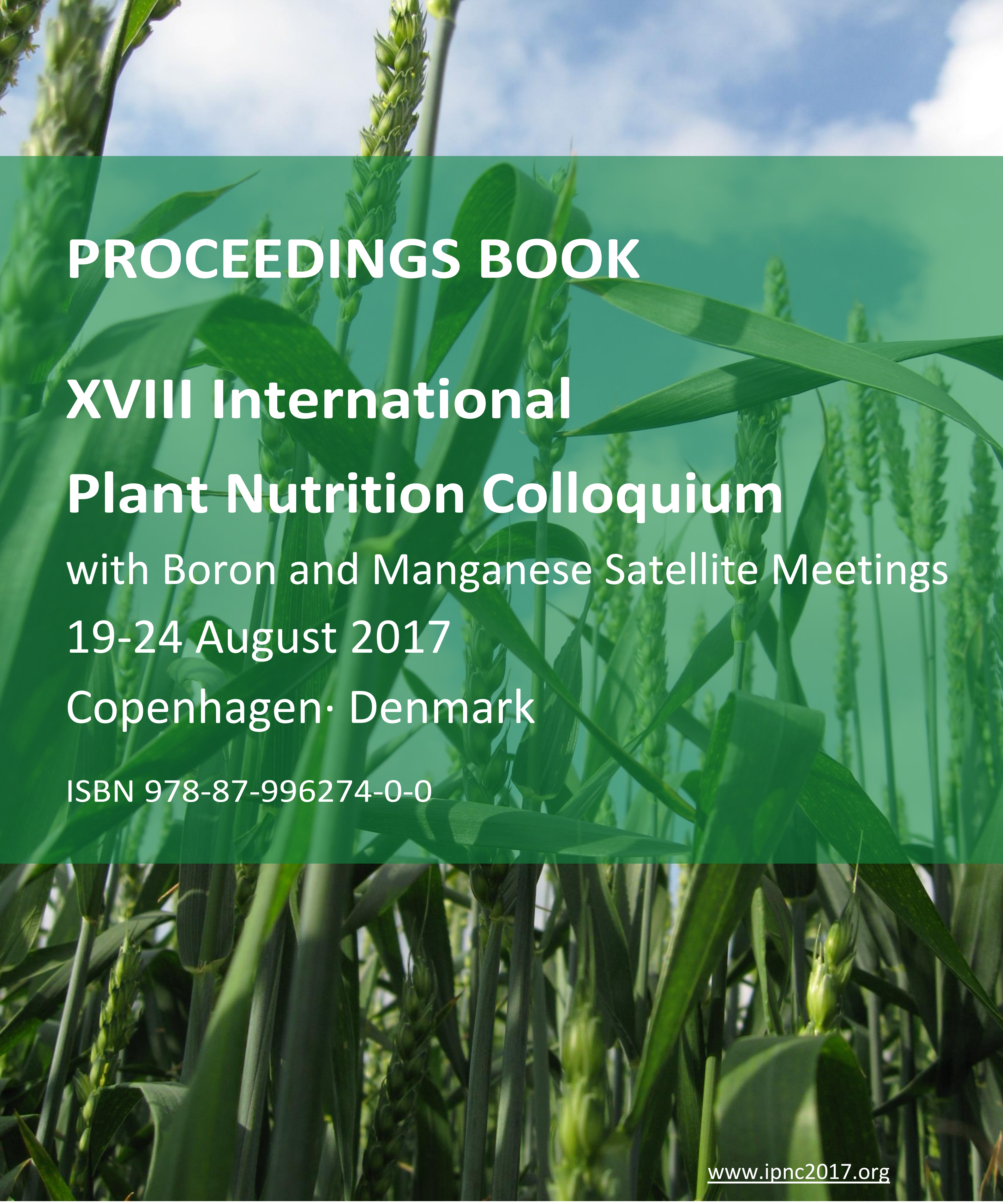

# PROCEEDINGS BOOK

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## with Boron and Manganese Satellite Meetings

