The impacts of CO_2 enrichment on the plant resources utilization efficiency of *Schima superba* Gardn. et Champ. seedlings leaves in subtropical China

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Introduction

The resources (light, nitrogen and water) utilization efficiency of plant is a key indicator reflecting the adaptive ability of plant to environment. CO_2 enrichment would increase photosynthesis substrate supply and nutrient absorption in plants，and also may lead to insufficient supply of soil nitrogen, thus change the trade-offs relationship between plant resource utilization efficiency. Although the trade-offs between plant resource utilization has become a hot topic in plant ecology research, the knowledge on the impact of CO_2 enrichment on the trade-offs between plant resources efficiency is still weak.

To improve the understanding of effects of CO_2 enrichment on plant resource utilization efficiency and the regulation mechanism, we conducted regular sampling analysis by combined methods of OTC (Open top champers) simulation test, situ observations and lab measurement for *Schima superba* seedlings in subtropical China. The purposes of the present study were to (1) determine whether there is a trade-offs relationship between different resource utilization efficiency, and (2) identify the determining factors for the resources utilization efficiency of *S. superba* seedlings leaves.

Methods

Before the experiment of fomigation, 36 one-year-old seedlings of container *S. superba with* similar height and basal diameter were randomly assigned to each of 12 open-top chambers (OTCs, octagonal base, 2 m in diameter, and 2.2 m in height.). According to the scenario prediction of IPCC, CO_2 fumigation treatments were set to 4 levels, including ambient air (AA), 550ppm, 750ppm and 1000ppm. CO_2 fumigation started on 1 April and lasted until 31 October 2019, with a daily 8 h (from 9:00 to 17:00).

We measured Pn, leaf nitrogen concentration, leaf transpiration rate, photosynthetic pigment concentration，soil nitrate and ammonium nitrogen concentrations at the end of June, August and October, respectively. Moreover, we also measured the total biomass at the end of experiment.

Results

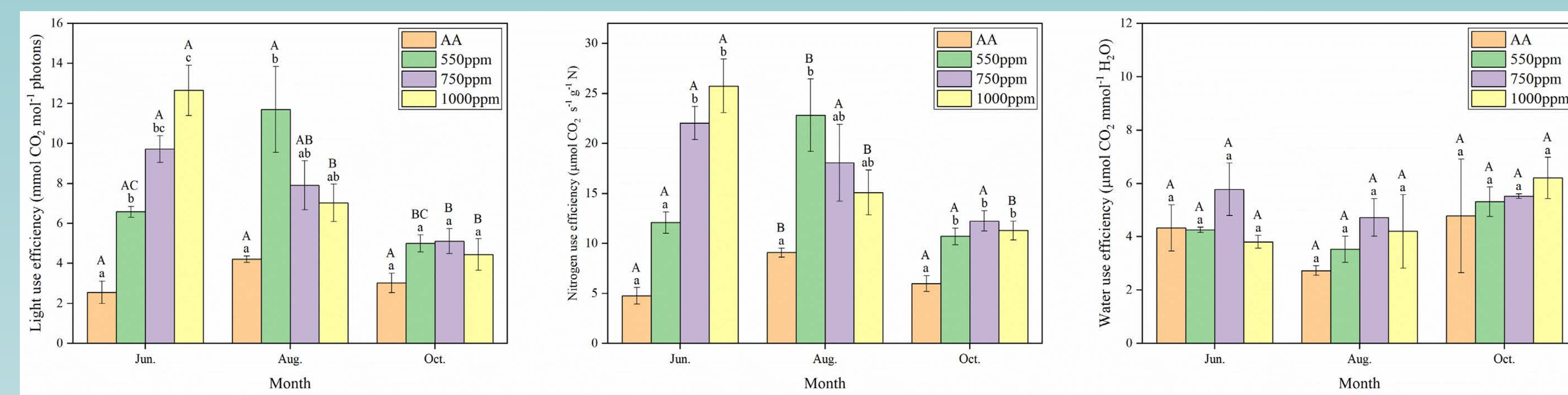

Fig.1 Variations in light use efficiency (LUE), nitrogen use efficiency (NUE) and water use efficiency (WUE) of *Schima superba* leaves under different CO_2 concentration treatments. Different capital letters indicate a significant difference between different month for the same treatment (p < 0.05), and different lower-case letters indicate a significant difference between different treatments in the same month (p < 0.05).

