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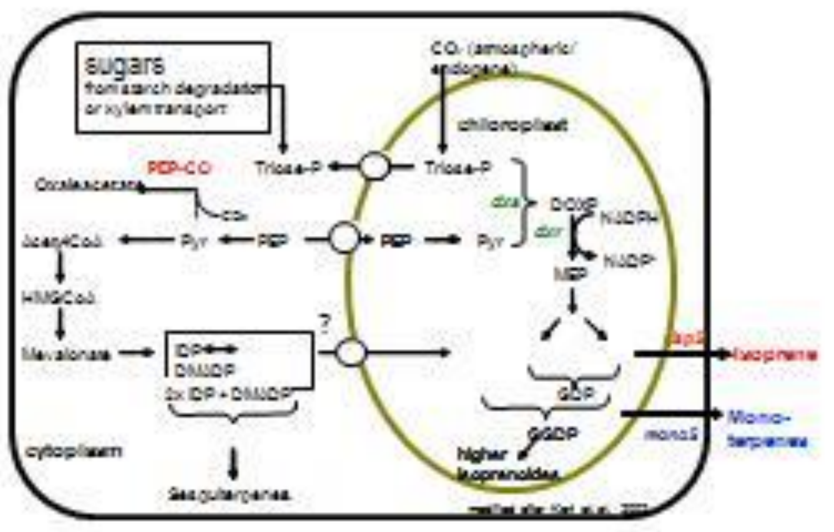
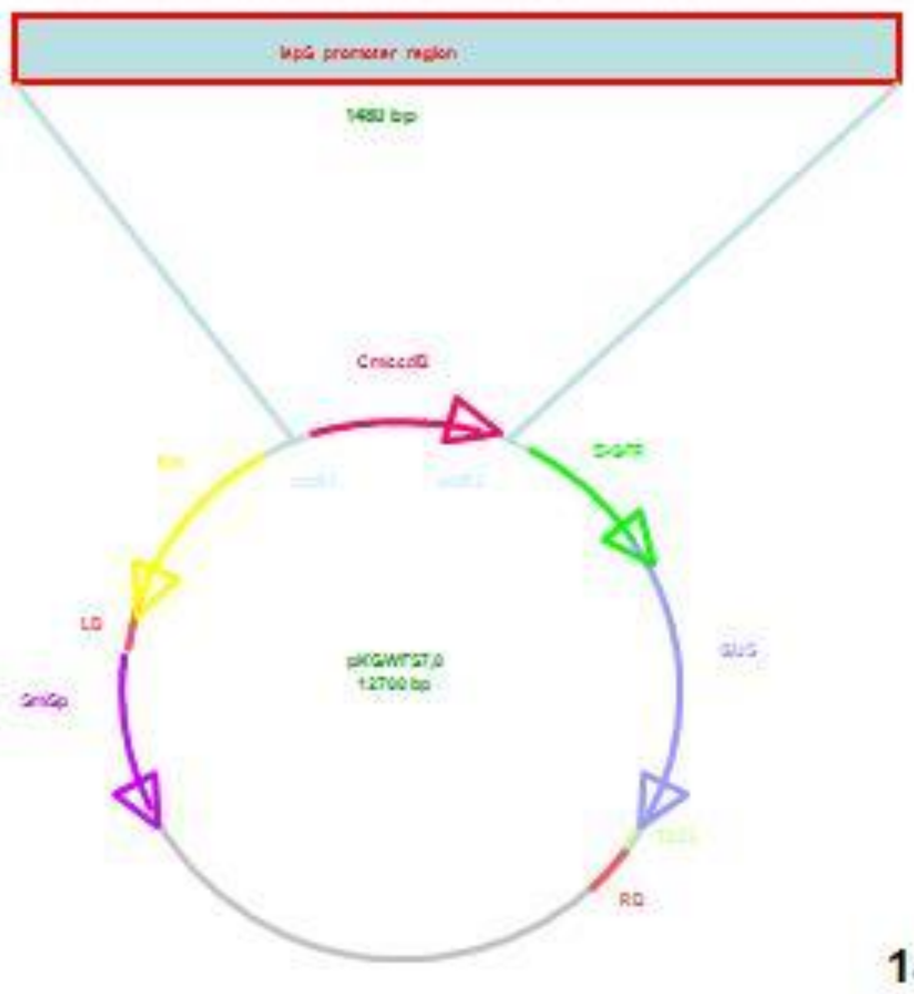
How varying CO_2-concentrations affect isoprene-synthesis and photosynthesis in *Populus* x *canescens*

Context

The influence of CO_2 on isoprene formation naturally deserves special interest in times of rising atmospheric CO_2-air concentrations [CO_2]. Most of the studies on this topic have shown that regardless to species isoprene emission decreased with increasing [CO_2] (Rosenstiel *et. al.*, 2003; Scholefield *et. al.*, 2004; Possell *et. al.*, 2005), which is in contrast to photosynthetic response. However, the underlying biochemical mechanisms how changes in [CO_2] affect plant isoprene emission are still unknown in detail. Poplar shoot cultures can be a model system to study responses of trees 'in miniature". Aim of the present experiment was to study "long-term" effects of different [CO_2] on isoprene formation and photosynthesis in poplar shoot cultures.

