



PROJECT CARBON

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Leadership in Energy and Environmental Design



- LEED promotes a whole-building approach to sustainability in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality.
- LEED currently lacks an agricultural connection to indoor plants and their role in promoting human health by improving indoor air quality (IAQ)



We hope to be able to address the question:

If an interiorscape of certain size and plant species is implemented under typical light levels, how much carbon would be removed from the air over given period?

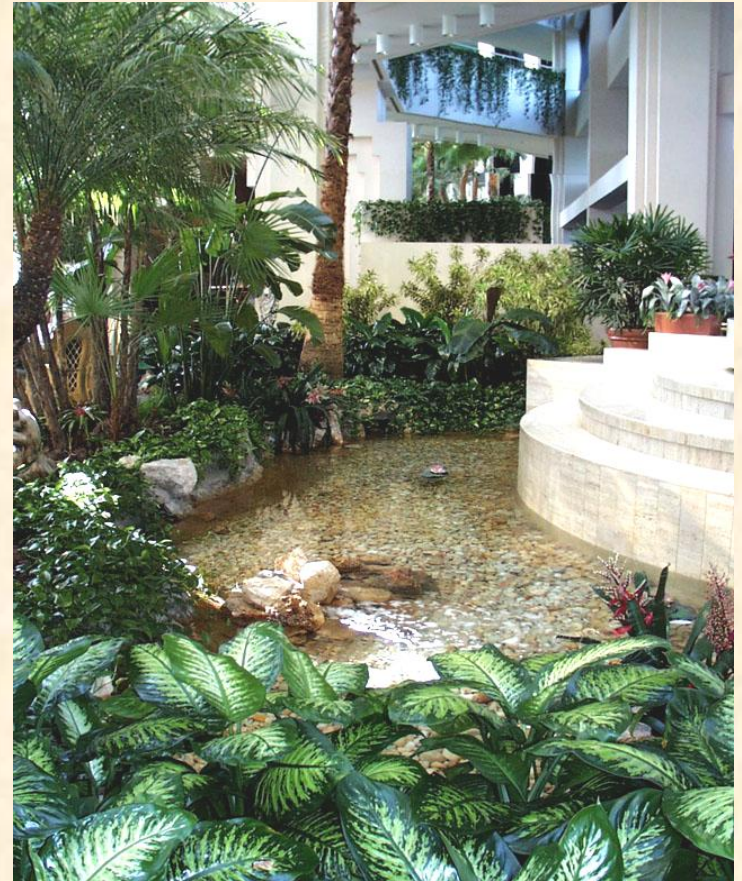


Ultimately, this research seeks to provide supporting data to substantiate the argument for using indoor plants as part of sustainable certification programs

OBJECTIVES

A two-pronged research protocol:

- 1) a methodical assessment of photosynthetic rates of interiorscape plants *in situ*;
- 2) a quantification of carbon assimilation under simulated environment similar to the light levels and temperatures of typical indoor environments.



Simulated Environment:

- In the growth chamber, plants are grown under 12-hour photoperiod and 21 °C day/18 °C for 10 weeks. They are irrigated weekly and fertilized biweekly (75 ppm N, 24N ~ 8P ~16K).



Simulated Environment:

- Plants are grown under three light levels: **low**, **medium**, or **high** (approx. 10, 20, or 30 $\mu\text{mol}/\text{m}^2/\text{s}$ respectively, or **70**, **140**, or **210** foot -candles).
- Artificial light source in the growth chamber are metal halide and high pressure sodium lamps.
- Light measurements are made with LI-COR (LI-250A) Quantum sensor, responsive to radiation in the PAR range of the spectrum.



Species grown:

