

# Plant Characterization Using Advanced Sealed Environment Technology

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Building on technological advancements in growth chamber technology, a collaboration between the University of Guelph's Controlled Environment Systems Research Facility, Conviron and Intravision Lighting has resulted in the development of a sealed environment chamber capable of high resolution measurement of whole plant photosynthesis and evapotranspiration. By precisely manipulating the environment conditions within the chamber, detailed plant-environment responses to a variety of environmental, chemical or biological variables can be achieved.

## Introduction

Plant-environment interactions are unique among plant species and there are often notable differences between cultivars developed for improved growth characteristics such as drought, insect and disease tolerances. These differences can be demonstrated in time periods considerably shorter than a typical field season, allowing for improved analytical throughput for phenotypic characterization.



## Sealed Controlled Environment System

### Modified CONVIRON A1000 growth chamber

- New door and frame with multipoint closure and hermetic seal
- Specular aluminium interior cladding
- Mettler Toledo 32 kg 0.1g balance for ET measurement

### HVAC

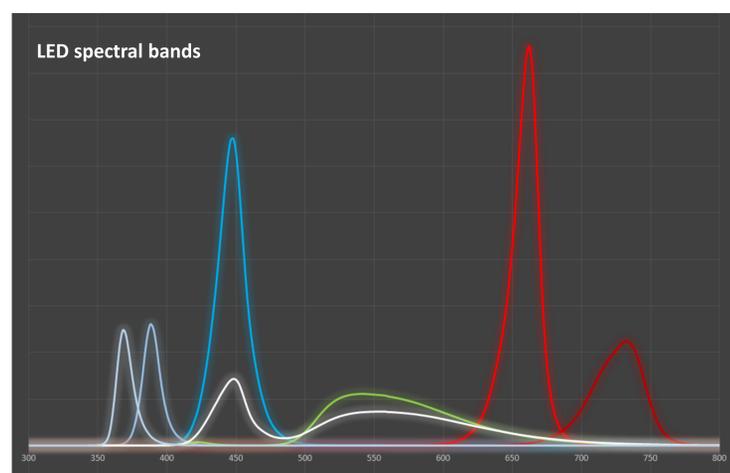
- Custom design with chilled and hot water heat exchangers
- Variable speed air flow with bottom up distribution

### Control

- Automated environment control system by Argus Controls

### LED Lighting by Intravision

- 2200 Watt water cooled LEDs with seven independently controlled channels
- UV (368 & 380), blue (448), white (5650K), green (568), red (655), far red (735)
- Wavelength and intensity programming through Argus interface



## Objective

A precision tool to better study plant physiological responses manipulation of multiple variables including:

- Temperature
- Humidity
- Carbon dioxide
- Oxygen
- Light (quantity, quality)
- Nutrients
- Plant water status
- Insect predation
- Pathogen application/response
- Chemical application (pesticide, biocontrol, fertilizer)

Using a sealed environment chamber, we can answer the question "what happens to photosynthesis when you change \_\_\_\_\_?"

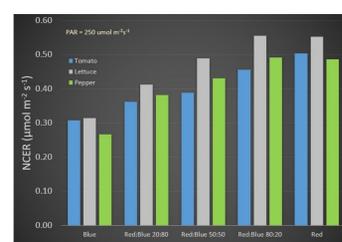
## Preliminary System Testing

Preliminary testing of the sealed environment was performed using three common plant species: pepper, tomato and lettuce.

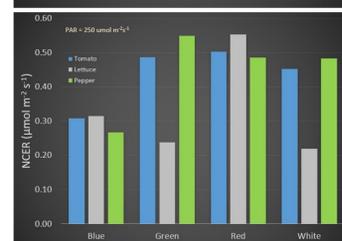


Various plants growing in a modified A1000 chamber

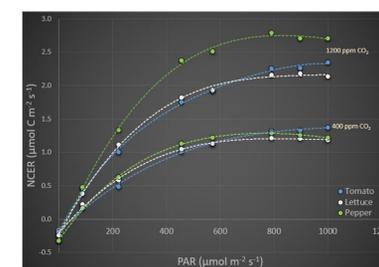
## Results



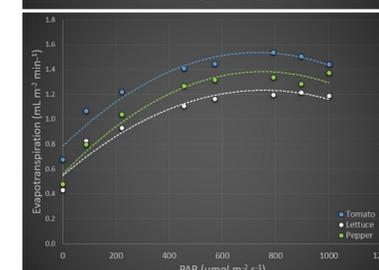
Plant photosynthetic response to red and blue light ratios. In these three species, higher red equals higher productivity.



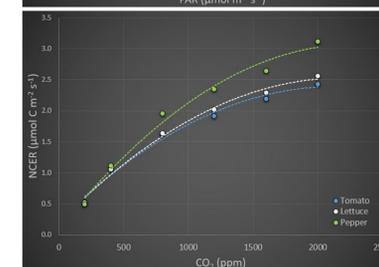
Plant photosynthetic response to blue, green, red and white light. Lettuce performed poorly with green and white, while pepper and tomato had very high green light responses.



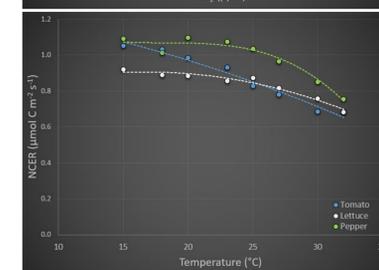
NCER: changes in net photosynthesis in response to increasing irradiance. Light curves help identify the optimal light intensity for growth. Tomato and pepper can use higher levels of light than lettuce.



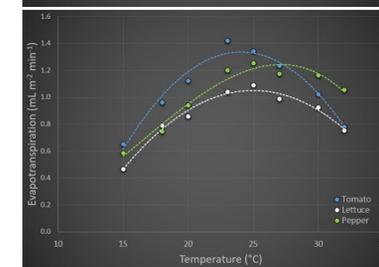
Evapotranspiration: change in the rate of ET (water loss) in response to increasing irradiance. Higher light = increased photosynthesis = increased water use.



NCER: changes in net photosynthesis in response to increasing concentrations of ambient carbon dioxide. As long as light is not limiting, more carbon dioxide = faster growing plants.



NCER: changes in net photosynthesis in response to increasing temperature. Temperature response to NCER along with ET can help identify drought tolerant plants.



Evapotranspiration: changes in the rate of ET (water loss) in response to increasing temperature. When temperatures are too high, stomates are closed, ET is reduced – but so is photosynthesis.

## Next Steps

- Examine relationships among environment variables in terms of plant responses
- Develop environment control recipes that reliably achieve predictable results in secondary metabolites such as taste and medicinal compounds
- Design more economic technical solutions for controlled environment systems