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Carbon balance of the typical grain crop rotation in Moscow region assessed by eddy covariance method

Joulia Meshalkina (1,2), Alexis Yaroslavtsev (1), and Ivan Vassenev (1)

(1) Department of Ecology, RSAU-MTAA, Moscow, Russian Federation (jlmesh@list.ru), (2) Soil Science Faculty, Lomonosov Moscow State University, Moscow, Russian Federation

Croplands could have equal or even greater net ecosystem production than several natural ecosystems (Hollinger et al., 2004), so agriculture plays a substantial role in mitigation strategies for the reduction of carbon dioxide emissions. In Central Russia, where agricultural soils carbon loses are 9 time higher than natural (forest's) soils ones (Stolbovoi, 2002), the reduction of carbon dioxide emissions in agroecosystems must be the central focus of the scientific efforts.
Although the balance of the CO_2 mostly attributed to management practices, limited information exists regarding the crop rotation overall as potential of C sequestration.
In this study, we present data on carbon balance of the typical grain crop rotation in Moscow region followed for 4 years by measuring CO_2 fluxes by paired eddy covariance stations (EC).
The study was conducted at the Precision Farming Experimental Fields of the Russian Timiryazev State Agricultural University, Moscow, Russia. The experimental site has a temperate and continental climate and situated in south taiga zone with Arable Sod-Podzoluvisols (Albeluvisols Umbric).
Two fields of the four-course rotation were studied in 2013-2016. Crop rotation included winter wheat (Triticum sativum L.), barley (Hordeum vulgare L.), potato crop (Solanum tuberosum L.) and cereal-legume mixture (Vicia sativa L. and Avena sativa L.). Crops sowing occurred during the period from mid-April to mid-May depending on weather conditions. Winter wheat was sown in the very beginning of September and the next year it occurred from under the snow in the phase of tillering.
White mustard (Sinapis alba) was sown for green manure after harvesting winter wheat in mid of July.
Barley was harvested in mid of August, potato crop was harvested in September. Cereal-legume mixture on herbage was collected depending on the weather from early July to mid-August.
Carbon uptake (NEE negative values) was registered only for the fields with winter wheat and white mustard; perhaps because the two crops were cultivated on the same field within one growing season. Other cases showed CO_2 emission. NEE for barley field was equal to zero or even positive during the whole year; considering only the growing season, NEE for barley was about 100 g C m^{-2} lower and usually was negative. Carbon uptake for cereals was strongly related with weather conditions: in favorable years it was higher. Potato crop and cereal-legume mixture showed difference in 50-100 g C m^{-2} per year in NEE in different years related to difference in yields.
The total agroecosystems respiration ranged from 400 to 550 g C m^{-2} per year and was closely linked to weather conditions.
Closed balance for whole years showed that carbon losses were observed for all studied agroecosystems. It was minimal for fields with winter wheat, with mustard, used as green manure, and it was maximal for fields with cereal-legume mixture.
Values about 200-250 g C m^{-2} per year may be considered as estimated values for the total carbon loss for the typical grain crop rotation in Moscow region. The use of mustard as a green manure reduced this value by three-quarters.