Moister soils at elevated CO₂ stimulate root biomass production but suppress aboveground biomass production in a temperate pasture

Mark J. Hovenden¹, Amanda Sinclair¹, Rose Brinkhoff¹, Kate Stevenson¹, Zachary Brown¹, Meagan Porter¹, Anna Flittner¹, Marion Nyberg¹, and Richard Rawnsley¹

¹University of Tasmania

October 28, 2020

Abstract

Increases in atmospheric CO₂ concentration ([CO₂]) drive increases in biomass production via impacts on photosynthesis and water use. In grasslands, the scale of this stimulation is related to soil water availability. Recently, seasonal influences on how precipitation controls elevated CO₂ (eCO₂) effects on grassland biomass production have emerged. We established the TasFACE2 experiment in a well-fertilised perennial ryegrass (*Lolium perenne*) monoculture with four seasonal irrigation schedules to determine how seasonal water availability affects aboveground, belowground and total biomass responses to three CO₂ concentrations. While total biomass production was strongly stimulated by eCO₂, this effect was almost entirely driven by belowground responses. The relationship between soil water content and aboveground biomass varied seasonally but there was a strong positive relationship between soil water content and root biomass production in all seasons. Increases in soil moisture caused by eCO₂, therefore, contributed to increases in root growth. However, root biomass production was also stimulated directly by eCO₂ regardless of eCO₂ impacts on soil moisture, further increasing the biomass allocation belowground. Restriction of irrigation, therefore, suppressed the belowground response to eCO₂ and created a non-linear response of biomass to CO₂ concentration. Thus, total biomass responses to eCO₂ cannot be predicted from aboveground measurements alone.

Hosted file

Hovenden et al PCEnv.R1.text.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig1.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig2.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig3.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig4.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig5.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig6.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>

Hosted file

Hovenden et al PCEnv.R1.Fig7.pdf available at <https://authorea.com/users/370917/articles/489420-moister-soils-at-elevated-co2-stimulate-root-biomass-production-but-suppress-aboveground-biomass-production-in-a-temperate-pasture>