Geophysical Research Abstracts
Vol. 13, EGU2011-5564, 2011
EGU General Assembly 2011

Carbon balance of crops: overview of 7 years of investigation

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The carbon balance of crop rotations has been studied for 7 years at the Belgian crop site of Lonzée. The field was cultivated as a 4 year crop rotation (sugar beet, winter wheat, potato and again winter wheat).

During the first 4 year rotation carbon balance, when taking carbon imports and exports into account, the crop behaved as a small but significant carbon source. However, this resulted notably from the fact that no organic matter had been applied for more than 10 years, that cereal straw had been systematically exported for livestock and that intercrop periods were not planted with cover crop. The second 4 year rotation is in progress. During this period, slurry was applied, cover crop was sown during a long intercrop period and more ploughings were operated. The impact of these management practices on the carbon balance was examined.

The inter-annual variability of CO2 fluxes, yield and development of winter wheat crops was deeply analysed. This allowed highlighting some mechanisms related to meteorological conditions and, sometimes, modulated by a cultivar effect. In particular, it was shown that grain yield could not be related to gross primary productivity or net ecosystem exchange. It also appears that the precociousness or lateness in stage development was mainly triggered by cumulated temperature during winter and early spring but the early development on one season was of no impact on the grain yield even if it could explain a larger ecosystem net carbon sequestration.

The 7 successive years of measurement also allow studying the impact of management practices on carbon balance and the different physiological responses of the 3 crop species in relation to crop development and biotic and abiotic factors such as, i.e. particular climatic events such as drought, management practices.

Finally, the soil respiration measurements carried out in planted areas and in root exclusion zones allow partitioning respiration into its autotrophic and heterotrophic components. Their relative contribution in the total ecosystem respiration and the relative contribution of below and above ground part of autotrophic respiration depended on crop species and on crop development stages. Moreover, the driving factors of the autotrophic and heterotrophic parts of the respiration were found different, the first responding mainly to gross primary productivity and the second to temperature.