1 Ficus benjamina
Pothos
Philodendron

2 Sansevieria
Aglaonema
Spathiphyllum

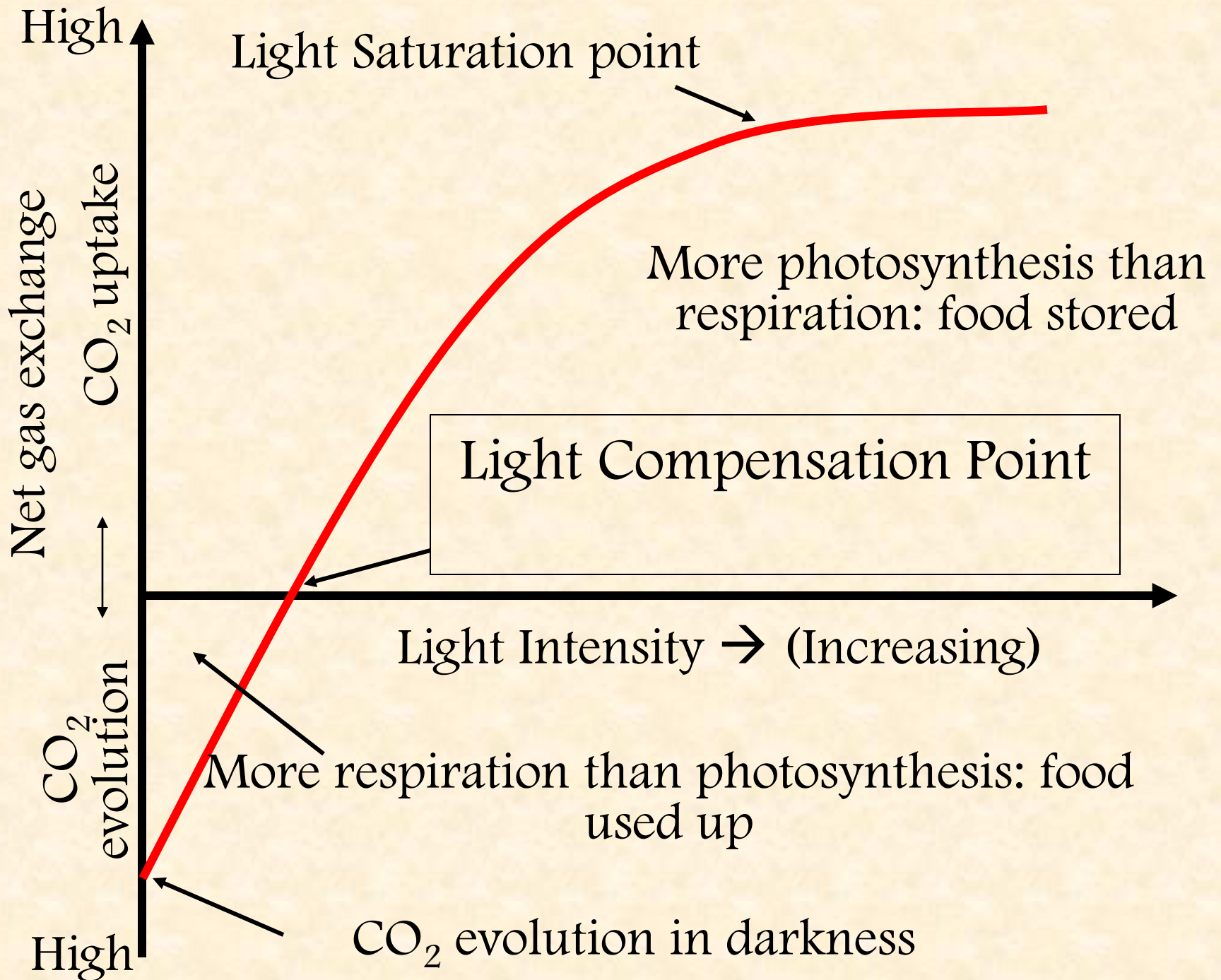
3 Ficus benjamina*
Hedera helix
Ctenanthe



4 Dracaena surculosa
D. Lemon Lime
Spathiphyllum*

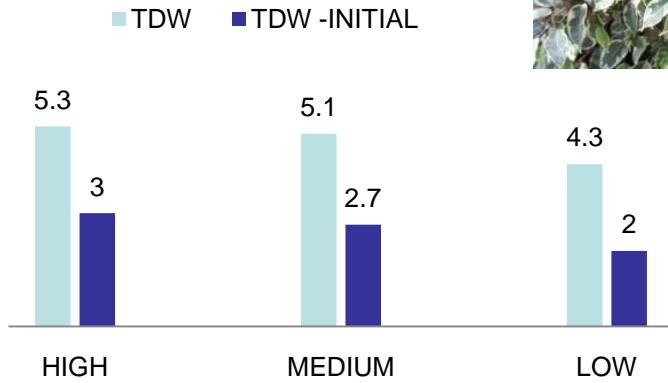
5 D. Janet Craig
Pachira
D. marginata

6 Sansevieria 'Hahnni'
Schefflera
Neanthe Bella Palm

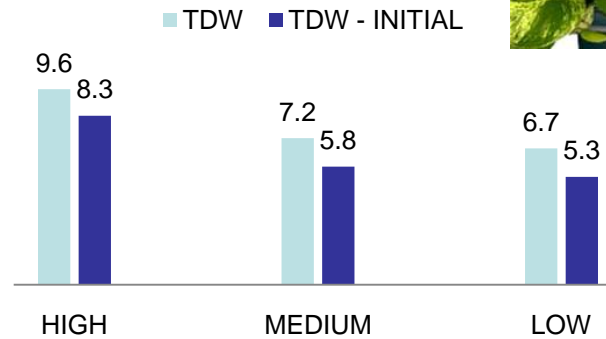


Plant Dry Weight (g) (shoot + root)

