Photosynthetic and Growth Response of *Triodia pungens* to Elevated CO_2 Concentration

Lisa Xian
The University of Queensland, Australia

Susanne Schmidt
The University of Queensland, Australia

Fernanda Dreccer
CSIRO, Australia

Paul Memmott
The University of Queensland, Australia

The XXII International Grassland Congress (Revitalising Grasslands to Sustain Our Communities) took place in Sydney, Australia from September 15 through September 19, 2013.

Proceedings Editors: David L. Michalk, Geoffrey D. Millar, Warwick B. Badgery, and Kim M. Broadfoot

Publisher: New South Wales Department of Primary Industry, Kite St., Orange New South Wales, Australia

Photosynthetic and growth response of *Triodia pungens* to elevated CO_2 concentration

Lisa Xian [A], Susanne Schmidt [A], Fernanda Dreccer [B], and Paul Memmott [C]

[A] School of Agriculture and Food Sciences, The University of Queensland, Brisbane, QLD 4072 Australia
[B] CSIRO Plant Industry, Queensland Bioscience Precinct, St. Lucia, QLD 4067 Australia
[C] Aboriginal Environments Research Centre, School of Architecture, The University of Queensland, Brisbane, QLD 4072, Australia

Contact email: l.xian@uq.edu.au

Keywords: Spinifex, grasslands, arid, water use efficiency.

Introduction

Triodia ("spinifex") is a widely distributed endemic C4 grass genus in Australia. *Triodia* species form the hummock grasslands which is one of Australia's dominant vegetation types covering approximately 30% of the continental land mass in the arid zone. Hummock grasslands are commonly used as rangelands and *Triodia* plays an important role in the ecosystem by providing habitat for arid fauna and maintaining arid lands vegetated.

Currently, *Triodia* survive extreme temperatures, water deficit and low nutrient availability. Predicted changes for Australia's arid climate under elevated atmospheric CO_2 (eCO_2) include reduction in rainfall and higher daily average temperatures in the next 50 years (CSIRO and BOM 2007). It is therefore likely that *Triodia* will experience more stressful conditions and there is insufficient knowledge to predict how *Triodia* species may respond to climate change.

Triodia may respond negatively which would result in lowered growth and potentially significant loss of Australia's largest arid vegetation. Alternatively, *Triodia* may respond positively and expand into other vegetations and alter fire regimes in these fire prone habitats. Therefore the objective of this study is to determine how *Triodia pungens*, a widely distributed species, may respond in the future under eCO_2.

Methods

Two month old *Triodia pungens* seedlings were grown in 4 L pots under either ambient 380 or elevated 600 ppm CO_2 atmospheric concentration in growth cabinets at temperatures of 35/25°C (day/night) and relative humidity at 30%. Water was held constant between 30-40% field capacity. Gas exchange measurements were performed with the portable photosynthesis system Li-Cor 6400 (Li-Cor, Lincoln, Ne, USA) after 6 months on the midleaf of the most recently fully expended leaf. Plants were harvested within 2 weeks after measurements and dry biomass of above- and belowground obtained. Data was analysed with student t-test.

Results

There was no difference in photosynthetic rate between plants grown in ambient and eCO_2 (Fig. 1a). However, elevated CO_2 resulted in lower transpiration and conductance (Fig. 1b, c). Increasing CO_2 concentration had improved instantaneous water use efficiency (WUE_i, Fig. 1d) as well as resulting in higher dry biomass for both above- (shoot) and belowground (root) (Fig. 2).

Discussion

This study is one of the first to examine how a *Triodia* species responds to eCO_2. The results here shows a positive effect of eCO_2 on *T. pungens* by improving WUE_i as well as increased both above and belowground biomass. Similar responses have been observed in other arid vegetations (Wand *et al*. 1999; Nelson *et al*. 2004). In contrast, semi-arid grasslands in Negav (Israel) showed only improved WUE but not biomass accumulation (Grünzeweig and Körner 2001) whilst primary production and root biomass

