Direct and indirect effects of elevated CO_2 on *Lolium perenne* root exudation: consequences on soil organic matter decomposition

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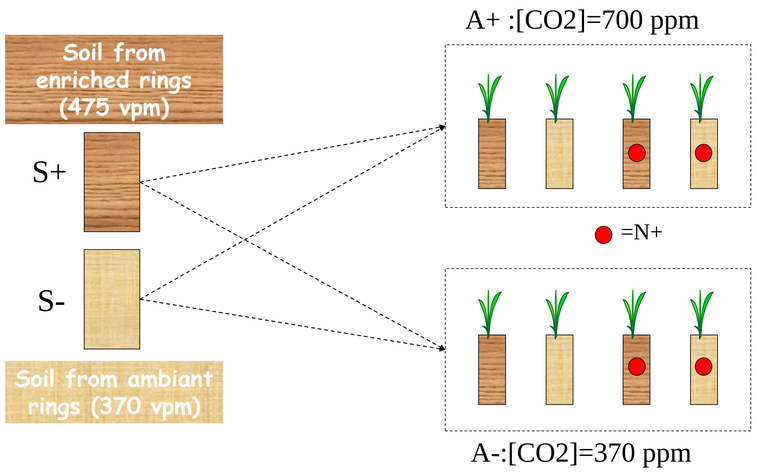
Objectives

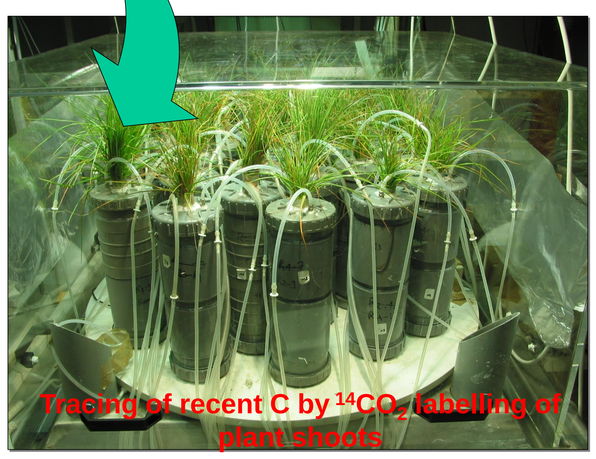
It is still unclear whether elevated CO_2 increases plant root exudation and affects soil microbial biomass by furnishing greater quantity of easily decomposable carbon (C). The effects of elevated CO_2 on the C and nitrogen (N) contained in old soil organic matter (SOM) pools is also controversial. The objectives of this work were to evaluate the impact of elevated CO_2 on the partitioning of C to the rhizosphere compartments and to determine the consequences on the decomposition of organic matter in the soil. These aspects are crucial for the availability of mineral N for plant growth and for the dynamics of C in the soil in the context of global change.

Methodologies

The short-term and long-term effects of elevated CO_2 on C and N pool and fluxes were evaluated by growing ryegrass (*Lolium perenne*) plants on soil monoliths originating from the New Zealand FACE site (ambient and enriched soil) and under low and elevated concentration of atmospheric CO_2. Using $^{14}CO_2$ pulse labelling, the effects of elevated CO_2 on C allocation within the plant soil system of plants were determined.



Undisturbed soil cores extracted from the FACE were set in the labelling chamber after a three-month growing period in CO_2-controlled glasshouses



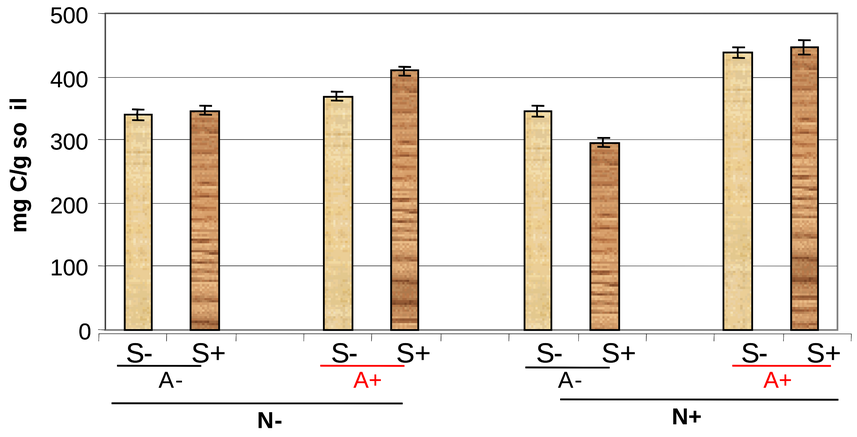
Results

☆ ^{14}C allocation

Treatment			% of total radioactivity recovered			
N	Atm	Soil	Plant	Rhiz. respiration	Soil	MBM
N-	A-	S-	85	11	4	0.4
		S+	83	12	5	0.6
	A+	S-	84	11	5	0.7
		S+	80	14	6	0.8
N+	A-	S-	85	12	3	0.3
		S+	85	11	3	0.3
	A+	S-	87	10	3	0.5
		S+	84	11	5	0.6
Effects of the treatments		N	+	n.s.	**	*
		A	n.s.	n.s.	+	***
		S	n.s.	n.s.	n.s.	+

Under elevated CO_2, more root derived C was found in the soil and in the microbial biomass indicating an increase in new C allocation belowground through the exudation process

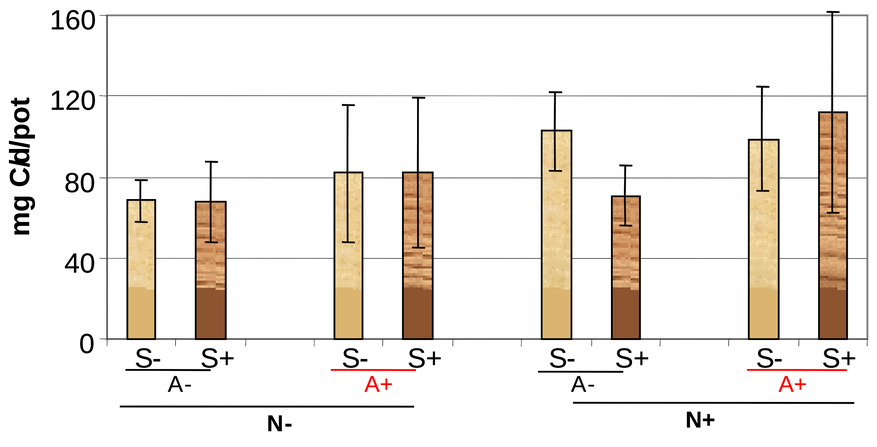
🕑 Microbial Biomass



Increased exudation leads to an higher availability of easily decomposable C to support microbial biomass growth

🕑 Belowground respiration

Greater microbial biomass under elevated CO_2 leads to higher belowground respiration. Since root biomass stayed unchanged under elevated CO_2, (data not shown) this increase in mainly due to higher heterotrophic respiration



This increase in belowground respiration was not accompanied by an increase in ^{14}C found in this pool. This suggest that the extra-C respired under elevated CO_2 originate mostly from the decomposition of unlabelled soil organic matter. This is a priming effect.

Conclusion

With respect to the difficulties of extrapolating glasshouse experiment results to the field, we concluded that elevated CO_2 stimulates microbial biomass through increased root exudation. This phenomenon is not likely to lead, at least by itself, to SOM accumulation under elevated CO_2 since a “priming effect” leading to enhanced SOM decomposition occurred.