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Effect of different soil carbon amendments on the post-harvest dynamics of soil microbial biomass carbon and -nitrogen in an agricultural field experiment

Jessica Clayton[1], Steffen Rothardt[2], Rüdiger Reichel[3], and Michael Bonkowski[1]
[1]Terrestrial Ecology, Universität zu Köln, Köln, Germany (j.clayton@uni-koeln.de)
[2]Agronomy and Crop Science Institute of Crop Science and Plant Breeding, Christian-Albrechts-Universität zu Kiel, Kiel, Germany (rothardt@pflanzenbau.uni-kiel.de)
[3]IBG-3 Agrosphere, Forschungszentrum Jülich, Jülich, Germany (ru.reichel@fz-juelich.de)

Every year agricultural soils lose significant amounts of nitrogen (N) over winter through N leaching and gas emissions as a result of freeze-thaw cycles. The incorporation of carbon amendments after harvest, such as crop residues or other carbon rich material, can help to promote soil microbial growth, and in doing so, immobilise N within the microbial biomass. It is still unclear which amendments are most effective at promoting microbial N immobilisation and at what time they should be incorporated into the soil to give best results.

In order to investigate this, we measured soil microbial biomass carbon (C_{mic}) and -nitrogen (N_{mic}) at 12 timepoints between harvest and spring in soils from an established agricultural field experiment in Kiel (Germany). We selected plots which had the same fertilisation regime and crop rotation (Faba bean-winter wheat-winter barley rotation) but differed in soil carbon amendment treatment; removal of residues (control), wheat straw, faba bean, and sawdust. In addition to microbial biomass measurements, we measured microbial nutrient limitation at each timepoint via substrate induced respiration, in order to give a qualitative indication of microbial activity in respect to growth limiting nutrients.

Our data show that there was little effect of wheat straw in comparison to the control on the microbial biomass carbon or -nitrogen, but different patterns were observed for the latter amendments. C_{mic} generally decreased over time after harvest in all treatments, but again the decreases were less pronounced in the faba bean and sawdust treatments. N_{mic} decreased over time after harvest in control and wheat straw treatment but increased with time in the faba bean and sawdust treatments, suggesting improved N immobilisation by the microbial biomass for these treatments. We found that all soils were nearly always N limited throughout the winter and were never P limited. However, a shift to C limitation was observed after addition of fertiliser in spring, except for in the sawdust treatment, which remained N limited despite the addition of mineral N in the field. This result suggests that sawdust has a higher potential for N immobilisation compared to the other soil amendments.

In summary, there was little difference in the microbial post-harvest dynamics between the control and wheat straw treatments but stronger effects were observed in the faba bean and saw dust treatments, which suggested improved microbial N immobilisation. Interestingly, the sawdust amendment seemed to have the highest potential for microbial N immobilisation over winter and enduring into spring.