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Respiration and priming effect in different land use types in semi-arid area of northern Ethiopia

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Abstract

Addition of easily available carbon (C) sources increases soil microbial activity, often resulting in priming effects (PEs)—short-term changes in soil organic matter (SOM) decomposition following substrate addition. Land use and agricultural management practices exert profound control on SOM turnover and its interactions with the global C cycle through different mechanisms. In this study, respiration and PE were quantified in soils sampled from four contrasting land uses (forest, exclosure, grazing and cultivated land) in four locations, across three layers (0–30, 30–60 and 60–90 cm) in a semi-arid area of northern Ethiopia. We hypothesised that land use might affect SOM turnover through changes in C input rates, nutrient availability, and PEs. Soils were incubated for 23 days and PE and respiration quantified after addition of 14C labeled glucose corresponding to 50 % of initial microbial biomass carbon (MBC). Generally, application of substrate to the soil stimulated production of CO_2 in all land use types. The CO_2 respired was 30–63 % lower in sub than in topsoil with most expressed depth gradients in croplands. In subsoil, the weak negative PEs is an indication of highly stabilised C. Contrary, glucose addition induced stronger positive PEs in topsoils sampled from forest, exclosure and grazing land. The temporal dynamics of PEs involved a strong positive peak for the first five days after glucose addition and a second smaller peak 10 days after glucose addition in natural ecosystem, corresponding to apparent and real PE, respectively. Lack of positive correlation between PEs and C/N ratio ruled out the N-mining hypothesis, but a positive correlation between PE and MBC suggests co-metabolism as possible mechanism behind the real PE. Higher priming in natural ecosystem compared to cropland is an indication that conversion of natural ecosystem to continuous cropping system leads to depletion of the "primable" C pool in dryland soils. Additionally, this land use conversion negatively affects biogeochemical C cycling by an altered response of soil microbes to C input.

Keywords: Glucose, land use, mineralisation, northern Ethiopia drylands, priming effect, respiration, soil organic matter

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