CO_2 LOSSES FROM AGRICULTURAL SOILS IN NORTHERN KAZAKHSTAN AS AFFECTED BY PHYSIOLOGICAL STATE OF SOIL MICROBIAL COMMUNITY

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ABSTRACT

Dynamics of organic matter in agricultural soils attract significant interest because of strong impact on global climate. Steppe ecosystems are considered as having high potential to preserve global carbon and are located mainly in arid and semiarid areas with annual precipitation smaller than 400 mm. Steppe ecosystems of the wheat belt in Kazakhstan have annual precipitation 250 to 350 mm. Here is our attempt to evaluate whether microbial quotients could be applied to evaluate the potential of soil to act as sink for CO_2.

Results of laboratory and field experiments were combined. The cumulative amount of CO_2 emitted from soil, which was subjected to four drying-rewetting cycles over 35 days, was approximately 23 % higher in comparison to soil incubated at constant soil moisture content. Concurrently, the metabolic quotient (qCO_2), defined as the ratio between basal respiration and microbial biomass and indicating C-use efficiency of active microorganisms, and the ratio of microbial biomass values obtained by substrate-induced respiration and fumigation-extraction techniques (SIR/FE), reflecting the metabolic-responsive biomass, were increased under short-term environmental changes.

Investigations of agricultural soils showed that the qCO_2 values did not differ significantly between the conservation tillage practices at 10 cm (CT10) and 20 cm (CT20) soil depth, and were higher in the conventional mould-board ploughing system (MBP) and lowest in the stubble field (SF) and non-cultivated soil. Metabolic-responsive biomass did not significantly differ between SF and CT10, was elevated in CT20 and highest under MBP. After 19 years of this management, soil organic C decreased from 45 mg C g-1 soil in non-cultivated soils to 26, 29 and 30 mg C g-1 soil in MBP, CT10 and CT20, respectively. Both the laboratory and field studies suggest that high CO_2 losses were attributed to high metabolic-responsive biomass and low C-use efficiency. The ability of soil to act as sink for CO_2 may be evaluated on the base of physiological state of soil microbial community.