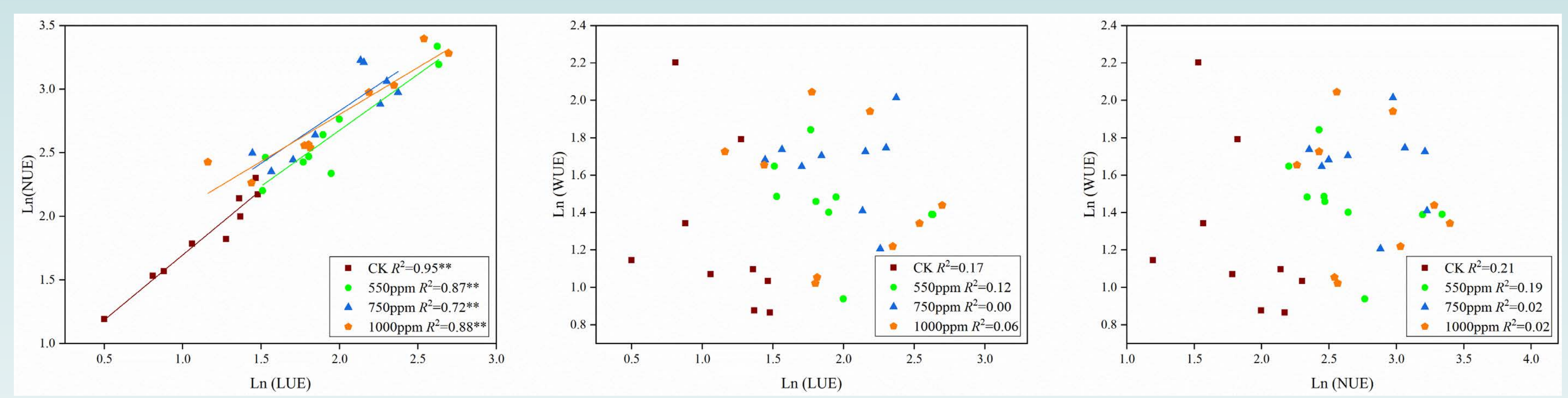

Fig.2 The relationship between light use efficiency (LUE), nitrogen use efficiency (NUE) and water use efficiency (WUE) of *Schima superba* leaves under different CO_2 concentration treatments. All raw data are logarithmically transformed.

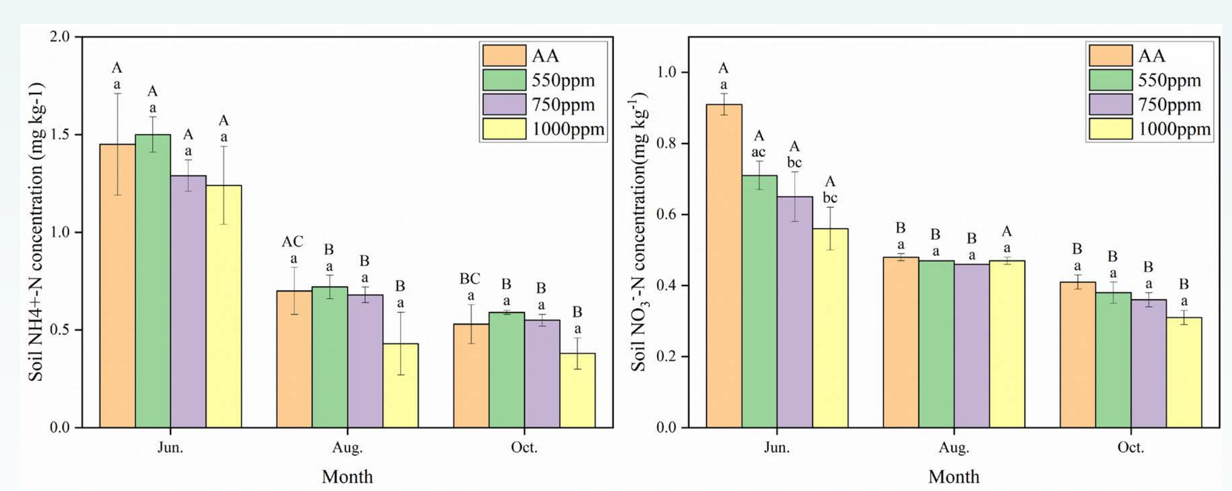

Fig.3 Variations in soil NH_4^+-N and soil NO_3^--N concentration under different CO_2 concentration treatments. Different capital letters indicate a significant difference between different month for the same treatment (p < 0.05), and different lower-case letters indicate a significant difference between different treatments in the same month (p < 0.05).

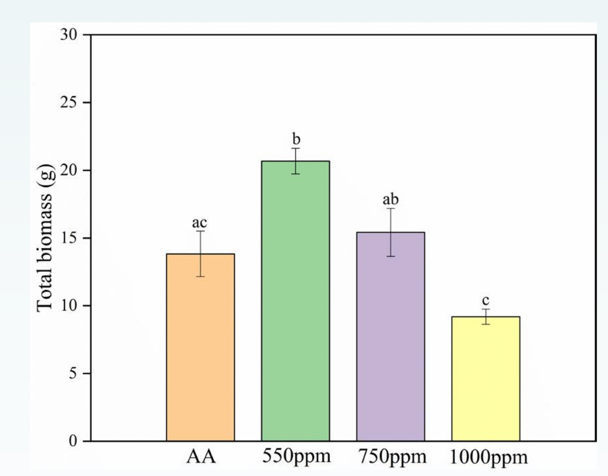

Fig.4 Total biomass under different CO_2 concentration treatments at the end of experiment. Different lower-case letters indicate a significant difference between different treatments in the same month (p < 0.05).