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***Editors***

Andreas Carstensen - Kristian Holst Laursen - Jan Kofod Schjoerring

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# CONTENTS

## SCIENTIFIC PROGRAMME



## ABSTRACTS XVIII IPNC 2017

### ORAL AND POSTER PRESENTATIONS



## ABSTRACTS BORON AND MANGANESE SATELLITE MEETINGS

### ORAL AND POSTER PRESENTATIONS

# Impact of climate change on plant nutrition

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## INTRODUCTION

Today climate changes are of major concern, and increasing atmospheric CO2 (hCO2) level is one of the most important and worldwide events. Currently the global CO2 concentration is about 400 ppm [1], but it is predicted to rise to 550 ppm by 2050. Elevated CO2 is known to affect plant growth, crops yield and nutritional status of agricultural products. Although hCO2 has been previously associated with increased yields, recent studies found a significant negative effect in protein and mineral concentrations in several crops [2]. Parallel to hCO2, restricted soil Fe supply will also impact the nutrition of the foods. On one hand Fe has low solubility and on the other hand about 30% of the arable land in the world is calcareous. The combination of these factors results in reduced Fe availability leading to reduced yields and nutritional quality [3]. Legume crops which provide a large share of the global population diet will certainly be affected by elevated CO2 and iron deficiency, but little is known about the interplay between these factors in plant growth, yield and nutritional status of legume crops.

## METHODS

In this study soybean (*Glycine max*) and common bean (*Phaseolus vulgaris*) were grown and two experiments were conducted. The first experiment aimed at understanding the combined effect of iron deficiency and hCO2. In the second study the aim was to select cultivars with contrasting behaviours in the presence of different atmospheric CO2 levels. **Experiment 1:** Plants were grown for six days under complete solution with 10 μM Fe followed by two weeks treatment under three hydroponic conditions, one that mimicked Fe-sufficient (10 μM Fe(III)-EDDHA [ethylenediamine-N,N_bis(o-hydroxyphenyl)acetic acid] and two that mimicked Fe-deficient (0 μM Fe and 10 μM Fe(III)-EDDHA plus 10 mM $NaHCO_3$) soil environments. Chlorophyll (SPAD), ferric chelate reductase activity (FCR) and photosynthetic rate (IRGA -infra-red gas analyser) were measured in these plants. **Experiment 2:** Eight plants of 18 lines of each species were grown to full maturity under hydroponic conditions at hCO2 (800 ppm) and ambient CO2 (400 ppm). A range of biomass, nutrient and yield parameters were produced. **Statistical analysis***:* Data were analysed with GraphPad Prism version 6. Differences between treatments were tested with one-way ANOVA or multiple t-tests, corrected using Holm-Sidak method.

## RESULTS AND DISCUSSION

**Experiment 1:** Results showed that Fe availability affects plant physiology. In soybean chlorophyll levels and photosynthetic rates were lowest in Fe- (Table 1), since under Fe- plants tend to develop iron deficiency chlorosis (IDC) which is characterized by reduced chlorophyll levels and consequent reduced photorespiration. Similarly, in common bean the chlorophyll levels were lower in the plants grown in Fe-. FCR activity was lower in common bean grown under Fe sufficiency and the highest activity was measured in the plants grown in Fe-. It has been previously shown in cucumber roots [4]. Soybean grown under Fe+/NaHCO3, apparently had the fastest rate of development according to the results. It is an unexpected result which suggests that the cultivar used in this study may be tolerant to IDC induced by elevated pH, being able to absorb to the maximum the low amounts of soluble iron available in the nutritive solution. Leaf area of common bean plants grown under Fe sufficiency was much higher than under Fe deficiency. However, it did not reflect in significantly higher chlorophyll levels, photosynthetic rates or dry weight.

**Experiment 2:** Under elevated CO2, plants from both species tended to develop faster with higher chlorophyll levels and heights (Figure 1). Nutrient accumulation was affected in both legumes (data not shown).

