Response of the soil mesofauna trophic structure to elevated CO2 and GM barley

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Soil is a complex ecosystem, and also one of the most important natural systems on the planet, given its fundamental role in biogeochemical cycles, the high richness of biodiversity and the many ecosystem services it provides. Soil fauna, with its multiple levels of specialization and its interactions with above-ground biota and with the mineral soil, is essential for the soil ecosystem, radically altering physical, chemical and biological properties of soil.

Agricultural soils are valuable resources for human activities, but are currently highly threatened, especially by anthropic pressures. In this sense, the growing use of genetically modified crops (GM) is pointed as a possible threat to the functioning of these ecosystems, by altering biodiversity and the ecological balance and dynamics. In addition there are other types of environmental changes, including the gradual increase in CO$_2$ in Earth's atmosphere, related to global climate change.

Several studies have been carried out to test the impact of varieties of GM crops on soil fauna (e.g. Cortet et al., 2006; Birch et al., 2007; Griffiths et al., 2007), however, for the moment, there are no studies in literature on the interaction of this factor with the increase in atmospheric CO$_2$. In this sense, we wanted to initiate a multi-factors experiment to assess the combined effects of the two factors on soil mesofauna (Acarina, Collembola and the oligochaete Enchytraeidae).

In order to use an experimental methodology intermediate between field studies, 3rd tier, and laboratory studies, 1st tier, a 2nd tier study (EFSA, 2010) was set up using mesocosms in a greenhouse, reproducing in each unit a typical North European agro-ecosystem with GM (Antisense C-hordein line; Lange et al., 2007) or conventional varieties of barley (*Hordeum vulgare*) exposed at ambient and elevated concentrations of CO$_2$. The aim was to verify possible effects of the two factors and their interaction on the dynamics of animal populations and trophic structure of communities, the latter studied measuring natural abundances of stable isotopes of carbon and nitrogen ($^{13}$C and $^{15}$N). Crushed maize leaves, mixed in the top layer, were used as an isotopic marker, having a high $\delta^{15}$N and $\delta^{13}$C. Mesocosms were destructively sampled after 5, 11 and 20 weeks, when data on populations, plant biomass, organic matter decomposition were taken and samples for stable isotopes analysis (SIA) from all the elements of the system were prepared.

Data from population abundances revealed interspecific interactions and dynamics, some of them also confirmed by SIA, which permitted to estimate trophic preferences and relations among species, as well as diet changes over the time. Diet preferences highlighted by our SIA confirmed literature data, e.g. for *Protaphorura fimata* being a root-feeder (Ulber, 1983; Endlweber et al., 2009).
Crushed maize leaves directly and indirectly influenced the isotopic signatures of ecosystem elements, hence confirming the potentiality of SIA to track changes in the system, especially using labelling elements. Injected CO$_2$ in the greenhouse ($\delta^{13}C = -29‰$; $\delta^{13}C$ of the mixed air in the room = -12.23‰; $\delta^{13}C$ of ambient air assumed -9‰) had the same role as an isotopic marker, as the different $\delta^{13}C$ value was reflected in the system in plant material.

Elevated CO$_2$ did not produce any significant difference in vegetal growth, probably due to lack of nutrients in the experimental soil, and had few effects on some animal species abundances. Nevertheless, SIA revealed an indirect effect of injected CO$_2$ on some collembolan species $\delta^{13}C$ values, confirming the power of this analysis in tracking changes in the system.

GMO presence had few effects on population abundances as well, but not on trophic structure. Both CO$_2$ and GMO effects need to be clarified by further studies.

The integrated approach using a mesocosm multi-species experiment together with SIA and organic matter decomposition measurement permitted to acquire multiple information on single species and community dynamics, and is hence proposed as a useful risk assessment tool to test effects on soil ecological functioning.

References


