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Converting natural forests to different coffee cropping systems affects soil nitrogen transformation in tropical Thailand

Nipon Mawan[1], Phonlawat Soilueang[2], Yupa Chromkaew[2], Sureerat Buachun[3], Wiriya Sanjunthong[1], Narit Yimyam[1], Kittipong Jaikarsan[1], Nuttapon Khongdee[1]

[1] *Chiang Mai University, Dept. of Highland Agric. and Natural Resources, Thailand*

[2] *Chiang Mai University, Dept. of Plant and Soil Science, Thailand*

[3] *Rajamangala University of Technology Lanna Phitsanulok Campus, Thailand*

Abstract

Land-use change significantly alters nitrogen (N) transformation and retention in soil and plays crucial roles in soil fertility and greenhouse gas (GHG) emissions. This study aimed to investigate the impact of natural forest conversion to different coffee (*Coffea arabica* L.) cropping systems on soil N transformation in tropical northern Thailand. Soil samples from two depths (0–20 cm and 20–40 cm) were collected from four land uses: forest conversion to coffee monocultures (C), coffee agroforestry (FC), coffee- persimmon (*Diospyros kaki* L.) intercropping (CH) and adjacent natural forest (F). The soil labile nitrogen pools (including ammonium (NH_4^+), nitrate (NO_3), dissolved organic N (DON) contents and microbial biomass N (MBN)) were measured, as well as the soil total N (STN) concentration. Soil nitrification and N mineralisation rates were determined using a 35-day laboratory incubation experiment. The forest conversion to coffee agroforestry significantly increased soil N stock in both soil depths, but no significant difference was observed in C and CH soils as compared to F soil ($p < 0.05$). The three labile N forms (NH_4^+, NO_3 and DON content) were significantly higher under the C, FC and CH soils in the 0–20 cm depth, while the coffee monoculture decreased the MBN content as compared to forest soil in both depths. The forest conversion to all the different coffee cropping systems enhanced the net nitrification and N mineralisation rates. Interestingly, the N immobilisation process in the forest soil was higher than those in C, FC and CH soils, which indirectly regulated a decreased nitrification rate. With the exception of the FC soil, the nitrification/N immobilisation ratios in the C and CH soils were higher than those in the F soil, indicating an increased N loss risk after forest conversion. Our results indicated coffee agroforestry systems had the potential to enhance soil N content associated with forest conversion to coffee plantations, but plantations of coffee monoculture and coffee-persimmon intercropping were less effective with regard to soil N increase.

Keywords: Coffee agroforestry, land-use change, nitrification rate, nitrogen transformation

Contact Address: Nuttapon Khongdee, Chiang Mai University, Dept. of Highland Agric. and Natural Resources, Huay Kaew Road, 50200 Chiang Mai, Thailand, e-mail: nuttapon.k@cmu.ac.th