Table 1: Analysis of soybean and common bean grown under Fe sufficiency (Fe+) and Fe deficiency (Fe- and Fe+/NaHCO3). Values represent the mean of five biological and three analytical replicates ±SE ($p$<0.05).

| | Soybean | | | Common bean | | |
|---|---|---|---|---|---|---|
| | Fe+ | Fe- | Fe+/$NaHCO_3$ | Fe+ | Fe- | Fe+/$NaHCO_3$ |
| Chlorophyll (SPAD units) | 15.4± 2.6 ab | 9.1± 1.2 a | 20.5± 1.6 b | 32.6± 1.2 a | 11.5± 4.4 b | 28.6± 1.0 a |
| Photosynthetic rate (mmol $CO_2$ $m^{-2}$ $s^{-1}$) | 6.80±1.10a | 1.55±0.54 b | 9.44±1.22 c | 7.60±0.61 a | 7.04±0.91 a | 8.36±0.54 a |
| Ferric chelate reductase activity (μmol Fe(II)/g root FW/h) | 4.53±1.56 a | - | 8.34±2.33 a | 0.26±0.16 a | 2.73±0.60 b | 1.02±0.58 ab |
| Total leaf area ($cm^2$) | 9.99±0.62 a | 9.33±.050 a | 9.47±0.96 a | 41.63±3.41 a | 19.84±3.23 b | 13.75±2.09 b |
| Root DW (g) | 0.11±0.022 a | 0.098±0.014 a | 0.188±0.016 b | 0.685±0.081 a | 0.803±0.0826 a | 0.797±0.032 a |
| Shoot DW | 0.25±0.02 a | 0.33±0.03 a | 0.234±0.014 a | 1.203±0.203 a | 1.264±0.116 a | 1.106±0.143 a |
| Leaves DW | 0.13±0.02 a | 0.12±0.02 a | 0.233±0.013 b | 1.647±0.114 a | 1.503±0.189 a | 1.416±0.280 a |

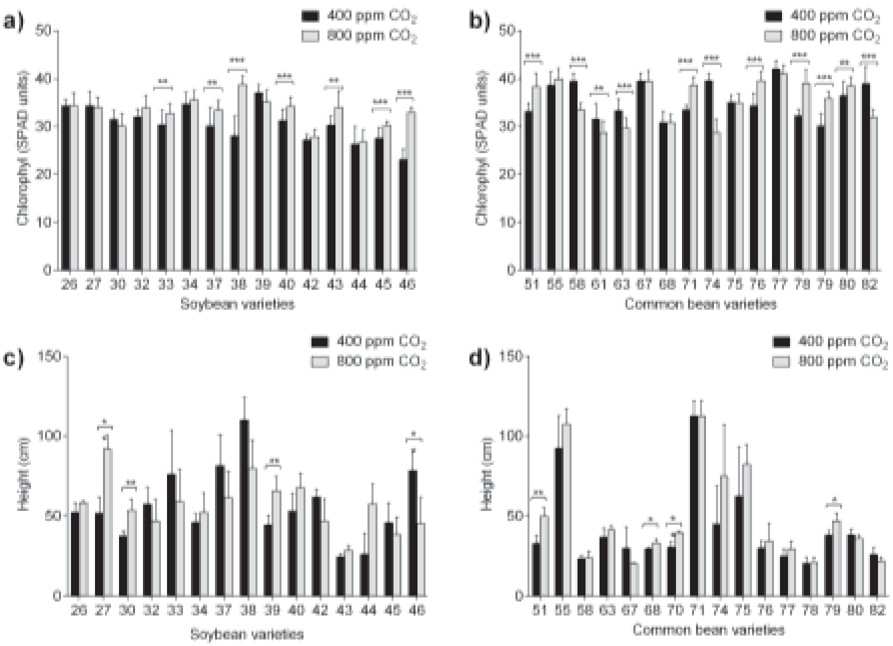


Figure 1: Chlorophyll (a,b) and plant height (c,d) of soybean and common bean grown at 400 and 800 ppm $CO_2$.

## CONCLUSIONS

Elevated $CO_2$ and Fe deficiency affect plant growth in legumes, as well as biochemical reactions linked to photosynthetic activity and Fe uptake. Studies are underway to correlate the combined effect of these parameters on nutrient accumulation in plants grown in growth chamber and field conditions.

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