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Soil organic carbon and lignin dynamics in an arable soil as affected by nitrogen fertilization

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Nitrogen probably influences soil organic matter (SOM) decomposition but rates and underlying processes remain unclear. Incubation and semi-field experiments show that nitrogen can enhance or inhibit SOM decomposition. The molecular structure of lignin does not contain nitrogen, and its decomposition is therefore likely limited by nitrogen availability. Therefore it can be hypothesized that high nitrogen availability might increase lignin decomposition. On the other hand, it is known that under nitrogen limitation microorganisms produce more exoenzymes, which could lead to co-metabolic decomposition of lignin and thus to the opposite hypothesis that low nitrogen availability might increase lignin decomposition.

The objective of our study was to find out if inorganic nitrogen fertilization affects the long-term (decadal) dynamics of soil organic carbon (SOC) and lignin in arable soils. We analysed SOC and CuO-oxidized lignin in a 35-year time series of six archived soil samples from the continuous maize experiment Cadriano (University of Bologna, Italy) which was conducted without and with conventional nitrogen fertilization (200-300 kg N ha^{-1} a^{-1}). We used the natural ^{13}C label of maize to track the decomposition of old SOC and lignin.

After 35 years, 50 to 30 % of the old lignin was still present in the soil, consistent with our earlier results from another long-term agricultural experiment. Thus, in arable soil a large fraction of lignin seems to be stable for decades, although the mechanisms are not yet clear. Our results show that nitrogen fertilization had no statistically significant

influence on lignin decomposition over the 35-year period. It could be speculated that this observation is caused by atmospheric nitrogen deposition that prevents extreme nitrogen depletion in the unfertilized plots. We conclude that for long-term lignin decomposition in this field experiment, nitrogen was neither a limiting nor an inhibiting factor.