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Decomposition of conifer tree bark under field conditions: effects of nitrogen and phosphorus additions

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In forest ecosystems, the processes of decomposition of coarse woody debris (CWD) can contribute significantly to the emission component of carbon (C) cycle and thus accelerate the greenhouse effect and global climate change. A better understanding of decomposition of CWD is required to refine estimates of the C balance in forest ecosystems and improve biogeochemical models. These estimates will in turn contribute to assessing the role of forests in maintaining their long-term productivity and other ecosystems services. We examined the decomposition rate of coniferous bark with added nitrogen (N) and phosphorus (P) fertilizers in experiment under field conditions.

The experiment was carried out in 2015 during 17 weeks in Moscow region (54o50'N, 37o36'E) under continental-temperate climatic conditions. The conifer tree bark mixture (ca. 70% of Norway spruce and 30% of Scots pine) was combined with soil and placed in piles of soil-bark substrate (SBS) with height of ca. 60 cm and surface area of ca. 3 m2. The dry mass ratio of bark to soil was 10:1. The experimental design included following treatments: (1) soil (Luvisols Haplic) without bark, (S), (2) pure SBS, (3) SBS with N addition in the amount of 1% of total dry bark mass (SBS-N), and (4) SBS with N and P addition in the amount of 1% of total dry bark mass for each element (SBS-NP). The decomposition rate expressed as CO_2 emission flux, g C/m2/h was measured using closed chamber method 1-3 times per week from July to early November using LiCor 6400 (Nebraska, USA). During the experiment, we also controlled soil temperature at depths of 5, 20, 40, and 60 cm below surface of SBS using thermochrons iButton (DS1921G, USA).

The pattern of CO_2 emission rate from SS depended strongly on fertilizing. The highest decomposition rates (DecR) of 2.8-5.6 g C/m2/h were observed in SBS-NP treatment during the first 6 weeks of experiment. The decay process of bark was less active in the treatment with only N addition. In this case the highest DecR of 1.9-4.1 g C/m2/h was observed in 2-7 weeks after the experiment started. The decay process of pure SBS treatment was slower than in SBS-N and SBS-NP. In this case, the maximal DecR varied between 1.8 and 3.6 g C/m2/h during 4-7 weeks. After 8-9 weeks of experiment, the DecR was almost the same in all SBS treatments and did not exceed 0.5-1.1 g C/m2/h. The DecR of pure soil was much lower compared to all SBS treatments and comprised 0.04-0.18 g C/m2/h. The total C loss from pure SBS amounted for 4.2 kg C/m2 while the fertilizer addition increased the intensity of bark decay by 37-48%. We observed higher rise of temperature during the experiment of SBS with N and P additions than in pure SBS. Concluding, the N and P amendments affected significantly both the pattern of CO_2 emission rate and total C loss during decay processes of bark.

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