Light quality (red:far-red ratio) does not affect the photosynthesis of developing leaf in white clover (Trifolium repens L.)

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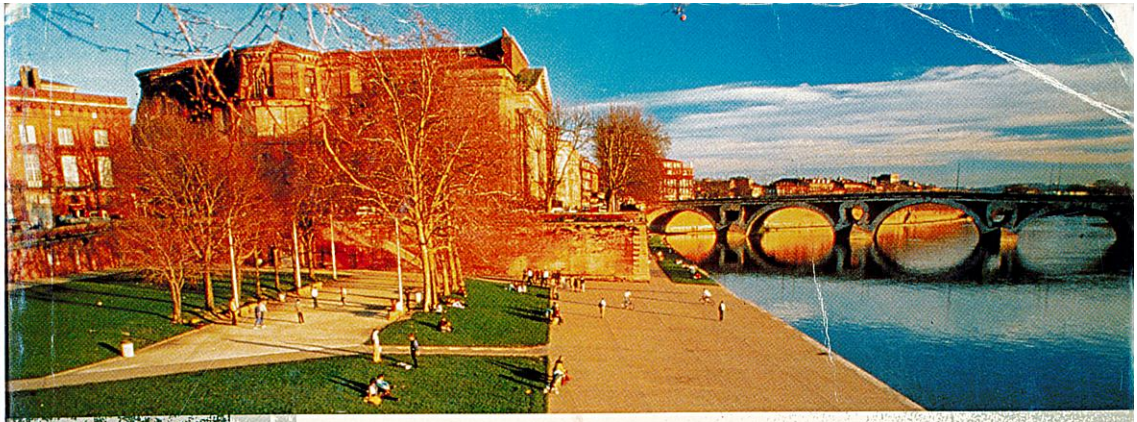

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LIGHT QUALITY (RED:FAR-RED RATIO) DOES NOT AFFECT THE PHOTOSYNTHESIS OF DEVELOPING LEAF IN WHITE CLOVER (*Trifolium repens* L.)

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In lower parts of a canopy, the foliage shade induces a drop of irradiance but also a decrease of the ratio between Red (R) and Far-Red (FR) wavelengths (Holmes and Smith, 1977). The red (660 nm) : far-red (730 nm) is perceived by the plant through the photoreceptor phytochrome. The photosynthesis of lowest leaves is obviously limited by the reduction of light intensity but the specific effects of low R:FR ratio on CO_2 fixation were little investigated particulary for a plagiotropic species like white clover (Sheehy *et al.*, 1983). This legume is mainly used as a component of mixed swards. The grass leaves overtop the lower parts of white clover (stolons, buds and young leaves) and the competition for light leads often to legume's decline (Soussana *et al.*, 1995).

In order to study the influence of R:FR ratio on photosynthetic activity of developing leaves, cuttings of white clover cv Huia were grown in a controlled environment under low irradiance (110 ± 40 µmol.m^{-2}. s^{-1} in PAR range) in combination with two light quality treatments. For the -FR treatment, the background light was provided by halogen metal vapour lamps with a R:FR ratio of 2.4. For the +FR treatment, the R:FR ratio of background light was reduced up to 0.4 by FR light supplementation. As simulation of foliage shade occuring within a sward, we limited the FR lighting to the developing leaf before its emergence from apical bud until its unfolding by using far red light emitting diodes (Figure 1).

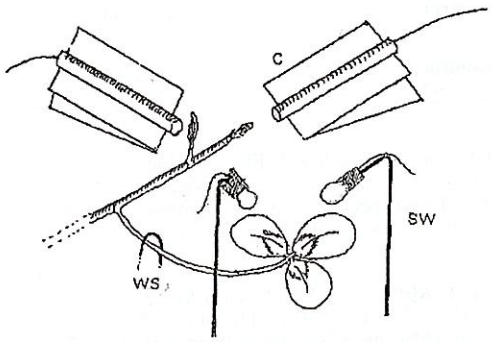

Figure 1 : Irradiation of developing leaves with FR diodes from the initiation within apical bud to the unfolding under +FR treatment. L, lead to power source ; C, collimator containing a FR diode ; BW, black wire holding up a FR diode ; WS, wire staple to avoid the irradiation of internode.

The results showed that low R:FR ratio does not affect the net CO_2 assimilation rate of unfolded leaf under growth irradiance (Table 1). The CO_2 fixation was neither limited by stomatal conductance nor by total carboxylase activity of Rubisco under FR lighting. Nevertheless, the measurements of chlorophyll a fluorescence showed that low R:FR ratio slightly decreased the photochemical quantum yield of PSII centers (parameter estimating the efficiency of the overall photosynthetic performance) without modification of apparent electron transport rate through PSII (Table 1). This reflects a decrease of the electron flow which is used by another process than CO_2 fixation, like photorespiration. Low R:FR ratio also reduced the chlorophyll a content without modification of chlorophyll b content (Table 1). This characterized an acclimation of thylakoid structure to foliage shade (Chow *et al.*, 1990).

Table 1 : A comparison of photosynthetic activities and components of developing leaf between -FR and +FR treatment. Values represent the mean of 9 replicates ± SD. The significance of light quality effects (p) were determined by variance analysis (** $p \leq 0.01$; * $p \leq 0.05$; ns = not significant)

Parameters	*-FR treatment*	*+ FR treatment*	*p*
Net CO_2 assimilation rate (μmol CO_2 m^{-2} s^{-1})	4.7 (1.56)	4.9 (0.95)	ns
Stomatal conductance (mmol H_2O m^{-2} s^{-1})	96 (19.4)	90 (23.5)	ns
Total carboxylase activity of Rubisco (mmol CO_2 m^{-2} s^{-1})	208 (53.3)	185 (43.3)	ns
Photochemical quantum yield of PSII centers	0.75 (0.009)	0.73 (0.024)	**
Apparent electron transport rate through PSII (μmol e^- m^{-2} s^{-1})	35.8 (5.40)	33.8 (5.64)	ns
Chlorophyll a content (μg cm s^{-2})	63.9 (9.76)	58.6 (10.21)	**
Chlorophyll b content (μg cm s^{-2})	11.7 (4.01)	9.3 (3.04)	ns

Conclusions : This study showed that low R:FR ratio does not determine the efficiency of CO_2 fixation under foliage shade. An other pocess of photosynthesis like photorespiration seems to be affected by light quality. This aspect remains to be investigated We also confirmed that white clover is an intolerant shade species as regard to morphology but also about its chlorophyll content.

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