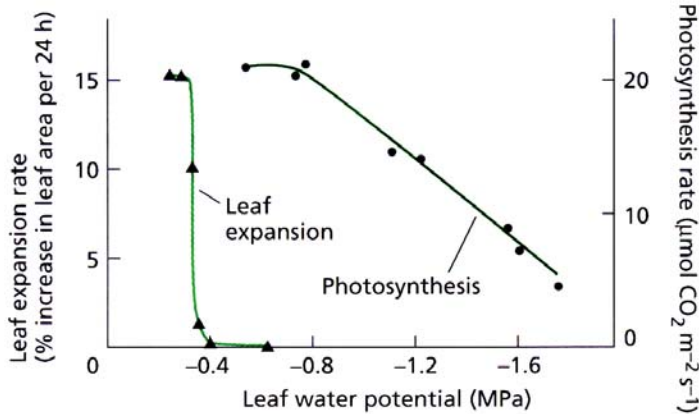


## Introduction

Leaf expansion is reduced in mild water stress (see graph below). Early detection of water stress can be accomplished with digital images taken at daily or hourly intervals.



**Effect of water stress on leaf expansion and photosynthesis. Leaf expansion is highly sensitive to water stress.**

## Materials and Methods

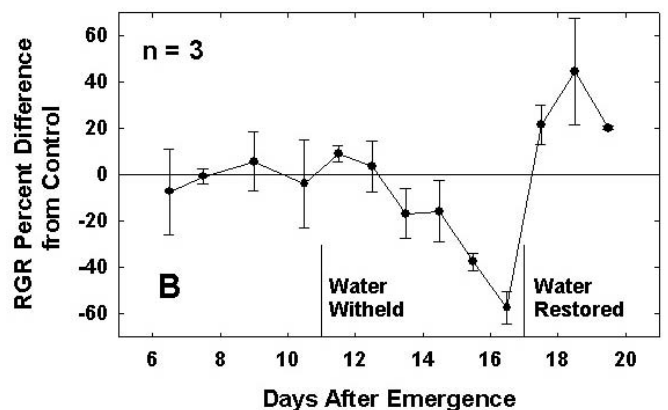
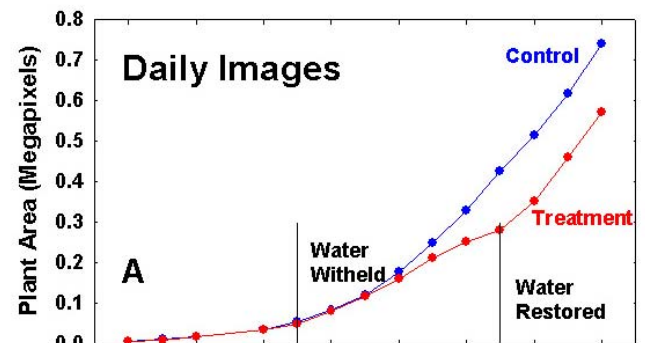
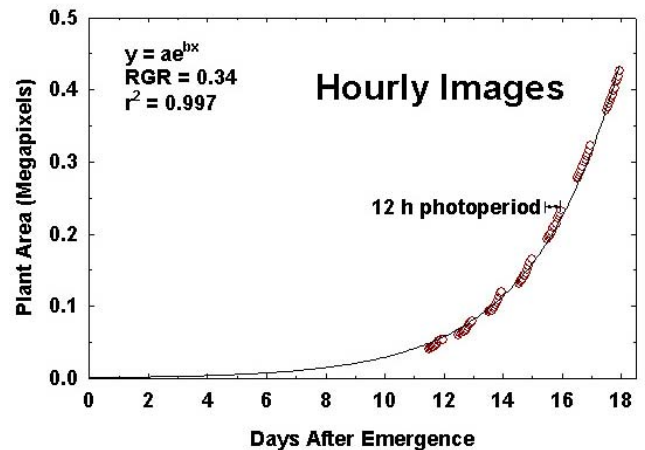
Digital images of 'Grand Rapids' lettuce were analyzed using Adobe Photoshop software. Plant pixels were isolated (below right) from the total digital image (below left) using the 'magic wand' tool. Daily images were used to monitor water stress effects.



Relative growth rate (RGR) was calculated using change in plant area (pixels) instead of the typical change in plant mass using the equation below.

$$RGR = \frac{\ln(\Delta \text{ area})}{\Delta \text{ time}}$$

## Results



**The effect of withholding water on leaf expansion (A) and relative growth rate (B). Two days elapsed before a change in leaf expansion was observed.**

## Conclusions

- Digital cameras can be used to determine leaf expansion and relative growth rate.
- Digital cameras can be used to detect early symptoms of water stress.