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Effect of CO_2 Concentrations on Roses: I CO_2 Uptake by Individual Leaves

C. J. THOMPSON AND JOE J. HANAN[1]

Four CO_2 concentrations of 500, 1000, 1500 and 2500 ppm were studied to determine their effects on the rate of CO_2 uptake by individual leaves of 'Forever Yours' roses. The light intensity at which maximum CO_2 uptake occurred increased up to 1500 ppm CO_2. At lower light levels, CO_2 uptake was enhanced at all levels of CO_2.

Methods

'Forever Yours' roses were grown in four individual houses that had CO_2 levels of 500, 1999, 1500 and 2500 ppm under clear day conditions. All other environmental factors were the same. Night temperatures were maintained at 63°F and day temperatures at a minimum of 72°F. Ventilation started at 84°F. The roses were grown directly in the ground and watered, as required, with automatic fertilizer injection. These conditions began Nov. 3, 1974, and ended May 3, 1975. During that period, outside temperatures were so low that little ventilation occurred.

A technique described by Aiken (1) was used for measuring CO_2 uptake in individual rose leaves. Essentially, 1 square centimeter of attached, whole leaves was exposed to a known quantity of radioactive CO_2 at the same concentration as in the house. The amount of radioactivity was correlated with the amount of CO_2 taken up by the leaf. All leaves were selected for maximum photosynthesis, accounting for leaf age. Samples were taken on clear, calm days over the full range of light intensities common to Colorado winters.

Results

At any given light intensity, CO_2 uptake was higher with higher CO_2 concentration. The differences were not always significant. The two extremes are shown in Fig. 1. The breaking point appeared to be between 1000 and 1500 ppm CO_2 (Fig. 2). Although there was a definite trend toward higher CO_2 uptake at 2500 ppm, the variability prevented the difference from being statistically significant.

[1]*Graduate assistant and professor. This work supported by a grant from Roses, Inc. Part of the thesis for the M.S. Degree by the senior author.*

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Results emphasize that additional CO_2 is beneficial on roses at any light intensity, and that up to 1500 ppm, the light saturation point — maximum light intensity for maximum CO_2 uptake — also increases. As shown by Aiken, for 500 ppm, the light saturation point was approximately 3300 ft-c. At 1000 ppm, the maximum light intensity was increased to 4600 ft-c., and to 5000 ft-c for both 1500 and 2500 ppm CO_2. In Colorado, it appears that 1500 ppm CO_2 represents the maximum desirable level of CO_2 for maximum CO_2 uptake for 'Forever Yours' under clear day conditions.

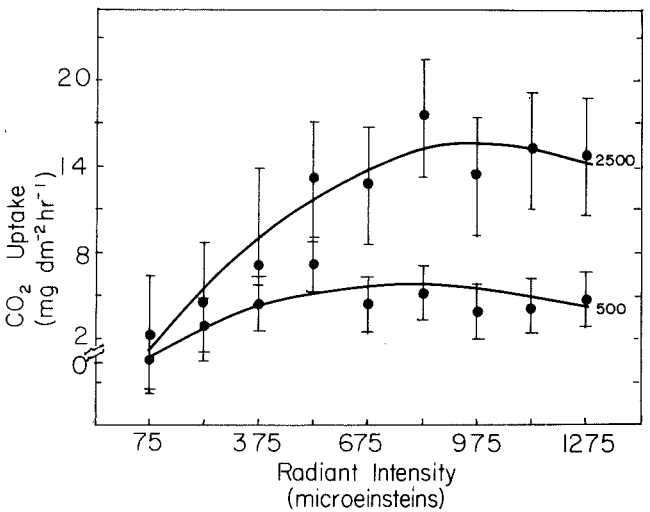

Fig. 1. Effect of light intensity on CO_2 uptake of individual leaves of 'Forever Yours' roses, maintained at 500 and 2500 ppm CO_2 under clear day conditions. Curves are transposed over a mean of individual data points obtained at different light intensities. The vertical bars show the differences required for statistical significance with a 5% chance of error.

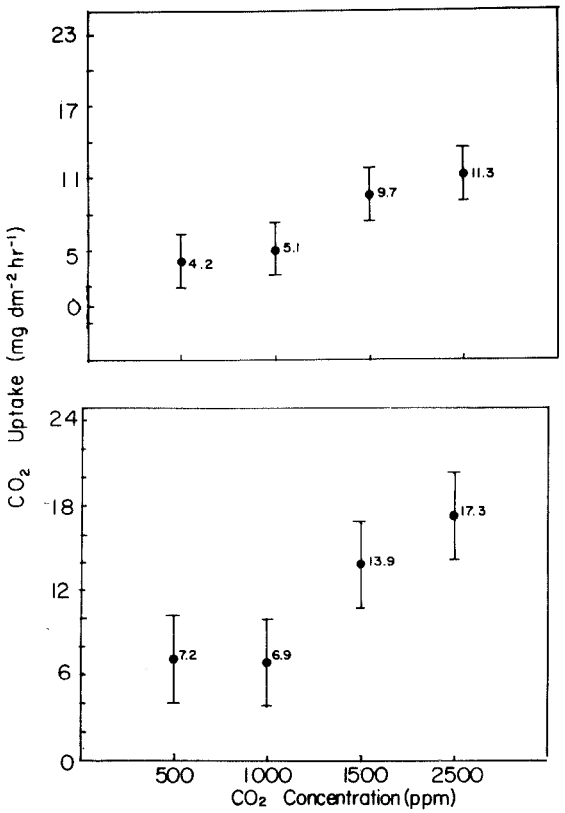

Fig. 2. *Upper:* Mean CO_2 uptake of individual 'Forever Yours' rose leaves at 500, 1000, 1500 and 2500 ppm CO_2, all light intensities combined.
Lower: CO_2 uptake of individual rose leaves at light saturation. Vertical bars that do not overlap are statistically significant from each other.

1. Aiken, W. J. 1974. Photosynthesis in roses. I. Effect of light intensity. *Colo. Flower Growers Assoc. Bul.* 289:1-3.