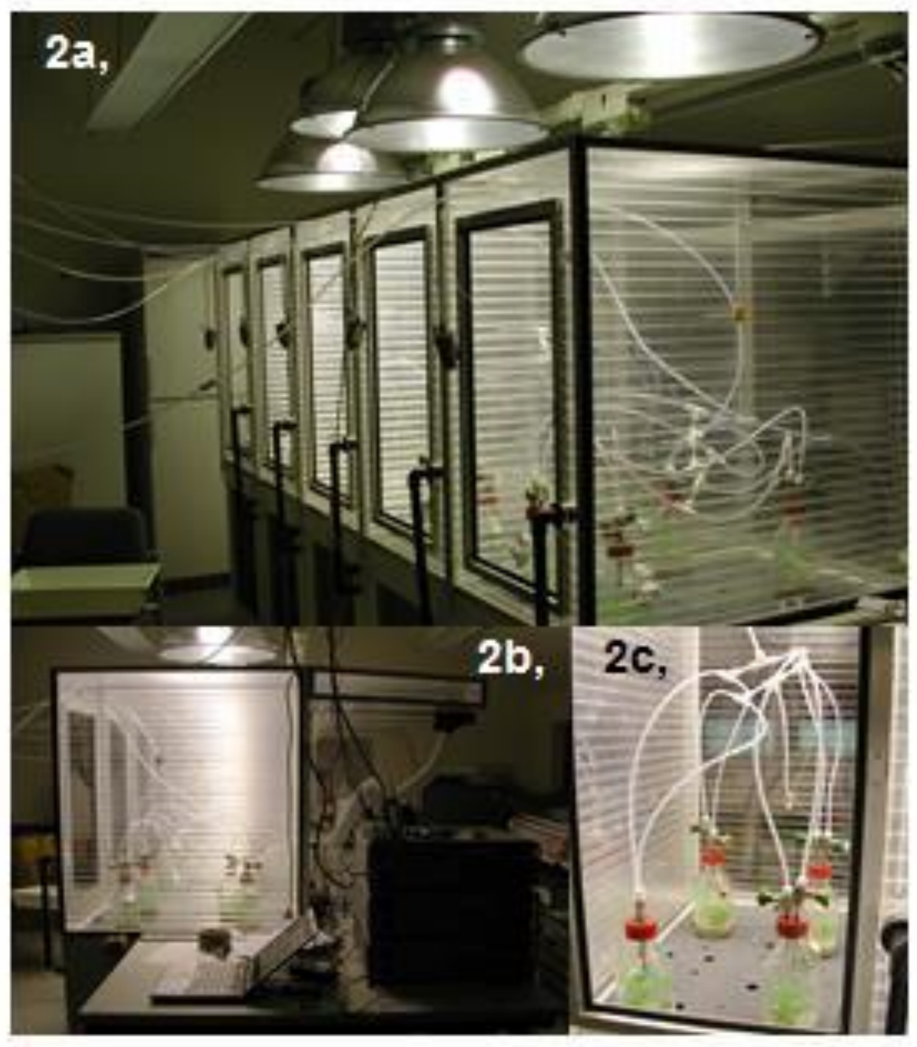


Plant Material and Experimental Setup



1a,

1b,

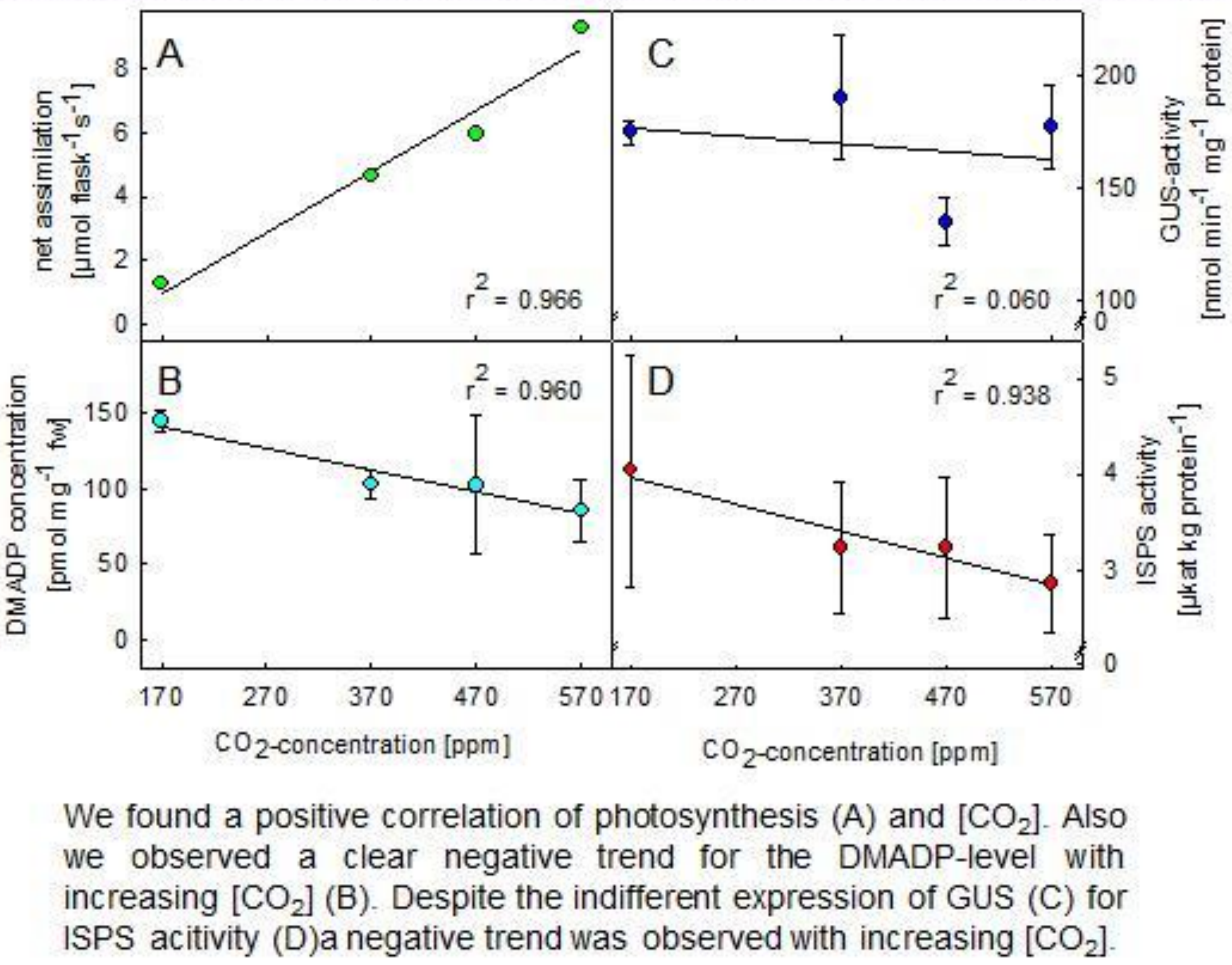


2a, 2b, 2c,

The experiment was performed using transgenic Grey poplar plants, transformed with a construct carrying the *Pc*ISPS (isoprene synthase) promotor fused to the E-GFP/GUS reporter genes (Loivamäki et.al. 2007, Fig.1a). These plants were cultivated and grown in sterile glass-bottles. Figure 1b shows a transgenic plant with intense GUS-staining (left) and a control plant without staining (right).

After precultivation of rooted plants in ambient [CO_2] for 2 weeks, young shoots were transferred into in 4 different [CO_2], 170ppm, 370ppm, 470ppm, 570ppm, respectively (2a). They were acclimated to the new atmosphere for 2 weeks followed by a 3-week measurement period. [CO_2] were monitored continuously with IRGA systems (Fig. 2b). For each [CO_2] 4 flasks containing 5 shoots were connected to the system (Fig. 2c). At the end of the experiment plants were harvested and analysed on DMADP-concentration in leaves, GUS activity, as well as ISPS activity.

Results



We found a positive correlation of photosynthesis (A) and [CO_2]. Also we observed a clear negative trend for the DMADP-level with increasing [CO_2] (B). Despite the indifferent expression of GUS (C) for ISPS acitivity (D)a negative trend was observed with increasing [CO_2].

Conclusion and Outlook

