What is a stronger determinant of soil respiration: soil temperature or moisture?

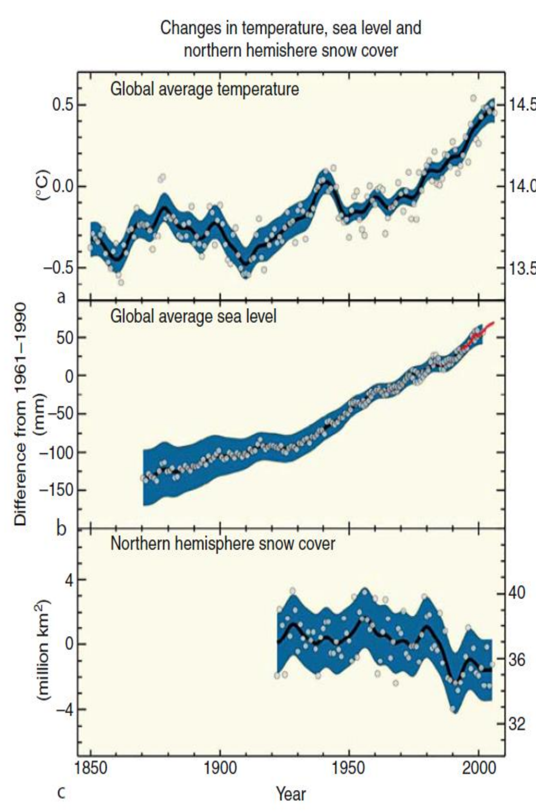
Brzezinska M*., Bulak P., Krzyszczak J., Pazur M., Walkiewicz A., Bieganowski A., Lipiec J., Slawinski C.

Institute of Agrophysics, Polish Academy of Sciences, ul. Doswiadczalna 4; 20-290 Lublin, Poland

*m.brzezinska@ipan.lublin.pl

Introduction

Increased atmospheric concentrations of greenhouse gases have led to global warming and climatic changes.
Soil CO_2 efflux has been assumed to be equivalent to soil respiration (defined as the flux of CO_2 resulting from the biological activity of soil micro-organisms, microfauna and plant roots). It is the second largest flux of CO_2 from terrestrial ecosystems to the atmosphere with 10% of atmospheric CO_2 cycling through soils annually. Both experimental and modelling studies are necessary to predict and to quantify gas exchange in agroecosystems.



