Night Temperature has a Minimal Effect on Respiration and Growth in Rapidly Growing Plants

Carbon gain depends on efficient photosynthesis and adequate respiration. The effect of temperature on photosynthetic efficiency is well understood. In contrast, the temperature response of respiration is based almost entirely on short-term (hours) measurements in parts of mature organisms to develop Q_{10} values (the value at which enzymatic activity increases for a 10° increase in temperature) for maintenance and whole-plant respiration. These Q_{10} values are then used to extrapolate across whole organisms for entire life cycles to predict the influence of temperature on plant growth.

In this study, night temperature in young, rapidly growing plant communities was altered from 17 to 34°C for up to 20 days. Day temperature was maintained at 25°C. CO_2 gas-exchange was continuously monitored in ten separate chambers to quantify the effect of night-temperature on respiration, photosynthesis, and the efficiency of carbon gain (carbon use efficiency).

Respiration increased only 20-46% for each 10°C rise in temperature (total respiratory Q_{10} of between 1.2 to about 1.5). This change resulted in only a 2-12% change in carbon use efficiency, and there was no effect on cumulative carbon gain or dry mass. No acclimation of respiration was observed after 20 d of treatment (Fig.1).

These findings indicate that whole-plant respiration of rapidly growing plants has a small sensitivity to temperature, and that the sensitivity does not change within the species tested, even after 20 d of treatment. Finally, the results support respiration models that separate respiration into growth and maintenance components.

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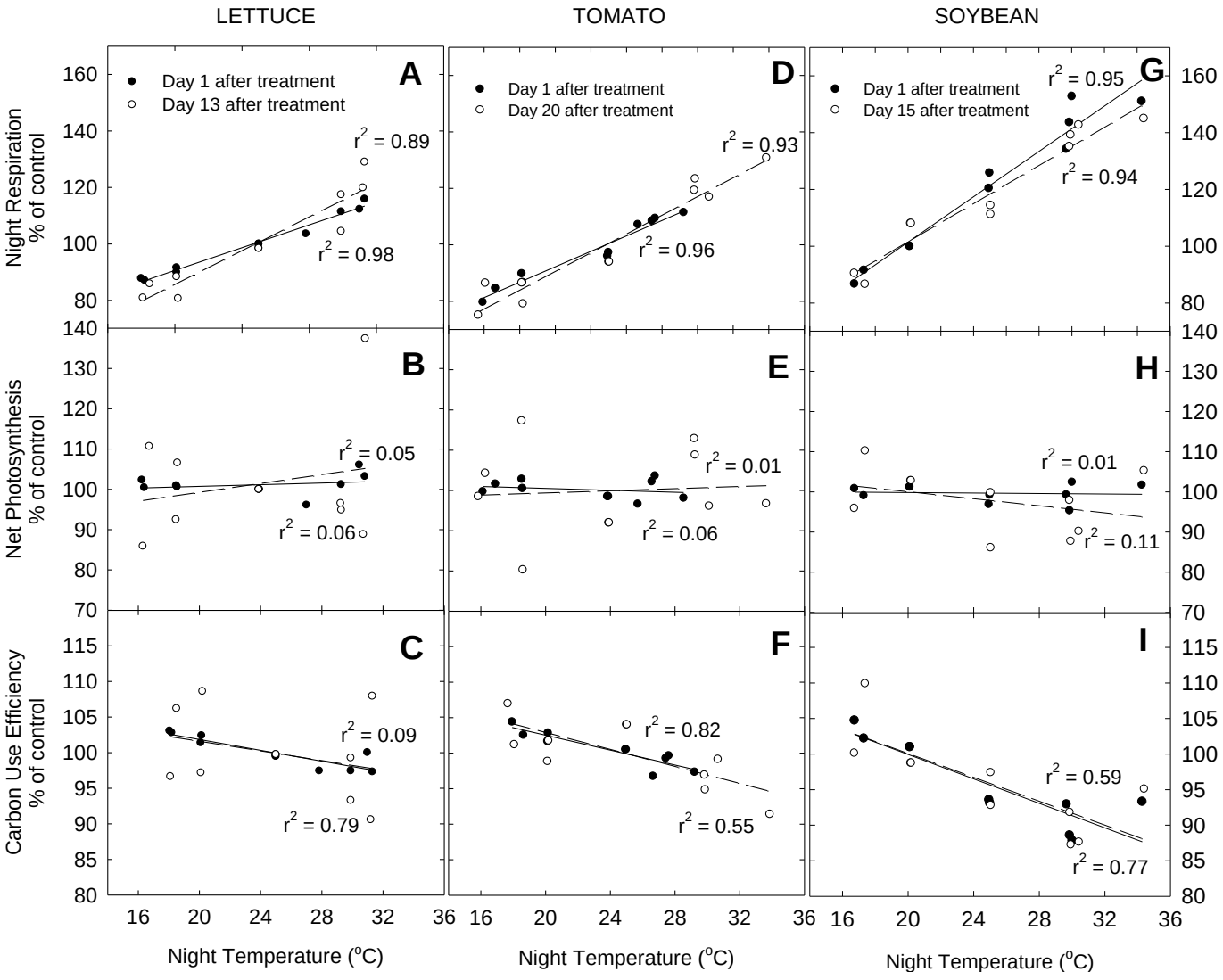
Figure 1.Impact of night temperature on night-time respiration (A, D, and G), photosynthesis (B, E, and H), and carbon use efficiency (C, F, and I) on three crops. Whole-plant responses were much less than previously believed and did not acclimate after 20 days.



Frantz, J. M., Cometti, N. N., and Bugbee, B. 2004. Night temperature has a minimal effect on the growth and respiration and rapidly growing plants. Ann. Bot. 94:155-166.