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Development of spring oilseed rape grown in different CO_2 exposure systems

Introduction

Atmospheric carbon dioxide (CO_2) is predicted to reach 550 ppm by the middle of this century [1]. In order to study responses of crops to future atmospheric CO_2 concentrations, two experiments were conducted on spring oilseed rape (*Brassica napus* cv. Campino) within the framework of the integrated DFG-project "Structure and Functions of Agricultural Landscapes under Global Climate Change - Processes and Projections on a Regional Scale" (PAK 346). A Mini-FACE (free-air CO_2 enrichment) facility and a climate chamber system at the Universität Hohenheim (Stuttgart, Germany) were used to expose plants to CO_2 enrichment.

Material and Methods

(i) Spring oilseed rape was cultivated in a Mini-FACE system at the Heidfeldhof experimental station in 2009 under ambient (AMB, 380 ppm) and elevated (ELE, 550 ppm) CO_2 concentrations;

(ii) Plants were grown in a climate chamber system at the Institute for Landscape and Plant Ecology in 2010 under ambient (380 ppm) and elevated (550 ppm) CO_2 concentrations using the climatic conditions from the field experiment.

In both experiments, plant development was examined from leaf emergence until crop maturity. BBCH codes were used to quantify the growth stages of oilseed rape [2]. The chlorophyll content was determined by using a portable chlorophyll meter (SPAD-502). Leaf area index (LAI) was measured by using a LAI-2000 Plant Canopy Analyzer. The results were analysed by SPSS version 15.0 for Windows using a one-way ANOVA.

Results and Discussion

Results from both experiments were compared concerning the effects of future CO_2 enrichment on oilseed rape growth.
In the Mini-FACE system, plant height did not significantly differ between the CO_2 treatments. In the climate chamber system, the canopy height was significantly increased under CO_2 enrichment at the beginning of the vegetative phase (P=0.049) and remained slightly increased (P≤0.1) during pod development (Fig.1). The LAI in both experiments did not show any significant CO_2 effects. In the Mini-FACE system, LAI reached highest values at the stage of full flowering and declined during growth of pods. In the climate chambers, LAI showed fluctuations at the beginning of plant growth, which might have been affected by the pot and chamber design. Only a slight CO_2-induced increase was observed at the stage of inflorescence emergence (P=0.084; Fig.2). The chlorophyll content of the youngest leaves in the Mini-FACE experiment was increased by elevated CO_2 during leaf development (P=0.027). At the end of flowering, SPAD values tended to decrease by 5.2% under elevated CO_2 (P=0.057). In the climate chamber experiment, a significant CO_2 effect on chlorophyll contents in youngest leaves was limited to the beginning of the vegetative phase (P=0.027; Fig.3). In both experiments, phenological development was not affected due to elevated CO_2 (Fig. 4).
Overall, the development of oilseed rape grown under realistic agronomic conditions and artificially controlled environmental chambers did not show pronounced responses to elevated CO_2.

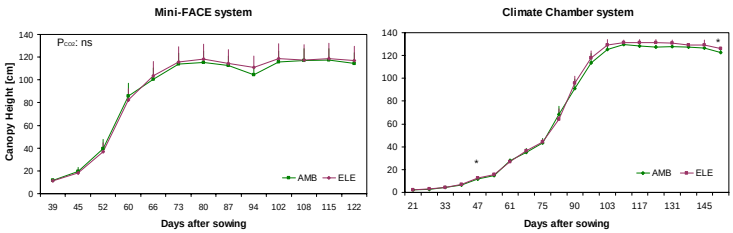

Fig. 1. Canopy height of spring oilseed rape under ambient and elevated CO_2. Given are the averages. Error bars indicate the standard deviation. Results of the statistical analysis (one-way ANOVA) are presented as P-level: * P≤0.05.

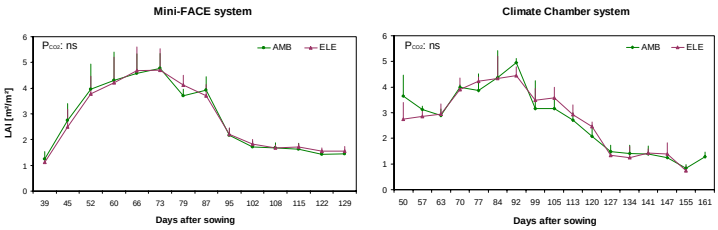

Fig. 2. Leaf Area Index (LAI) of spring oilseed rape. Given are the averages. Error bars indicate the standard deviation. Results of the statistical analysis (one-way ANOVA) are presented as P-level: not significant.

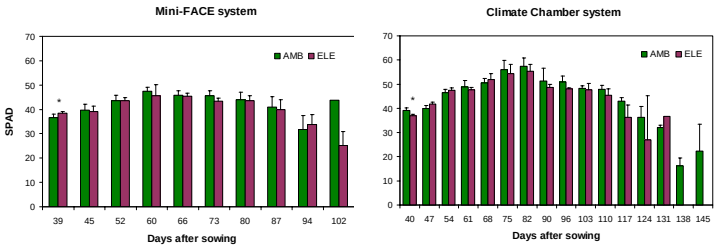

Fig. 3. Chlorophyll content in the youngest leaves of spring oilseed rape. Given are the averages. Error bars indicate the standard deviation. Results of the statistical analysis (one-way ANOVA) are presented as P-level: * P≤0.05.

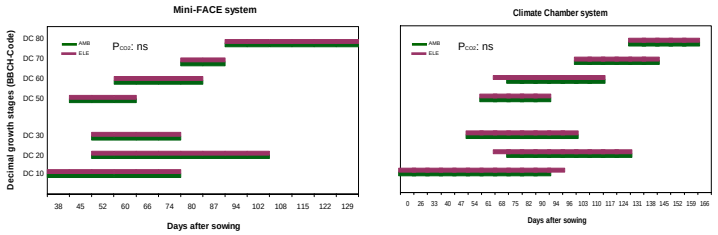

Fig. 4 . Duration of phenological phases after sowing of spring oilseed rape. DC stands for Decimal Code used to quantify the growth stages in oilseed rape [2]. DC10: Leaf development; DC20: Formation of side shoots; DC30: Stem elongation; DC50: Inflorescence emergence; DC60: Flowering; DC70: Development of fruit; DC80: Ripening.

References

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2. Meier U. (ed), 2001. Growth stages of mono- and dicotyledonous plants. BBCH-Monograph. Federal Biological Research Centre for Agriculture and Forestry. Blackwell, Oxford, pp 622.

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