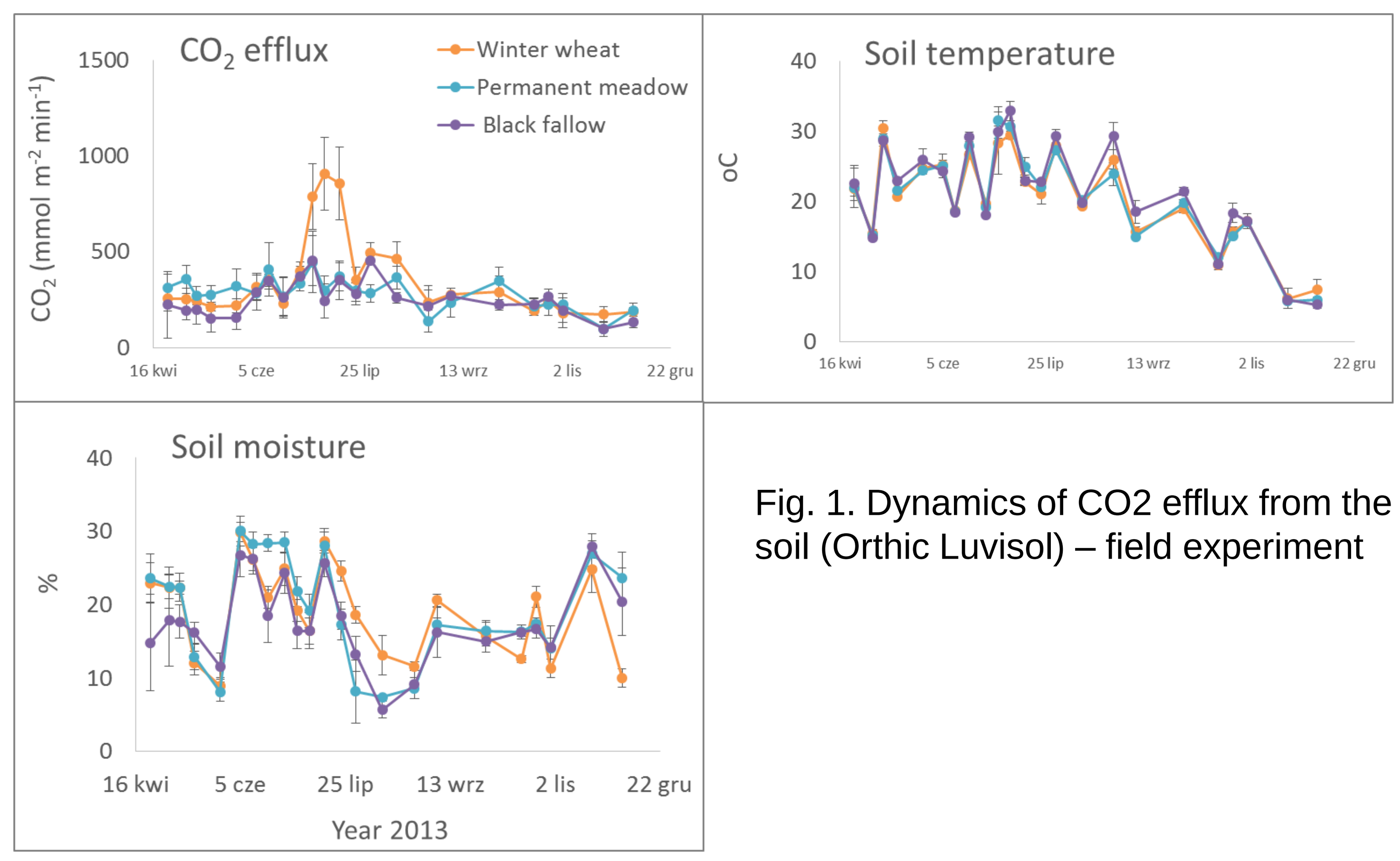


Fig. 1. Dynamics of CO2 efflux from the soil (Orthic Luvisol) – field experiment

Aim of this work was to study the effect of soil moisture and temperaturę (important environmental factors) on CO_2 emission from agricultural soil under field and laboratory conditions.

