

We Thought We Knew How to Grow Lettuce: Exploring the Limits of Crop Productivity

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Introduction

Lettuce is typically grown at 25/20C day/night and a PPF of 300 to 400 $\mu\text{mol m}^{-2} \text{s}^{-1}$. Warmer temperatures are thought to increase bitterness and tip burn, while higher light increases tip-burn and photo-bleaching. Temperatures above 25 C are also thought to reduce growth rates.

We sought to determine the limits of lettuce productivity in elevated CO_2 . We studied the effect of temperature from 21 to 33C, and the response of four cultivars to PPF levels at 400 to 800 $\mu\text{mol m}^{-2} \text{s}^{-1}$. Density was 80 to 100 plants m^{-2} . The growth temperature optimum was 28.5C. The PPF for maximum productivity was 800 $\mu\text{mol m}^{-2} \text{s}^{-1}$ and 400 for optimum efficiency.



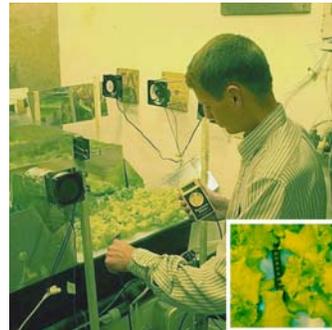
Materials and Methods

Trial 1. Five temperatures (21, 24, 27, 30, and 33C) with five-degree difference in day/night using 'Grand Rapids'.
Trial 2. Cultivars 'Grand Rapids', 'Waldmann's Green', 'Buttercrunch', and 'Bibb' were evaluated at 400 and 800 $\mu\text{mol m}^{-2} \text{s}^{-1}$.



Gas-Exchange System

10 chambers measured continuously.
Temperature control to ± 0.2 C.



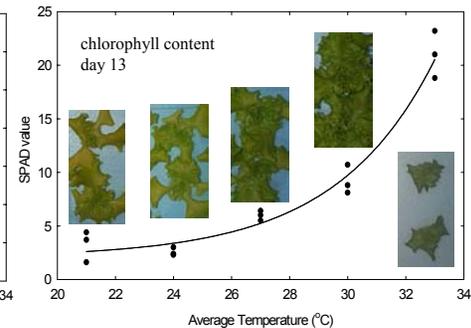
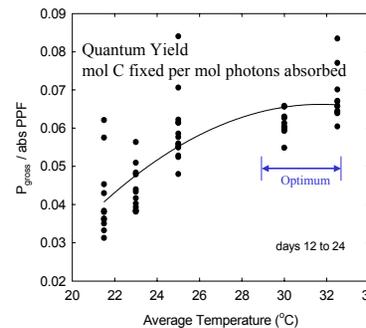
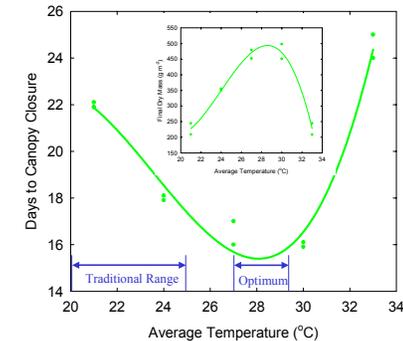
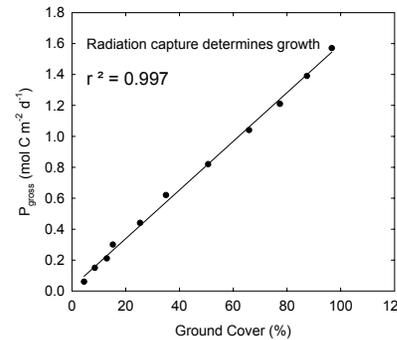
Radiation capture

Images recorded daily with digital camera from above the canopy.
Radiation capture measured daily with a line-quantum sensor.

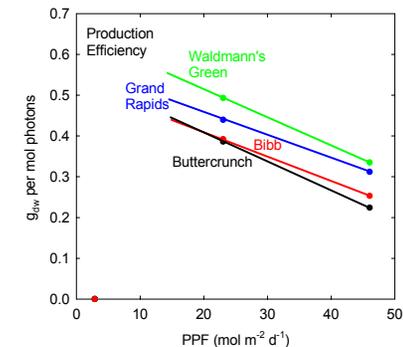
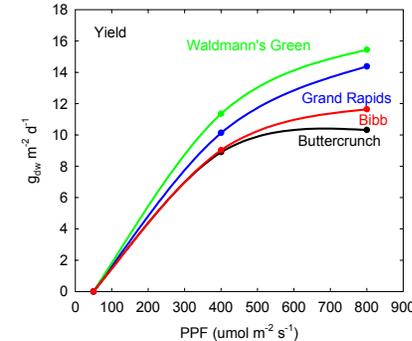
CO_2 was 1200 $\mu\text{mol mol}^{-1}$ in all studies.
HPS lamps were used in all trials because growth is superior to MH lamps (Dougher and Bugbee, 2000).
Relative humidities were maintained between 60 to 80%.
Lettuce was harvested on day 28 after imbibition and day 24 after turning on lights.

Results

Temperature



Light



Conclusions

Optimum temperatures in a high- CO_2 environment are 5 degrees above those typically used for lettuce production. Higher light maximizes productivity, but reduces production efficiency.