Confirming literature data the presented experiment showed an increase of net assimilation with increasing [CO_2] while leaf DMADP concentrations stepwise decreased in accordance with data shown by Rosenstiel *et. al.* (2003). Also ISPS activity became reduced under enhanced [CO_2]. However, such a reduction of enzmye activity was not reflected on the level of *PcISPS* promotor activation. Reasons for this difference are unclear. This could indicate a posttranscriptional regulation of the mRNA-processing or posttranslational modification of the enzyme. The sequestration of isoprene precursors thus remains subject of further investigation.

This initial study indicates that shoot cultures can be used as model to study long-term acclimation of poplar. However, future experiments will run over a longer time period and a more detailed analysis of isoprene biosynthesis related parameters will be studied. In particular the influence of different [CO_2] on PEP carboxylase – a key regulatory step (according to Rosenstiel et al. 2003) will be analyzed.

References:

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- **Increased CO_2 uncouples growth from isoprene emission in an agriforest ecosystem**; Rosenstiel T. N., Potosnak M. J., Griffin K.L., Fall R., Monson R.K.; Nature; 2003 (421); 256-259
- **Circadian rhythms of isoprene biosynthesis in Grey poplar leaves**; Loivamäki M., Louis S., Cinege G., Zimmer I., Fischbach R. J., Schnitzler J. P.; Plant Physiology; 2007 (143); 540-551

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