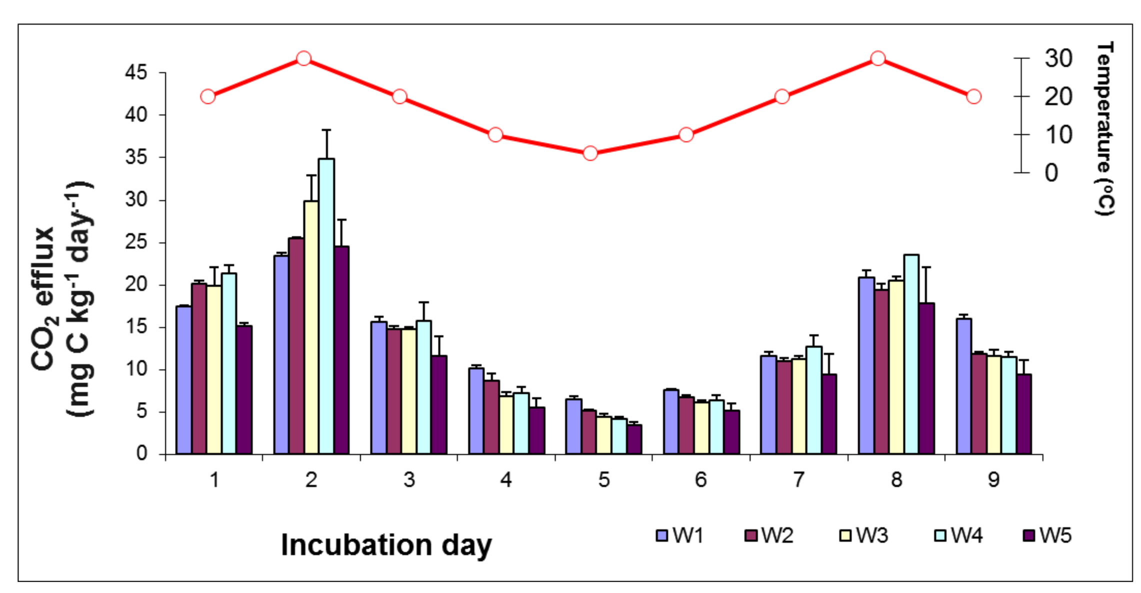


Fig. 2. CO_2 efflux determined under controlled soil moisture and temperature conditions (Orthic Luvisol)

Methods

Experimental farm of the Lublin University of Life Sciences located in Felin (near Lublin, south-eastern part of Poland). The climate: moderately warm continental. Long-term annual mean temperature and precipitation: 7.4ºC and 572 mm, respectively. The soil: Orthic Luvisol developed from loess, over limestone with silt loam texture containing (in g kg^{-1}) 660 sand (2-0.02 mm), 280 silt (0.02-0.002 mm) and 60 clay (<0.002 mm), pH (H_2O) 5.85, bulk density 1.33 Mg m^3 and particle density 2.61 Mg m^3 (Lipiec et al. 2012).

Field experiment: soil covered with winter wheat, permanent meadow or black fallow; the *in situ* CO_2 efflux form the soil, air and soil temperature and moisture were measured from April to December 2013.

Laboratory experiment: soil collected from a depth of 0-10 cm was air-dried and passed through an 2 mm sieve. Next, soil samples were rewetted to obtain soil moisture in a range from water saturation (pF 0) to plant wilting point (pF 4.2), and incubated in closed vessels at different temperatures (from 5º C to 30º C). CO_2 production was determined by gas chromatography (Shimadzu GC-14A, TCD detector)

	Soil moisture in the laboratory experiment
W1	Full water saturation (pF 0)
W2	Gravitational water (pF 1,0)
W3	Field water capacity (pF 2,2)
W4	Water easy available (pF 2,7)
W5	Wilting point (1500 kJ m^{-3}, pF 4,2)

Conclusions

Under field conditions, the CO_2 efflux was influenced by plant cover ($F=7.96$; $p<0.001$), and was related to both, soil temperature ($p<0.001$) and slightly less by soil moisture ($p<0.01$).

Multifactor analysis of variance has shown that the soil respiration, as measured in laboratory under controlled soil moisture and temperaturę conditions, was much more affected by soil temperature ($F=237.0$; $p<0.0001$), than by soil moisture ($F=4.99$; $p<0.01$).

References

IPCC, 2007 Climate change: the physical science basis. Summary for policymakers. Cambridge, New York: Cambridge University Press.

Kutilek M. (2011) Climate Change: Environmental Effects In: Encyclopedia of Agrophysics (Gliński J., Horabik J., Lipiec J. eds.), Springer Verlag, Heidelberg, Germany, pp. 125-134.

Lipiec, J., Brzezińska, M., Turski, M., Szarlip, P., Frąc, M. (2015) Wettability and biogeochemical properties of the drilosphere and casts of endogeic earthworms in pear orchard. Soil & Tillage Research 145, 55–61;

Rey A. (2015) Mind the gap: non-biological processes contributing to soil CO2 efflux. Global Change Biology doi: 10.1111/gcb.12821

The work was partially supported by **FACCE MACSUR (P162)**