Rise in CO_2 affects microscale soil water relations

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Background

- Research suggests elevated CO_2 will influence a range of soil physical processes.
- Impact caused by greater plant growth and substrates.
- We hypothesise that under elevated CO_2 (1) increased drying and aggregation will enhance transport but (2) greater levels of exudates and biomass will off-set this slightly by increasing very low levels of water repellency.

Doubling CO_2 – A 22nd Century Scenario

Specially constructed plant growth chambers allow for soil and air temperature to be controlled and CO_2 to be doubled.

- Barley (Hordeum vulgaris c.v. Pipkin) planted in soil tubes 22 x 48 mm wide and 1.2 m length that were packed to a density 1.2 g cm^{-3}.
- Plants grown at 360 ppm (ambient) and 720 ppm CO_2 concentration for 10 weeks.
- Soil irrigated to prescribed water content along entire depth fortnightly and water loss measured.
- Soil dried at 40°C before testing.

Measuring microscale soil water infiltration and repellency

Microinfiltrometer developed with a tip size of 0.14 mm radius.

Three parameters are determined:

1) Water Sorptivity – rate of water uptake at the onset of wetting

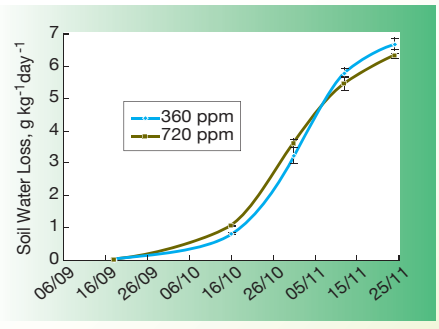
2) Ethanol Sorptivity – removes impact of repellency, related to pore structure

3) Water Repellency – ratio of ethanol to water sorptivity, highly sensitive at low levels

Water repellency measured at 10 different depths down each tube.

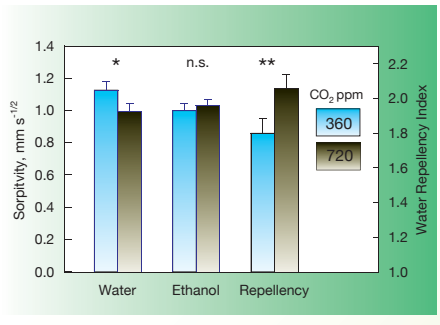
Plant Growth and Soil Water Uptake

CO_2 conc.	Stem Weight (g)	No. of Tillers	Soil Water Loss (g kg^{-1})
360 ppm	14.7	16.0	224
720 ppm	17.7	16.3	225
P (t-test)	0.01**	n.s.	n.s.



- Stem weight at harvest was greater under elevated CO_2 but soil water uptake not affected.

Impact of CO_2 on Water Transport and Repellency



- Transport and repellency did not vary with depth.
- Decrease in water sorptivity under elevated CO_2.
- Ethanol sorptivity, which indicates pore structure impact, not affected by CO_2.
- Indicates higher water repellency, which was significantly greater at 720 ppm.

Conclusions

Doubling of CO_2:

1) Increased plant growth but did not influence plant-water relations.

2) Decreased water sorptivity because of greater water repellency.

3) Did not influence ethanol sorptivity.

Future research needs to measure repellency over a wider range of soil water contents, and determine the impact of different plants and projected changes to soil and atmosphere temperatures.

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