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Photosynthetic response of two caragana species to the stimulated climate change in Mu Us sand land of Northwest China

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Introduction

Due to human activities, the concentration of carbon dioxide (CO_2) in the Earth's atmosphere is rising rapidly. The atmospheric CO_2 concentration has increased to 360 μmol/mol from 280 μmol/mol at the end of the 19th century, and it will be doubled in the late 21st century (Alcamo 1996). Since CO_2 is a key factor for plant growth and development, much more attention has been paid to the effect of an elevated atmospheric CO_2 concentration on many ecosystem processes (Hungate *et al*. 1997; Idso *et al*. 1992; Oren *et al*. 2001; Sun *et al*. 2002).

Caragana davazamcii and *Caragana korshinskii* which belong to legumes family play an extremely important role in protection soil from the wind, water conservation and eco-environment protection in Mu Us sand land of Northwest China. There have been a lot of research done on ecophysiological characteristics of caragana species under natural conditions, but there has been little focused on the physiological changes that may occur under stimulated CO_2 enrichment. This study compares the changes of photosynthetic characteristics of two caragana species to simultaneous CO_2 enrichment and explores their adaptation mechanisms.

Methods

Field measurement

At the peak of growing season (late July), we randomly sampled 10 normal plants of two caragana species to measure the leaf photosynthetic parameters under the simulated conditions using Li-6400 portable photo-synthesis equipment with LED and CO_2 injection system at sand and grassland ecological station in Ordos, Chinese Academy of Sciences (39°02′N; 109°51′E).

Data analysis

One-way ANOVA test was performed to evaluate the differences on photosynthetic parameters of *C. davazamcii* and *C.korshinskii*. The statistical analysis was performed using Excel and SPSS software for Windows ver. 20.

Results

The response of transpiration rate (Tr) and photo-synthesis rate (Pn) to CO^2 enrichment

The Tr of two caragana species showed the same response trend to instantaneous elevated CO_2 (Fig. 1a). When CO_2 concentration was <800 μmol/mol, the Tr of *C. davazamcii* and *C. korshinskii* increased 6.9% and 0.8% respectively, while at CO_2 concentrations >800 μmol/mol, the Tr of *C. davazamcii* and *C. korshinskii* decreased 12.3% and 2.1% respectively. In the scope of experimenting CO_2 concentration (200-2000μmol/mol), the Tr value and variation of *C. korshinskii* was always significantly greater than that of *C .davazamcii* ($P<0.01$).

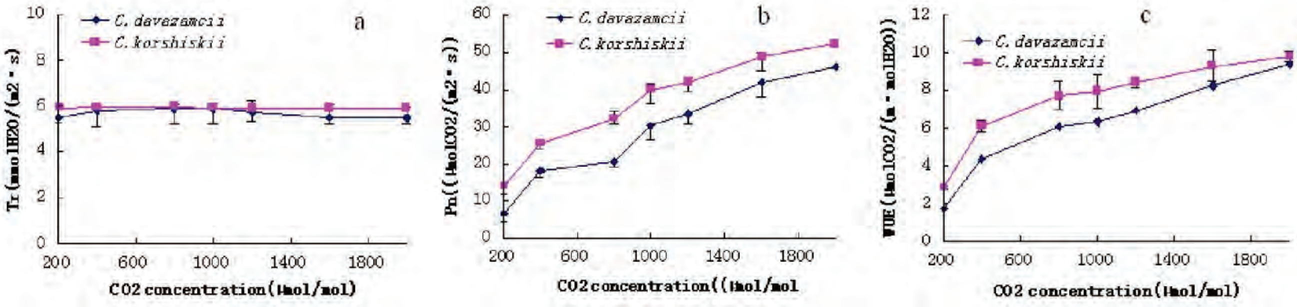

Figure 1. Transpiration rate (a), Photosynetheis (b) and water use efficiency (c) response of *C. davazamcii* and *C. korshinskii* to CO_2 enrichment

Table1. Photosynthetic response of *C. davazamcii* and *C. korshinskii* to CO_2 enrichment.

Species	Responses equations	R^2	CCP (μmol /mol)	CE
C. davazamcii	y = 16.233Ln(x) - 73.995	0.98	96	0.0408
C. korshinskii	y = 16.437Ln(x) - 67.234	0.97	60	0.0458

The regression analysis showed that there existed logarithm relations between the Pn of two caragana species and elevated CO_2 concentration with the correlation factor of over 0.9623 (Fig. 1b and Table 1). In the scope of this experiment, the CO_2 concentration, the Pn value and variation of *C. korshinskii* was always greater than that of *C. davazamcii*, but the differences were not significant (P>0.05). In addition, *C. korshinskii* presented lower CO_2 compensation point (CCP) and higher carboxylation efficiency (CE), which suggested that *C. korshinskii* had higher ability to CO_2 use efficiency compared with *C.davazamcii*.

The response of WUE to CO_2 enrichment

The water use efficiency (WUE) of two caragana species increased with elevated CO_2 concentration (Fig. 1c), but there weren't significant differences (P>0.05).

Conclusion

Instantaneous CO_2 enrichment increased Tr, Pn and WUE of two caragana species, but *C. korshinskii* was promoted more significantly. In these physiological change processes, *C. korshinskii* presented lower CCP, higher CE and higher WUE. Two caragana species showed different adaptation strategies to maintain water balance: the optimal WUE of *C. korshinskii* was promoted by increasing Pn, while that of *C. davazamcii* depended mostly on reducing water loss. Therefore, in the light of photosynthetic system, *C. korshinskii* may better adapt to the global climate change.

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