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Effect of ground fire of low intensity on soil organic matter decomposition

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Seasonal grassland fires in Russia occupy the greater area and spread quicker than peat-bog or forest fire. During short-term grassland fire of low intensity the vegetation and plant litter are usually burned down, while soil is not affected by high temperatures. Thus, the pyrogenically transformed plant material is the main factor affecting the soil microbial community after the seasonal grassland fire. Input of pyrogenic substrates to soil can alter microbial activity resulting in accelerated turnover of native soil organic matter (SOM), and in carbon losses from soil. Our study aimed to estimate the effect of seasonal grassland fires on microbial communities of soils under forest and meadow using the eco-physiological profiling (Anderson, 2003).

The following variables were determined under field and laboratory conditions: 1) dynamics of CO2 evolution (basal respiration); 2) microbial biomass C by glucose-induced respiration; 3) Cmic – to- Corg ratio, 4) metabolic quotient qCO2; 4) specific growth rates of microorganisms by the kinetics of substrate induced respiration. The indirect effect of short-term ground fire on mineralization activity of soil microorganisms was studied in incubation experiments after application of pyrogenically modified plant residues to the soil.

Since the values of the variables studied differed from each other in a large scale, they were generalized by the mathematical indices allowing the comparison of different variables at the base of non-dimensional scale. The eco-physiological profiles combining the biological indicators mentioned above allowed the comparison of post-fire and undisturbed soils.

The acceleration of basal respiration caused by the fire was observed in soils of both biocenoses at least during two months after the fire. Cumulative increase in CO2 efflux from 5cm soil layer amounted for 5 % (meadow) and for 10 % (forest) of annual CO2 emission.

Post-fire effect resulted in total mineralization of grassland floor on the meadow in two months after the fire. Grassland fire caused the decrease in plant diversity, the decrease in biomass of cereals, while the increase in total biomass of grasses was observed after the fire. The soil amendment with plant ashes resulted in stable long-term decrease in microbial specific growth rates. We conclude that the pyrogenic transformation of plant residues caused the shift in functional structure of microbial community with domination of slow growing microorganisms with K-strategy. Since enzyme systems of K-strategists are able to degrade complex organic substrates they can co-metabolize SOM under substrate limitation. So, accelerated mineralization of native SOM, i.e. priming effect can occur as a consequence of the ground fire.

Reference:
Anderson TH. 2003. Microbial eco-physiological indicators to assess soil quality. Agric Ecosyst Environ 98:285-293.