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Artificial stimulation of soil amine production by addition of organic carbon and nitrogen transforming enzymes

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The major part of nitrogen (N) in boreal forest soil is in organic form (Soil Organic Nitrogen, SON). One of the main pathways for amine production is the decay of SON in soil. Amino acids react with specific decarboxylase enzymes which transform them to amines. Amino acid turnover time in forest soil is relatively fast (in hours) because amino acids can be used as N and C source by plants and microbes. Therefore, amino acid production by protease enzymes might be the critical step for amine production and release from forest soil.

The aim of the study was to artificially introduce enzymes responsible for protein transformation into amino acids (proteases) as well as soil organic matter (SOM) decomposition (laccase and manganese peroxidase) in order to increase SON transformation and amine synthesis. Glucose addition has been shown to induce natural soil protease activity. Bovine serum albumin (BSA) was used as control protein. Treatments were conducted both in Scots pine seedlings containing as well as non-planted microcosms. N transformations were examined, as well as amine concentration in soil.

The experiment consisted of eight different treatments; two as controls concerning enzyme addition, four treatments were planted with one year old nursery grown Scots pine (Pinus sylvestris L.) seedlings and four were non-planted. The experiment lasted approximately six months and the treatments with the additions were conducted within one more month.

The protease activity was discovered more commonly after the treatment with protease or glucose additions. In planted BSA-control some natural protease activity was found but not in non-planted controls. Different substrate additions did not cause any differences in total N percentage, but the presence of the seedlings diminished soil N% by approximately 20%. In addition, the same effect was clearly seen in dissolved N, NH4+ and NO_3-. Plant has exploited the soluble N forms almost entirely from the system, irrespective of the substrate treatment. However, the presence of the seedling changed the ratio of organic N - inorganic N from inorganic nitrogen towards organic nitrogen in the soil compared to the non-planted treatments which were dominated in inorganic nitrogen forms, NH4+ and NO_3-.

The overall sums of the detected amines did not differ between any of the treatments although there was a trend of increased amine production in the absence of plants. Some amines in soil had a positive correlation with the presence (ethanol amine, spermidine, sec- and isobutylamine) or absence (dimethylamine) of plants.

Based on the results obtained so far, it seems that artificial induction of amines in forest soil condition was not successful. However, it is evident that the effect of plant is crucial on many soil biochemical processes, and that soils did contain high quantities of certain amines and there were differences in amine compounds present and concentrations between planted and non-planted treatments. Therefore, the results confirm that if detected amines are volatilised, soils may be a significant source of amines in forest environment.