EGU2020-11990, updated on 27 Feb 2021
https://doi.org/10.5194/egusphere-egu2020-11990
EGU General Assembly 2020

Glucose concentration controls priming effects and soil carbon storage under pasture and forest in volcanic ash soils of Hokkaido, Japan

Chie Hayakawa[1], Taichi Kobayashi[2], Kazumichi Fujii[3], Yoshiyuki Inagaki[3], and Keishi Senoo[2]
[1]Utsunomiya University, Tochigi, Japan (chayakawa@cc.utsunomiya-u.ac.jp)
[2]The University of Tokyo, Tokyo, Japan (asenoo@mail.ecc.u-tokyo.ac.jp)
[3]Forestry and Forest Products Research Institute, Ibaraki, Japan (fkazumichi@affrc.go.jp)

Introduction & objectives: Over ten thousand years, soils have been formed through events of volcanic ash deposition in Hokkaido, Japan. The soil organic matter (SOM) in the past surface layer has been buried in the deeper soil. The buried humic horizons serve as a large carbon (C) reservoir. The SOM in the deeper soil horizons is preserved due to lower microbial activities and limited inputs of fresh organic matters. However, when the buried humic horizons are exposed to the surface by deep plowing and bottom plow tillage, decomposition of the exposed SOM may be accelerated through priming effects, due to the increased supply of low-molecular-weight (LMW) substances from fresh plant litter inputs. To test this, we examined glucose concentration dependency of priming effect and the change of SOC balance through priming effect using ^{13}C tracer incubation.

Materials & methods: Soil samples were collected from the volcanic soil profiles in pasture site and adjacent forest sites in Hokkaido, Japan. The moist soils were sieved (< 4 mm) to eliminate plant debris and stones for the incubation study and the other analysis. A ^{13}C-glucose solution (99 atom%; 0 – 3.9 mg glucose g^{-1}) was added to moist soil (equivalent to 10 g oven-dried weight) and incubated at 20ºC in the dark for 30 days. The head space gas sample was periodically taken into the vial, and $^{13}CO_2$ and $^{12}CO_2$ concentrations were determined by GC-MS. Priming effect (PE) was calculated by subtraction between the amounts of $^{12}CO_2$ with and without glucose. The head space gas in the bottle was flush out and replaced to CO_2-free-air every sampling time. We also measured soil microbial biomass C (MBC) by chloroform fumigation method, bacterial and fungal biomass by 16S and 18S rRNA genes targeted real-time PCR, SOC concentrations, inorganic N concentrations (ammonium and nitrate) and the other physicochemical properties of the soil profiles.

Results & discussion: Glucose addition induced the positive PEs in the buried humic soil samples of both sites, and the magnitudes of PEs (cumulative primed-CO_2 amounts) in the buried humic soil samples were 0.4 to 1.5 times as those in the surface soils. However, the negative PEs were detected in the forest surface soil, probably because of low soil pH and relatively high inorganic N concentration. The magnitudes of PEs were dependent on added glucose concentrations for all the soils, and the threshold between negative and positive PEs corresponded to 3.5 % of glucose-C relative to MBC in the forest surface soil. The positive correlation between evolution rates of primed-CO_2 significantly and bacterial or fungal biomass suggests both bacteria and fungi contributes to PE in the soils studied. Even if glucose addition induced PE, total SOC after incubation increased when glucose-C was added more than 0.5 mg C g^{-1} in the all soils. This implies that the optimized fresh litter input can control priming effects and C sequestration in volcanic soils.