Effect of temperature on the photosynthesis of irrigated pastures

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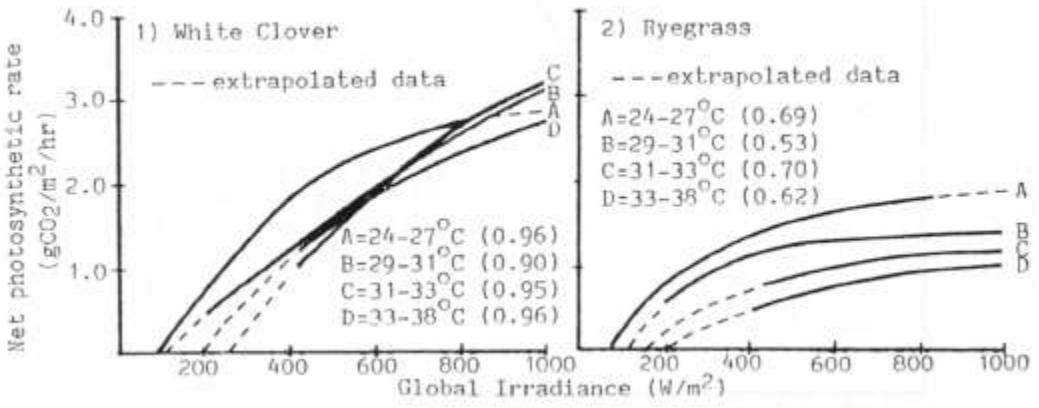
The productivity of irrigated pasture in the Goulburn Valley is low. These pastures are based on mixtures of white clover (Trifolium repens) and perennial ryegrass (Lolium perenne). During summer, water and solar energy for photosynthesis are abundant and there is a large potential for growth. However, the growth rate of white clover redains constant and that of ryegrass declines during this period. The average maximum temperature during summer is 30"C with one day in four being 33?C or more. These temperatures are well above the optimum of 20-25?C reported in the literature for white clover and ryegrass. This short-term study investigated the productivity of white clover and ryegrass swards over a range of temperatures typical of summer conditions in the Goulburn Valley.

Methods

Pure, well-watered swards of white clover and ryegrass, intercepting 80-90% light were used in this study. The net photosynthetic rate of canopies was measured over a series of days using field gas-exchange chambers. During this period a wide range of global irradiance and air temperature (24-38?C) occurred. Photosynthetic data were grouped according to temperature and plotted against the irradiance at which they were collected. Asymptotic functions were fitted to the data. Temperature ranges were 24-27?C, 29-31?C, 31-33?C and 33-38?C.

Results and discussion

Figure 1 shows the fitted curves for white clover, with the R' in parentheses. This shows that at high irradiance, maximum rates of photosynthesis are reached at temperatures between 29 and 33?C. Thus, during summer, the average maximum temperature of 30?C should enable this species to reach peak levels of net photosynthesis. In contrast, Figure 2 shows that the photosynthetic rate of ryegrass at high irradiance is reduced by almost 50% as temperature increases from 24 to 38?C. An increase in temperature at low irradiance tends to reduce the photosynthetic rate of both species, presumably because of increased rates of respiration. These results confirm that high temperatures limit the productivity of ryegrass during summer, causing large inefficiencies in the use of solar energy and irrigation water. Since we cannot control temperature, alternative species should be investigated.



Figures 1 and 2: Response of net photosynthetic rate to irradiance and temperature in white clover and ryegrass.