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Mechanisms of short-term soil carbon storage in experimental grasslands

S. Steinbeiss (1), V.M. Temperton (1,2), G. Gleixner (1)

(1) Max Planck Institute for Biogeochemistry, POB 100164, 07701 Jena, Germany (sstein@bgc-jena.mpg.de)

(2) Now at the Phytosphere Institute ICG-3, Juelich Research Centre GmbH, 52425 Juelich, Germany

We investigated the fate of root and litter derived carbon into soil organic matter and dissolved organic matter in soil profiles, in order to explain unexpected positive effects of plant diversity on short-term carbon storage. A time series of soil and soil solution samples was investigated at the field site of The Jena Experiment. In addition to the main biodiversity experiment with C3 plants, a C4 species (*Amaranthus retroflexus* L.) naturally labeled with ^{13}C was grown on an extra plot. Changes in organic carbon concentration in soil and soil solution were combined with stable isotope measurements to follow the fate of plant carbon into the soil and soil solution. A split plot design with plant litter removal versus double litter input simulated differences in biomass input. After 2 years, the no litter and double litter treatment, respectively, showed an increase of 381 g C m^{-2} and 263 g C m^{-2} to 20 cm depth, while 71 g C m^{-2} and 393 g C m^{-2} were lost between 20 and 30 cm depth. The isotopic label in the top 5 cm indicated that 11 and 15 % of soil organic carbon were derived from plant material on the no litter and the double litter treatment, respectively. Without litter, this equals the total amount of carbon newly stored in soil, whereas with double litter this corresponds to twice the amount of stored carbon. Our results indicate that litter input resulted in lower carbon storage and larger carbon losses and consequently accelerated turnover of soil organic carbon. Isotopic evidence showed that inherited soil organic carbon was replaced by fresh plant carbon near the soil surface. Our results suggest that primarily carbon released from soil organic matter, not newly introduced plant

organic matter, was transported in the soil solution and contributed to the observed carbon storage in deeper horizons.