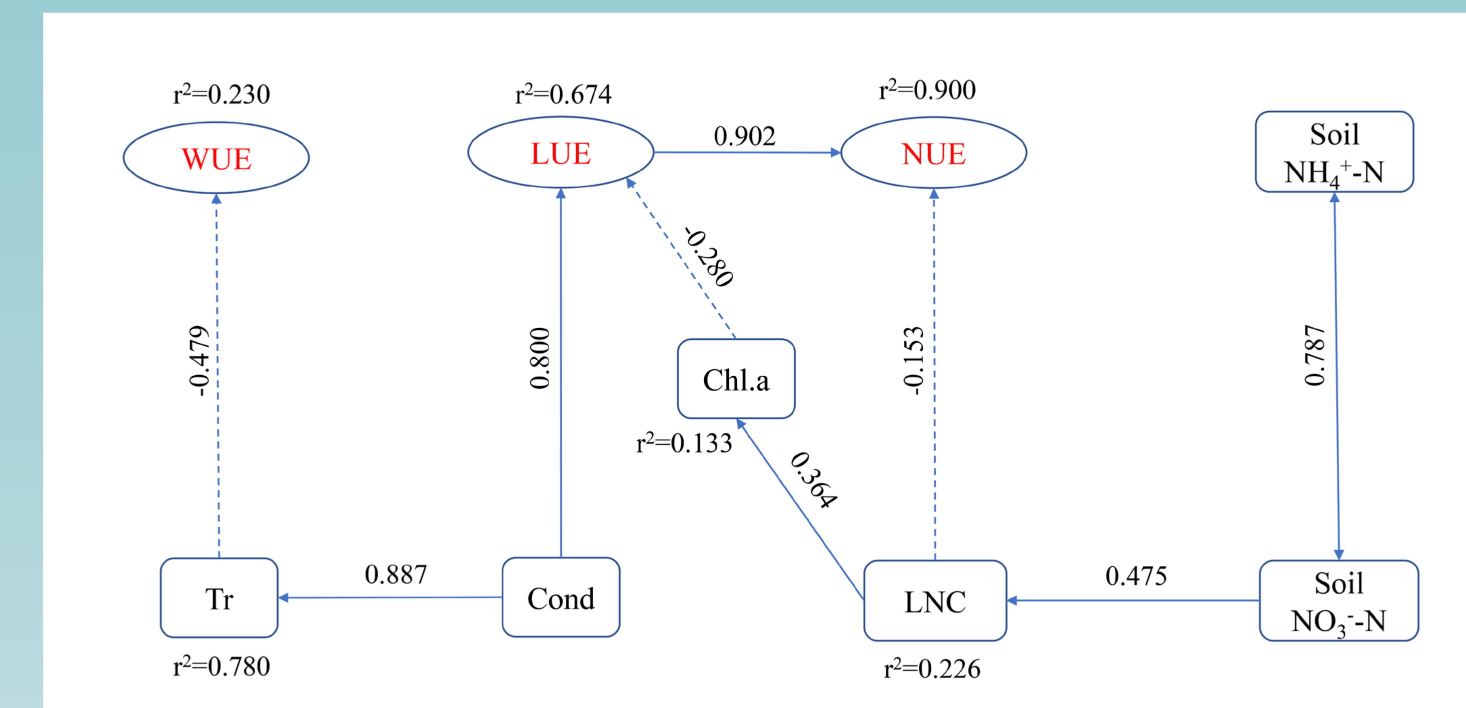

Fig.5 Final path diagrams for effects determining factors on light use efficiency (LUE), nitrogen use efficiency (NUE) and water use efficiency (WUE) of *Schima superba* leaves. (Chl.a, Tr, Cond and LNC denote Chlorophll a, Transpiration rate, stomatal conductance, and leaf nitrogen concentration, respectively.)

Conclusions

- The impacts of CO_2 enrichment on light use efficiency (LUE) and nitrogen use efficiency (NUE) of *S. superba* seedlings leaves varied with time. However, CO_2 enrichment did not induce the significant changes in water use efficiency (WUE) of *S. superba* seedlings leaves. In addition, LUE and NUE showed a significant positive relationship regardless of treatments.
- Compared with the AA treatment, only the CO_2 enrichment treatment of 550ppm concentration increased the total biomass of *S. superba* seedlings at the end of growing season.
- The stomatal conductance and leaf nitrogen concentration were the two critical determining factors for LUE an NUE of *S. superba* seedlings leaves, whereas, the transpiration rate was the sole impact factor for the variation in WUE of *S. superba* seedlings leaves.

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