Net photosynthesis rate and chlorophyll content of Caucasian and white clover leaves under different temperature regimes

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Keywords: Caucasian clover, chlorophyll, photosynthesis, temperature, *Trifolium ambiguum*, *T. repens*

Introduction In spring and summer in intensive temperate pastures, Caucasian clover (Cc) (*Trifolium ambiguum*) has higher dry matter (DM) production rates than white clover (wc) (*Trifolium repens*) (Black *et al.*, 2003). An examination of the physiological basis for these differences can provide a greater insight into the suitability of Cc for inclusion in temperate pastures. Specifically, leaf photosynthesis rate is a major driver of seasonal growth and is strongly regulated by temperature and chlorophyll content. This study aimed to compare the net photosynthesis rate (Pn) and chlorophyll content of Cc and wc leaves under different temperature regimes.

Materials and methods 'Endura' Cc and 'Demand' wc were grown under field irrigation at Lincoln University, New Zealand (Black *et al.*, 2003). Pn was measured on a random sample of 10 youngest fully expanded intact leaves using a photosynthesis system (LI-6400 LiCor, USA) at 7 light intensities, 0, 100, 250, 500, 750, 1000 and 2000µmol/m^2/s photosynthetic photon flux density (PPFD) following Peri *et al.* (2002). Leaves were measured for chlorophyll using a chlorophyll meter (SPAD-502 Minolta, Japan) and estimated for chlorophylls *a* and *b* and total chlorophyll, after Salisbury & Ross (1985). Pn and chlorophyll were recorded when measured air temperatures were either limiting (12ºC, T_{lim}) or non-limiting (23ºC, T_{opt}) for the growth of both species (Black *et al.*, 2003).

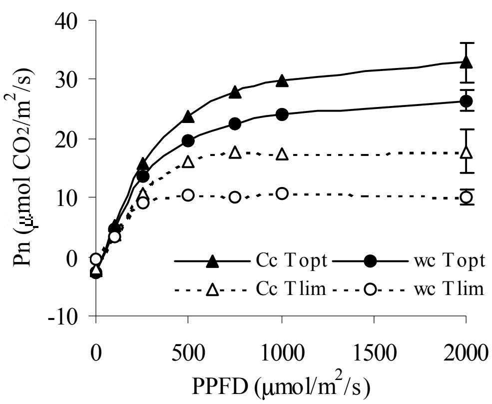

Figure 1 Pn against light intensity for Cc and wc with air temperatures either limiting (12ºC, T_{lim}) or non-limiting (23ºC, T_{opt}). Bars represent standard errors for Pn_{max}.

Results The response of Pn to light intensity followed a non-rectangular hyperbola for both species at 12ºC and 23ºC (Figure 1). The maximum rate of Pn (Pn_{max}) for Cc was 32µmol CO_2/m^2/s at 23ºC, but decreased to 17µmol CO_2/m^2/s at 12ºC. These Pn_{max} rates were about 6µmol CO_2/m^2/s higher than for wc at both temperatures. The concentrations of chlorophylls *a* and *b* and total chlorophyll were higher for Cc than for wc irrespective of air temperature (Table 1).

Table 1 Chlorophyll content (mg/g) of Cc and wc leaves grown with air temperatures either limiting (12ºC, T_{lim}) or non-limiting (23ºC, T_{opt})

	T_{lim}		T_{opt}		
	Cc	wc	Cc	wc	s.e.d.
Chlorophyll *a*	2.01	1.79	1.90	1.74	0.033
Chlorophyll *b*	0.32	0.25	0.29	0.24	0.010
Total chlorophyll	2.33	2.05	2.20	1.99	0.044

Conclusions The higher Pn for Cc leaves can be explained by their higher chlorophyll content than wc leaves at the air temperatures experienced. Thus, for any given canopy leaf area index, the canopy photosynthesis rate of Cc can be expected to exceed that for wc and give more assimilate/unit leaf area. Confirmation of this would provide an explanation for the DM production advantage of Cc over wc observed in temperate pastures.

References

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