How important is soil aggregation in regulating the activity of enzymes involved in the depolymerization of soil organic nitrogen?

*Jumpei Fukumasu[1], Liz Shaw[2], Yasushi Mori[1]

1.Graduate School of Environmental and Life Science, Okayama University, 2.Soil Research Centre, Department of Geography and Environmental Science, University of Reading

The process of nitrogen (N) mineralization in soils is regulated by extracellular N-acquiring enzymes (e.g. protease and chitinase) as N- containing organic polymers such as protein and chitin need to be depolymerized into monomers prior to microbial uptake and intracellular metabolism. In addition, this depolymerization could be regulated by the presence of soil aggregates which can protect soil organic N from enzymatic attack. However, the direct impact of soil aggregation on modulating the activity of enzymes involved in N mineralization has not been fully elucidated. Thus we tested the following hypotheses: (1) soil de-aggregation would promote N mineralization due to increased availability of organic N, and (2) there would be a stronger correlation between the mineralization rate and potential enzyme activities in de-aggregated soils than aggregated ones. In the present study two different soils from grassland (GL) and arable land (AL) respectively were air-dried and sieved for isolation of three fractions (4.75-2mm, 2-0.25mm and 0.25-0.063mm) of soil aggregates. For aggregate soil samples, three fractions were mixed based on the following proportion: 24g of 4.75-2 mm, 24g of 2-0.25 mm and 6g of 0.25-0.063 mm fraction. Corresponding de-aggregated soil samples were prepared by physical disruption with a pestle and mortar. To quantify N mineralization rate, anaerobic incubations of the soils at 26 were conducted for 10 days. Using the soils harvested from the aggregated and de-aggregated samples, potential protease and chitinase activities were determined using colorimetric assays.
The first hypothesis was supported for both land uses as N mineralization rates were significantly higher in de-aggregated soils than in aggregated ones ($P < 0.05$). The second hypothesis was supported in the case of the GL soil: significant correlations ($P < 0.05$; $r > 0.89$) between N mineralization rate and protease and chitinase activities were detected in de-aggregated soil whereas correlations for aggregated soils were weaker and not significant ($P > 0.05$; $r > 0.7$). For AL soils, only chitinase activity was reliably above the limit of detection of the assay. There were no significant correlations between the chitinase activity and N mineralization rate for both treatments, however, there was a positive correlation ($r > 0.7$) for de-aggregated soils.
The stronger correlations for the GL de-aggregated soil indicated that soil proteases and chitinases had access to, and depolymerized, organic polymer N which was physically protected before de-aggregation. We concluded that the difference between two land uses could be attributed to tillage effects on the relative location of extracellular enzymes and their substrates.

Keywords: Soil aggregate, Extracellular enzyme, Nitrogen minralization, Depolymerization

