Rangeland grass growth with nitrogen limitation is increased by high levels of atmospheric carbon dioxide

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Atmospheric CO_2 concentrations are increasing at a rate of 0.5% per annum and are expected to reach twice present concentrations by late next century (I). An experiment with 3 grass genera commonly found in Australian rangelands was undertaken to evaluate the effect of this rise on above-ground plant productivity and forage quality when growth is closely related to the availability of nitrogen.

Methods

Danihonia richardsonii, Microleana stipoides and *Vulpia ciliata* were grown as single spaced plants from seed in 20 cm pots in a pair of naturally lit phytotron glasshouses. Two nitrogen levels (0.4 & 1.6 mg/pot.day, supplied twice weekly) and two atmospheric CO_2 concentrations (359 & 723 ppmv, one per glasshouse) were imposed. Water and other nutrients were non-limiting. The plants were grown at a daily average temperature of 20?C (sine wave, 17?C minimum and 23?C maximum) for a period of 73 days. Temperature and dew point were monitored and controlled automatically to be identical in the two glasshouses. Plants were rotated within each glasshouse daily, and CO_2 concentrations and plants were swapped between glasshouses once during the experiment. It was assumed that environmental conditions were uniform across the experiment and it was analysed as a completely randomised design. Shoot biomass and leaf lamina carbon and nitrogen concentrations were determined.

Results and discussion

The responses of shoot dry matter production and leaf lamina C:N ratio are summarised in Table I. Shoot dry weight and C:N ratio increased in response to CO_2 enrichment at both N levels ($P<0.001$).

Table 1. Response of shoot dry matter and leaf lamina C:N ratio due to the increase in CO2 concentration.

			Percent increase due to high CO_2	
	N rate (mg/pot.day)	Control shoot DW (g)	Shoot DW	Leaf C:N
D. richardsonii	0.4	1.2	12.2	42.0
	1.6	2.8	36.2	31.5
M. stipoides	0.4	1.0	24.3	54.7
	1.6	2.0	44.3	53.7
V. ciliata	0.4	0.6	52.9	50.7
	1.6	1.8	70.9	51.7

From this experiment it could be expected that rangeland grasses may increase their dry matter production as atmospheric CO_2 concentrations rise, even when experiencing severe nitrogen limitation. However the forage quality of these grasses may be reduced as their carbon to nitrogen ratio increases. Changes in temperature, rainfall and soil moisture content driven by CO_2 and other global atmospheric trace gas increases may also affect dry matter production and forage quality.

References

1. Houghton. J.T., Jenkins. G.J., and Ephraums, J.J. (Eds). 1990. Climate Change: The IPCC Scientific Assessment. Cambridge University Press, Cambridge.