots, are required. Soil physical properties such as moisture content affect mass transport in soils, hereunder influencing water and ion uptake by roots.
In this study, using a rhizobox system, soil water and ion movements in the vicinity of soybean roots were investigated for soils with different moisture contents. Sandy soil taken from the agricultural field at Namie-town, Fukushima Prefecture, Japan was repacked to soil box compartment (width:14 cm x height:10 cm x thickness: 3 cm) in rhizobox system. The ^{137}Cs concentration of the soil was around 3000 Bq/kg. Mass water content (w) of the samples was adjusted to either 20% or 28%. The soybean roots which were pre-grown up to root length of around 6 cm were placed on the surface of soil box compartment. The soybean in the rhizobox was grown for around 7 days in the climate controlled room. After the growth, soil box compartment was removed from the rhizobox and sliced at 2.0 mm interval. Mass water content and ion concentration of each sliced sample were measured.
Results showed mass water content in the soil decreased due to root water uptake and more significant decrease was observed at the condition of w = 28%. In addition, mass of K uptake by the roots was higher at w = 28% as compared to the one at w = 20%. Those results indicate water stress at w = 20% reduced water and K uptake by the roots. Mass of ^{137}Cs uptake was higher at w = 20% as compared to w = 28%, likely suggesting the ^{137}Cs was more selectively absorbed due to reduced K uptake under lower moisture condition. The K and ^{133}Cs concentrations at w = 20% increased and decreased near roots (within 5 mm), respectively, while those concentrations at w = 28% maintained almost constant regardless of the distance from the roots in the soil box.

Keywords: rhizosphere, mass transport, Cesium

