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Priming effects in Haplic Luvisol after different substrate additions

I. Bogomolova (1,3), E. Blagodatskaya (2,3), S. Blagodatsky (2,3), and Y. Kuzyakov (3)

(1) V.V. Dokuchaev Soil Science Institute, Moscow, Soil Science, Moscow, Russian Federation (ibogomolova2000@mail.ru), (3) Dep. of Agroecosystem Research, University of Bayreuth, D-95440 Bayreuth, Germany, (2) Institute of Physicochemical and Biological Problems in Soil Science, RAS, 142290 Pushchino, Russia

Although soils contain considerable amounts of soil organic carbon (SOC), most of it is not easily available for microorganisms. Addition of various substrates to soil (for example, plant residues, root exudates) may affect SOC mineralization. The addition of mineral nutrients, especially N, may also affect C turnover and so change the mineralization rate of SOC. Such short-term changes in mineralization of organic substance of soil were termed as "priming-effects" (Bingemann et al., 1953). Priming effect leads to additional mineralization of SOC (van Elsas and van Overbeek, 1993). It has been shown that not only plant residues induce priming effects (Sauerbeck, 1966; Stemmer et al., 1999; Bell et al., 2003), but also easily available substrates such as sugars or amino acids, which are present in soil solutions and root exudates (Vasconcellos, 1994; Shen and Bartha, 1997; Hamer and Marschner, 2002). Since easily available substrates may not only accelerate SOC mineralization, but also may retard it, Kuzyakov et al. (2000) differentiated between positive and negative priming effects. It is not clear until now, how long priming effects persists in soil after substrate addition, and if they are induced every time when a substrate becomes available in soil. So, the aim of this study was to evaluate effects of glucose and plant residues on SOM decomposition, and influence of glucose on plant residues decomposition in soil.

The experimental layout was designed as two factor experiment: 1) plant residues and 2) available substrate amendment. Maize shoot residues (50 mg added to 5 g soil) were 14C labeled (9•104 DPM per 5 g soil). Soil without of any plant residues served as a control for this treatment. Two levels of D (+) glucose as easily available substrates were added after three months of pre-incubation of soil samples with maize residues: 0.009 mg glucose C g-1 soil and 0.225 mg glucose C g-1 soil. The glucose was uniformly labelled with 14C (2.37•104 DPM per 5 g soil). The glucose was added together with nutrient solution, containing N, P and K. After glucose addition the soil moisture increased up to 70% WHC. Soil samples without glucose amendment were used as a control treatment.

After treatment with glucose soil samples were incubated for 14 days at 22 °C. The produced CO2 was trapped in 0.45 ml of 1 M NaOH solution. The amount of evolved total CO2 was analysed by titration of an aliquot of the NaOH solution with 0.1 M HCl after precipitation of the trapped CO2 as BaCO3. The activity of 14CO2 trapped in the NaOH solution was measured with a Liquid Scintillation Counter (Microbeta, Perkin Elmer) after mixing of the aliquot NaOH solution with 0.5 ml of the scintillation cocktail Rotiszint Eco Plus.

Combination of treatments with 14C labeled plant residues and 14C labeled glucose allowed calculation of (1) the effect of glucose on SOM decomposition, and (2) the effect of glucose on plant residues decomposition.

The glucose was consumed within one day after addition. Similar results were obtained also in other studies (Nguyen and Honrz, 2002). The maximal rate of glucose mineralization was measured within the first day and was three times higher in soil without plant residues (43% and 15% of input for low and high glucose amount, respectively). Our estimation of the proportion of 14C-CO2 evolved from glucose was very close to that by Šantruckova et al. (2004). They found 27% of 14C evolved as CO2 after 72 h of aerobic incubation of soil with 315 μg glucose-C g-1. Twelve days after glucose addition 47.2 and 32.8% of the added glucose was mineralized to CO2 for low and high glucose amount, respectively.

Both concentrations of glucose increased SOM decomposition and increased maize residue decomposition compared to the control without glucose. The apparent PE observed under C-limiting conditions after the addition of small glucose amount can be explained by the "signal" or "triggering" effect. The addition of easily available substrates such as glucose to soil can induce an extra CO2 efflux within a few hours to days after the amendment.