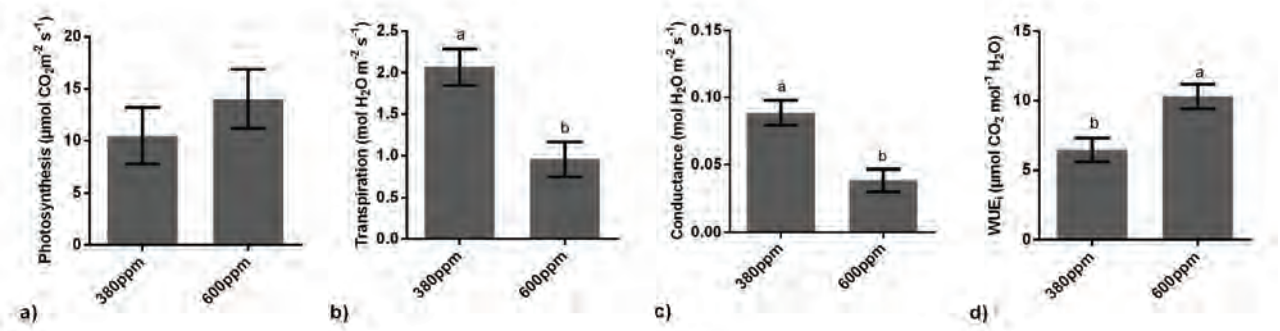

Figure 1. Mean values of photosynthesis (a) transpiration (b) conductance (c) and instantaneous water use efficiency (WUE_i, d) of *T. pungens* grown at ambient 380 ppm and elevated 600 ppm atmospheric CO_2 concentrations. Error bars are standard errors and different letters showing significant differences, $P<0.01$.

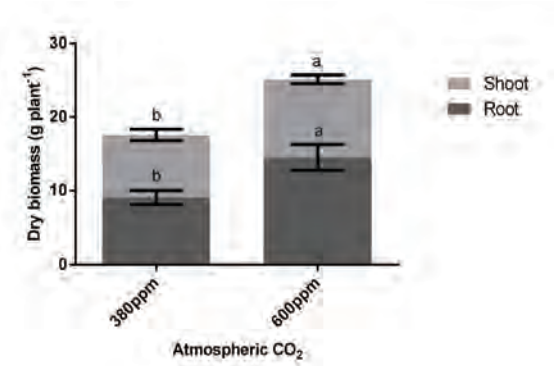

Figure 2. Dry biomass of above- (shoot,) and belowground (root,) of *T. pungens* grown at CO_2 concentration of ambient 380ppm and elevated 600ppm. Error bars are standard errors and different letters showing significant differences, *P*<0.05.

allocation was lowered for a Californian (USA) grassland under eCO_2 (Shaw *et al*. 2002). Due to a range of water deficiency in these arid biomes, water deficit may have a greater effect on plant response than eCO_2

(Lecain *et al*. 2003) thus resulting in a range of plant response to eCO_2 across arid biomes. Unlike transpiration and stomatal conductance, photosynthetic rate of *T. pungens* was unaffected by CO_2 concentration which could be a result of near saturation for a C4 grass under ambient CO_2 concentration (Lecain *et al.* 2003).

Conclusion

Although Australia's arid climate is predicted to become drier and hotter, future eCO_2 concentrations may improve water use efficiency of *T. pungens* and plant growth thus counteracting the effect of the harsher future of Australia's arid climate.

Acknowledgments

Thank you to the members of the Schmidt lab group for assisting with the sticky mess of harvesting this experiment which was completed in such a short time frame. Without the assistance from the technical staff for growth cabinets, this experiment would not have been possible. And thank you to my supervisors for direction and support.

References

Commonwealth Scientific and Industrial Reseach Organisation & Australian Bureau of Meteorology, CSIRO and BOM (2007) 'Climate change in Australia: technical report 2007.' CSIRO

Grünzweig J, Körner C (2001) Growth, water and nitrogen relations in grassland model ecosystems of the semi-arid Negev of Israel exposed to elevated CO_2. *Oecologia* **128**, 251-262.

Lecain DR, Morgan JA, Mosier AR, Nelson JA (2003) Soil and Plant Water Relations Determine Photosynthetic Responses of C3 and C4 Grasses in a Semi-arid Ecosystem under Elevated CO_2. *Annals of Botany* **92**, 41-52.

Nelson JA, Morgan JA, Lecain DR, Mosier AR, Milchunas DG, Parton BA (2004) Elevated CO_2 increases soil moisture and enhances plant water relations in a long-term field study in semi-arid shortgrass steppe of Colorado. *Plant and Soil* **259**, 169-179.

Shaw MR, Zavaleta ES, Chiariello NR, Cleland EE, Mooney HA, Field CB (2002). Grassland responses to global environmental changes suppressed by elevated CO_2. *Science* **298**, 1987-1990

Wand SJE, Midgley GF, Jones MH, Curtis PS (1999) Responses of wild C4 and C3 grass (Poaceae) species to elevated atmospheric CO_2 concentration: a meta-analytic test of current theories and perceptions. *Global Change Biology* **5**, 723-741.