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Importance of winter process on soil nitrogen mineralization rate under the change in temperature and moisture

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Winter processes associated with microbe and vegetation has not been studied well in nitrogen cycling of forest ecosystem because biological activities are generally inactive under the cold environment. However, recent studies have indicated that most of nitrogen in stream water during the melting period was possibly passed through the soil microbial metabolisms, and that green house gasses such as N2O and CH4 were emitted by the microbial activities in the soil under the snowpack in winter. We conducted field incubation studies of forest surface soil in four sites located in Japan on annual basis to quantify and characterize the net nitrogen mineralization and nitrification rates of soil under the winter cold environment. We also analyze the response of the nitrogen mineralization rates against the change of temperature and moisture by conducting the transplant field incubation among each site.
Filed incubation of surface soil was conducted in natural forest ecosystems at northern Hokkaido, northern Kanto, central Kinki and southern Kyushu. The surface mineral soil (0-10cm) was incubated under field conditions using the resin-core method. The inorganic nitrogen content (ammonium and nitrate) in soil and the ion exchange resin set under the column were analyzed before and after the field incubation to measure the net nitrogen mineralization rate.
Net nitrogen mineralization rate in winter was high, corresponding 18%-40% to the annual rates in each site, especially in northern Hokkaido (cold and snowy site), although the daily rates in winter was lower than the other seasons in each site. These results indicated the winter nitrogen metabolisms in soil were quite important for the annual nitrogen cycling and soil nitrogen dynamics after spring. In the three sites excluding northern Hokkaido, net nitrification was dominant compared to the net ammonium production during non-winter periods. On the other hands, the contribution of the net ammonium production increased in all sites in winter. It was suggested that cold and moist condition under the snow pack suppressed nitrification and enhanced the ammonium production. In addition, transplant incubation from outside of Hokkaido to northern Hokkaido tended to increase the net nitrogen mineralization rate, especially net ammonium production in winter. These our results suggested that cold and moist environment in soil strongly affects the properties of soil nitrogen mineralization, and relates to the pattern of their responses against the environment changes.

Keywords: Forest ecosystem, Nitrogen cycling, Resin-core method, JaLTER, Biogeochemistry