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Carbon gain of C3 and C4 grasses in a dense canopy in the field

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Introduction

The daily carbon gain of C3 (*Lolium perenne*) and C4 (*Paspalum dilatatum*) individuals growing in a mixed dense canopy in the field was measured with a novel approach based on steady-state ^{13}C-labelling.

This work analyse the partitioning of canopy carbon gain between the two species, and the role of the amount of leaf area per unit mass (LAR) and of carbon gain per unit leaf area (GAR) in determining the relative photosynthesis rate (RPR) of individual tillers forming the canopy: RPR = LAR x GAR

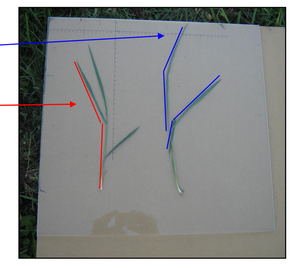
Materials & Methods

Conditions

- *Pampas* region (37°45'S, 58°18'W; Argentina), end of summer (15/03/08)
- Soil was loam Mesic Fine Typical Argiudol (6.2 %MO), high water and nutrient availability
- Canopy largely composed by a mixture of *L. perenne* and *P. dilatatum*
- Canopy LAI = 4.0 m^2 m^{-2}, Canopy height = 28 cm
- Four chambers (0.3 x 0.3 x 0.6 m) received ^{13}C-enriched CO_2 ($\delta^{13}C$=398‰) at 380 µmol mol^{-1} during 7 h (12:00-19:00 h)
- Mean air temperature during labelling = 25 °C
- Mean photosynthetic active radiation incident = 1326 µmol m^{-2}

Harvest and measurements after labelling

- 30 tillers per specie
- Total biomass of 2 quadrates (0.2 x 0.2 m)
- Unlabelled plants as reference for 13C content
- Blade area per tiller
- Extended height per tiller
- Carbon mass per tiller
- ^{13}C content of labelled plants (*L*)
- ^{13}C content of unlabelled plants (*U*)



Estimations

- Relative Photosynthesis Rate (RPR) = (*L* – *U*) / (*N* – *U*),

  L and *U* are the ^{13}C content of labelled and unlabelled plants, respectively.

  N is the ^{13}C content of plants growing continuously with the ^{13}C-enriched CO_2.
- Leaf area ratio (LAR, m^2 g^{-1}) = blade area per tiller / carbon mass per tiller
- Gross assimilation rate (GAR, mg m^{-2} h^{-1}) = RPR / LAR

Results and Discussion

	P. dilatatum (C4)	*L. perenne* (C3)
Standing carbon mass (g m^{-2} ground)	164	22
Canopy carbon gain (mg m^{-2} ground h^{-1})	830	120
RPR (mg g^{-1} h^{-1})	5.1	5.5

P. dilatatum (C4) higher biomass and higher carbon gain than *L. perenne* (C3)

but

both species showed similar ability to capture carbon per unit canopy mass

Canopy level analysis

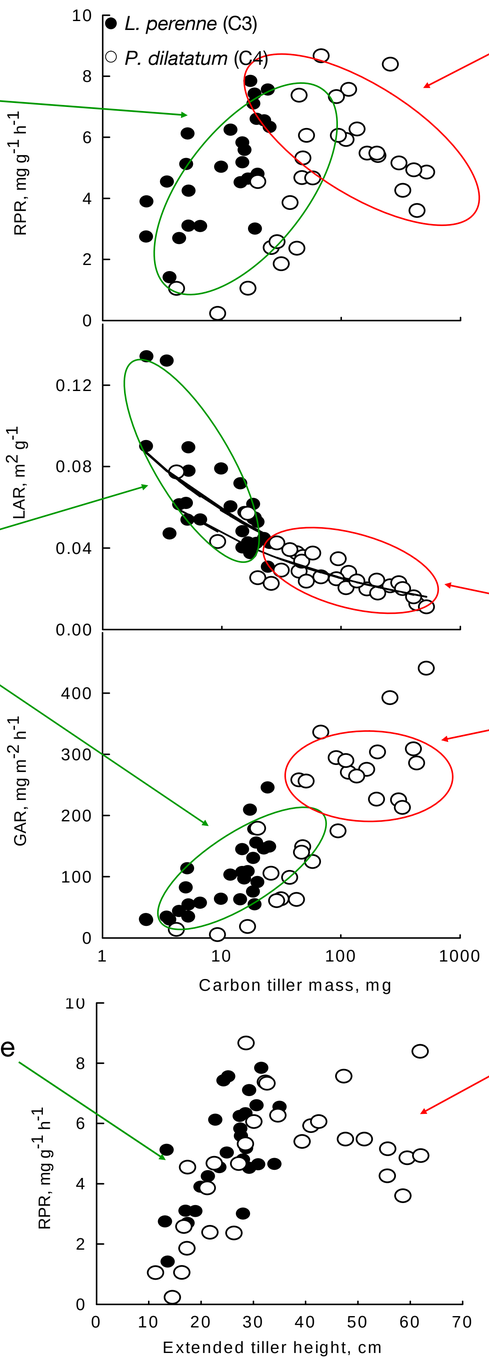
Balance between species within the mixture depends upon the RPR of each component. Then, the similar RPR species suggest that species balance did not change

Smaller individuals

higher RPR than bigger, and positive relationship with size

Bigger individuals

stable or decreased RPR

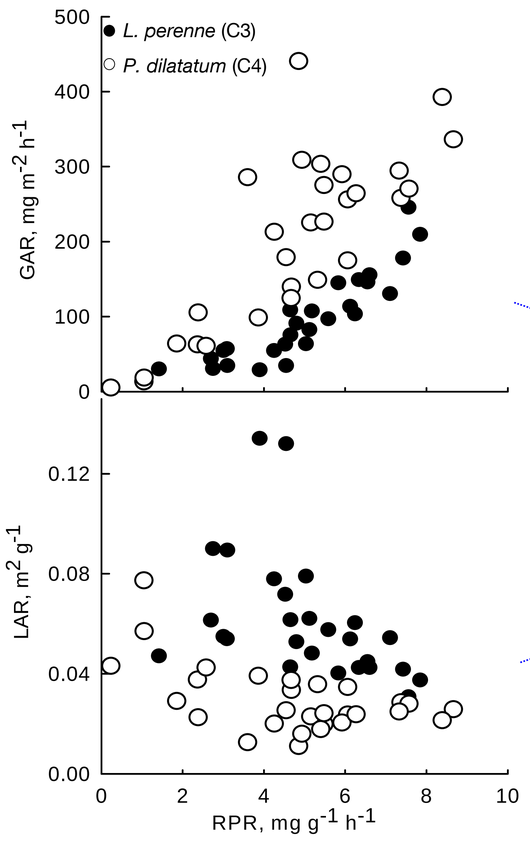


Increasing LAR did not compensate the lower GAR

Decreasing LAR and stable GAR

Smaller tillers, were subordinate (*i.e.* shaded) in the canopy

Stabilization in light intercepted per unit area?



Tiller level analysis

In both species, in small (subordinate) individuals competition appeared to be size-asymmetric, but size-symmetric between dominant individuals

A presumably stable species composition of the canopy can be achieved through different mechanisms:

higher carbon gain per unit leaf area (GAR) in *P. dilatatum*

lesser carbon investment per unit leaf area (LAR) in *L. perenne*

Conclusion

Combining carbon gain data at canopy- and at tiller level, with a set of readily-measured variables at tiller (height-weight-area) and canopy level (biomass), was useful to mechanistically analyse the partition of carbon gains among species forming the canopy.