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Response of an alfalfa-timothy mixture grown in open-top chambers to elevated CO_2 concentration

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Introduction

The increase in atmospheric carbon dioxide concentration ([CO_2]) and resulting increase in air temperature is expected to have significant effects on plant growth and nutritive value.

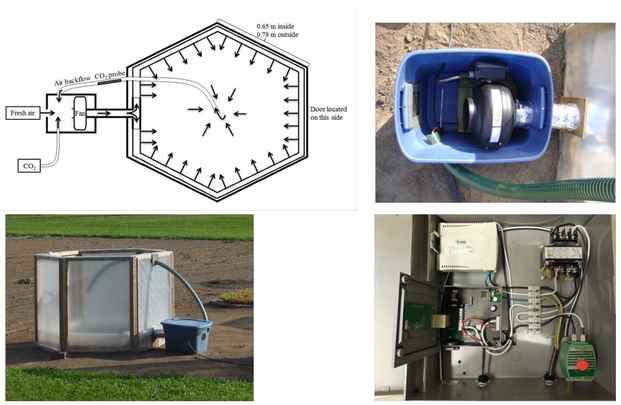
Studies examining the effects of elevated [CO_2] on plants under field conditions have been limited by the inherent difficulty to modify air composition in open air.

We designed an efficient and inexpensive open-top chamber (OTC) system to study the effect of elevated [CO_2] on a perennial alfalfa-timothy mixture (Messerli et al. 2015).

Using this system, our **objectives** were to assess the effect of elevated [CO_2] on:

- Changes in species proportion in the mixture over time.
- Forage yield and nutritive value.
- Fall organic reserves accumulation and winter survival.

Materials and methods



Overview of OTC system

- Alfalfa and timothy plants were transplanted in an uniformly distributed 50:50 mixture in 8 OTC : four at 600 µmol mol^{-1} CO_2, and four under ambient CO_2 (400 µmol mol^{-1}) along with four control plots without a chamber.
- Two successive growing seasons (2013-2014).
- One cut during establishment year (2013); four cuts on the same date for all treatments during first post-establishment year (2014).
- Measurements: Forage yield, acid detergent fiber (ADF), neutral detergent fibrer(NDF), In vitro true digestibility (IVTD), [sugars], organic reserves and winter survival.

Results and discussion

- For all treatments, the proportion of alfalfa in the mixture increased over time to finally outgrow timothy (Fig. 1a)
- Forage yield increased under elevated [CO_2] (mean = +18%) but the response varied across cuts (Fig. 1a)
- Concentrations of ADF and NDF increased under elevated [CO_2] (Fig. 1b) while IVTD slightly decreased (Fig. 1c)
- Elevated [CO_2] had no effect on sugar and fall organic reserve accumulations, nor on winter survival (data not shown).

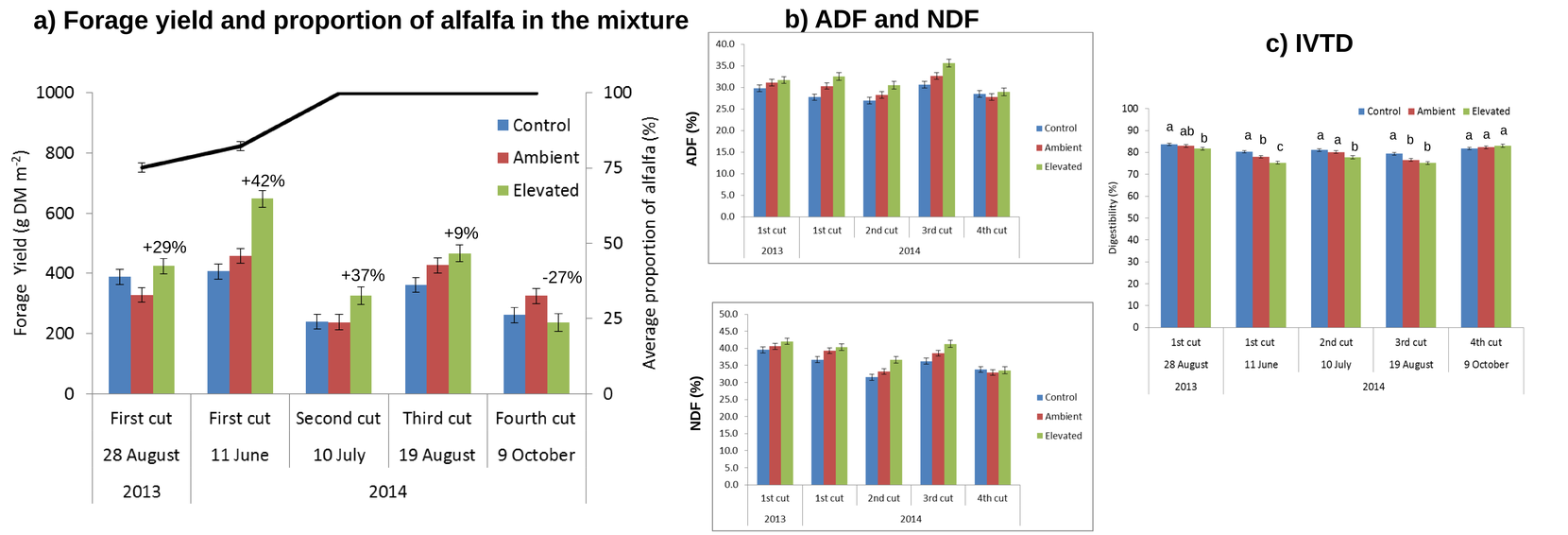


Fig. 1. a) Forage yield of an alfalfa-timothy mixture and proportion of alfalfa under ambient (400 µmol mol^{-1}) and elevated (600 µmol mol^{-1}) [CO_2] and in control plots at each cut; b) ADF and NDF concentrations for each CO_2 treatment at each cut; c) In vitro true digestibility (IVTD) of forage under ambient (400 µmol mol^{-1}) and elevated (600 µmol mol^{-1}) [CO_2] and in control plots at each cut in 2013 and 2014.

Conclusions

- After three growing seasons of continued use, our system has proven its effectiveness for studying the effects of [CO_2] and climate change in the field at low cost;
- Overall, the positive effect of increasing yield under elevated [CO_2] was partly offset by a decrease in forage digestibility. Adapting cut management could allow maintaining the digestibility of forage mixtures under future climate (Thivierge et al. 2016)

References

Messerli et al. 2015. Agronomy Journal, 107 (4); Messerli et al. 2015. CSA News 60-5; Thivierge et al. 2016. Agronomy Journal 108:4-19.

Acknowledgements

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