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Elevated CO2 and extreme climatic events modify nitrogen content and ruminal protein digestion of temperate grassland

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Introduction

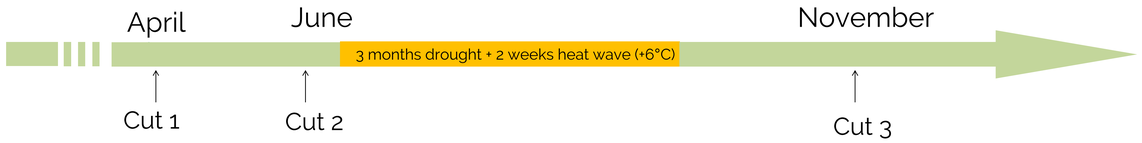
- Climate change results in warmer temperatures, elevated atmospheric CO2 and increased frequency of extreme climatic events such as drought and heat waves
- Botanical and ecophysiological changes in plants in response to climate change can affect the chemical composition of forages and their digestive use by domestic herbivores.

Objective of the study

The aim of this study was to analyze changes in nitrogen (N) content and *in vitro* protein rumen digestion of an upland grassland exposed to climate changes in controlled conditions

Experimental design

- Climate manipulation in semi-controlled conditions (French Ecotron, CNRS Montpellier)
- Scenario 2050 (+ 2°C) + extreme event
- 4 treatments in triplicate:
  - 2 CO_2 concentrations : current (390 ppm) and future (520 ppm)
  - 2 modalities : with and without extreme event



- Determination of N content in above ground biomass
- *In vitro* rumen fermentation assay

➡ Determination of fermentation end-products in the incubation medium
  - Total volatile fatty acids (VFA)
  - Markers of protein degradation (iso-VFA, ammonia)

RUMEN FERMENTATION ASSAY

- Incubation of above ground biomass in buffered rumen juice from sheep
- Anaerobic conditions and temperature simulating the rumen environment

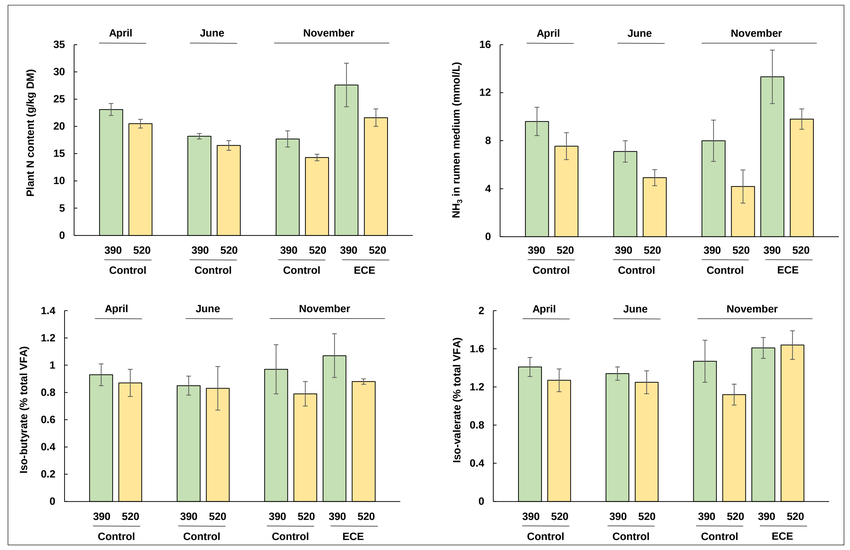
Conclusions / take home message

This study shows that the impact of different drivers of climate change, namely elevated CO_2 concentration and ECE (drought and heat wave), have contrasted impacts on N content in the plant biomass of grasslands, and affect differently the subsequent digestive use of N by the ruminants.

Reference

Niderkorn, V., Morvan-Bertrand A., Le Morvan, A., Augusti, A., Decaux M.L., Picon-Cochard C. (2021) Effects of elevated CO2 and extreme climatic events on forage quality and *in vitro* rumen fermentation in permanent grassland. Biogeosciences, 18, 4841-4853.

Results



	Cut April	Cut June	Cut November		
	CO_2 effect	CO_2 effect	CO_2 effect	ECE effect	CO_2 × ECE effect
N	<0.001	0.003	0.007	<0.001	0.346
NH_3	0.014	0.001	0.005	<0.001	0.882
Total VFA	0.056	0.577	0.256	0.186	0.871
Iso-butyrate	0.308	0.755	0.063	0.289	0.999
Iso-valerate	0.062	0.134	0.111	0.006	0.067

Figure 1: Plant nitrogen (N) content and fermentation end-products (ammonia (NH_3), iso-butyrate and iso-valerate) produced during in vitro rumen incubation of plant communities subject to two levels of CO_2 concentration (390 and 520 ppm) with or without an extreme climatic event (ECE) at three different cuts. The table represents the effects of factors (p-values).

- The N content in the above-ground biomass was significantly lower at 520 ppm CO_2 concentration compared to the 390 ppm level
- After the recovery of the ECE in November, the N content strongly increased (+54%)
- The ECE increased the NH_3 concentration in the incubation medium (+90%) and the proportions of iso-valerate (+25%)

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