Nitrogen and carbon isotope composition of plant and soil in Sugi and Hinoki plantations along a precipitation gradient

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Natural abundance of stable isotope is a powerful tool for understanding a long-term ecosystem processes. Organic nitrogen in forest soil is mineralized into ammonium by heterotrophic microbes. Then, ammonium is converted into nitrate by the nitrifying microorganisms. Nitrate in forest soil can be lost from the ecosystem by leaching or denitrification. Although, nitrogen dynamics in forest soil is complicated, the previous studies have shown that the pattern of natural abundance of stable isotope can give us insights for the understanding ecosystem processes. In the present study, the pattern of ^{13}C and ^{15}N in plant and soil is evaluated in Sugi (*Cryptomeria japonica*) and Hinoki (*Chamaecyparis obtusa*) plantations along a precipitation gradient in Shikoku Island. Four areas were selected from Setouchi region (annual precipitation, 1500-2000mm) and Pacific region (2500-4000mm). In each area, a pair of Sugi and Hinoki plantation was selected. In each stand, leaves, roots, organic layer and surface soil at 5cm depth were collected and analyzed for C and N concentration, ^{13}C and ^{15}N. Soil N mineralization rate is determined by the 30-d laboratory incubation.

Nitrogen concentration in leaves is higher in the low precipitation area (LPA, Setouchi) than the high precipitation area (HPA, Pacific). Nitrogen concentration in leaves is higher in Hinoki than Sugi stands. Hinoki stands showed clearer responses of N concentration to a precipitation gradient than Sugi stands. Nitrogen concentration in roots and organic layers is higher in LPA than HPA. Natural abundance of ^{15}N in leaves and roots was higher in Sugi stands than in Hinoki stands while is not different between LPA and HPA. Natural abundance of ^{15}N in soil is not different between Sugi and Hinoki stands, while is higher in HPA than LPA. The difference of d^{15}N of leaves, roots and organic layers from soil (d^{15}Nleaf-soil, d^{15}Nroot-soil, d^{15}Nlitter-soil) is greater in HPA than LPA. The nitrogen mineralization rate is negatively correlated with the difference of ^{15}N between leaf and soil (d^{15}Nleaf-soil). The results suggested that the N mineralization rate is lower in HPA and the ecosystem in HPA has tight and efficient N cycling. The nitrogen fractionation by plant uptake from soil is larger in HPA than LPA. The pattern of ^{15}N in forest ecosystems is affected by N availability along a precipitation gradient.

Natural abundance of ^{13}C in leaves is higher in Hinoki than Sugi while is higher in LPA than HPA. Leaf d^{13}C of Hinoki cypress in LPA is high because trees have higher water use efficiency. Natural abundance of ^{13}C in organic layer and surface soil is higher in Hinoki stands than Sugi stands while is not different between HPA and LPA. The difference of d^{13}C between surface soil and leaves are greater in HPA than LPA. Although the initial values of d^{13}C in leaves are different along a precipitation gradient, HPA has greater ^{13}C fractionation during organic matter decomposition. Thus, values of d^{13}C in soil are not different between two areas.

The previous studies have shown that ^{13}C fractionation during organic matter decomposition is affected by temperature, climate condition and soil N availability. The results of the present study have shown that the precipitation gradient in Shikoku Island also have strongly affect ecosystem N cycling and pattern of ^{13}C and ^{15}N abundances.