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Soil Labile Organic Matter under Long-term Crop Rotation System

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Temperate grassland soils, typically Mollisols, have remained agriculturally productive with limited inputs for many years, despite the mining of energy and nutrients reserves contained within the soil organic fraction (Janzen, 1987; Tiessen et al., 1994). Such system can be considered resilient, at least initially, but one must question for how long such systems can be sustained.
Effect of long-term land-use on biologically active fractions of soil organic matter is not well understood. Investigations were conducted in more than 40-year static experiments in northern Kazakhstan. We examined five fallow-wheat (Triticum aestivum L.) cropping systems with different frequencies of the fallow phase: continuous wheat (CW), 6-y rotation (6R), 4-y rotation (4R), 2-y rotation (2R) and continuous fallow (CF). A unique sample from nationally protected virgin steppe near the experimental field was sampled for comparison with long-term cultivated soils. Soil samples were collected from the two phases of each rotation, pre- and post-fallow, and analyzed for biological soil properties that are potentially mineralizable C (PMC), potentially mineralizable N (PMN), microbial biomass C (MBC) and N (MBN) and “light fraction” C (LFC) and N (LFN). Potentially mineralizable C was inversely proportional to the frequency of fallow and was highest in CW. Potentially mineralizable N was more responsive to rotation phase than other indices of SOM. Light fraction OM was negatively correlated to the frequency of fallow and was higher in pre-fallow than in post-fallow phases. All studied biological characteristics were drastically greater in the soil from the natural steppe. The results suggested that the yearly input of plant residues in a less frequently fallowed system built up more PMC, whereas PMN was closely correlated to recent inputs of substrate added as plant residue. We concluded that a frequent fallowing for long period may deplete SOM via accelerated mineralization. The results may provide prediction of SOM response to fallow frequency in wheat-fallow based cropping systems in semi-arid regions.