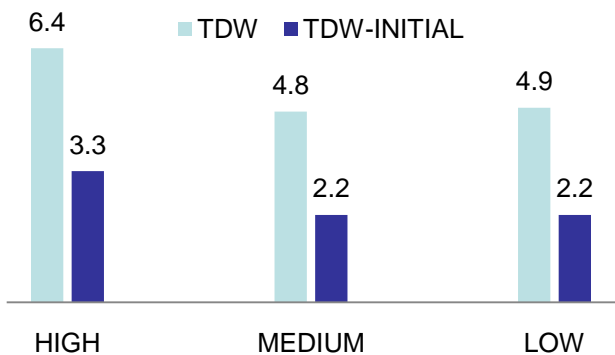
Ficus benjamina



Pothos



Philodendron



Carbon Content per Species (Percent of Dry Biomass)

Species	% Carbon
Ficus benjamina	42.95
Philodendron	40.22
Aglaonema	39.98
Spathiphyllum	38.79
Sanseveria	38.69
Pothos	38.24

*Tissue analysis
complements of
Jonathan Frantz,
USDA*

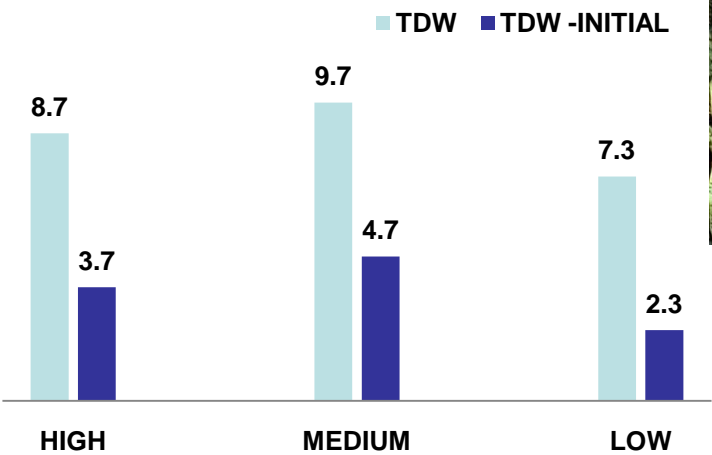
Total amount of carbon removed (fixed) from a certain size of space

[720 ft³ (7' W x 9' L x 10' H)]

Species	Grams Carbon Fixed			Grams Carbon Fixed/ Species
	High Light	Medium Light	Low Light	
Weeping Fig	14.4 (1.2gx12 plants)	13 (1.1gx12)	9.6 (0.8gx12)	37
Pothos	39.6 (3.3gx12)	27.6 (2.3gx12)	25.2 (2.1gx12)	92.4
Philodendron	15.8 (1.3gx12)	10.6 (0.9gx12)	10.6 (0.9gx12)	36.9

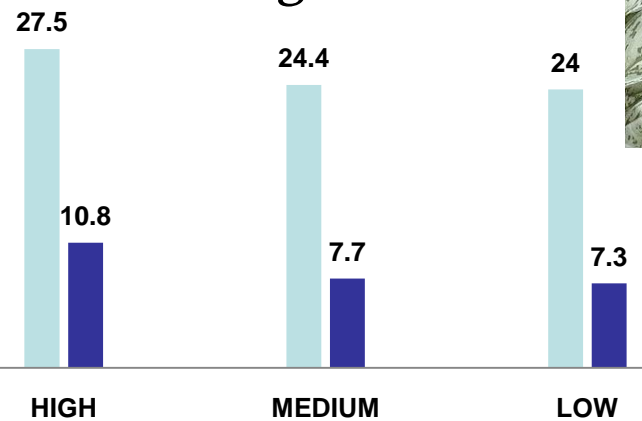
Grand Total 166.3 g

Sansevieria

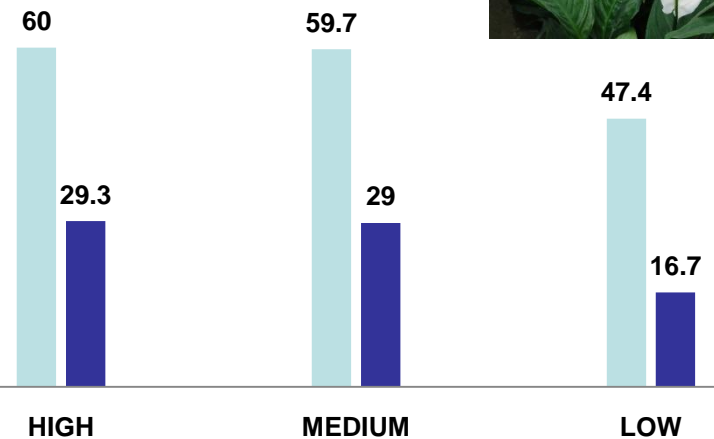


Plant Dry Weight (g) (shoot + root)

Aglaonema



Spathiphyllum



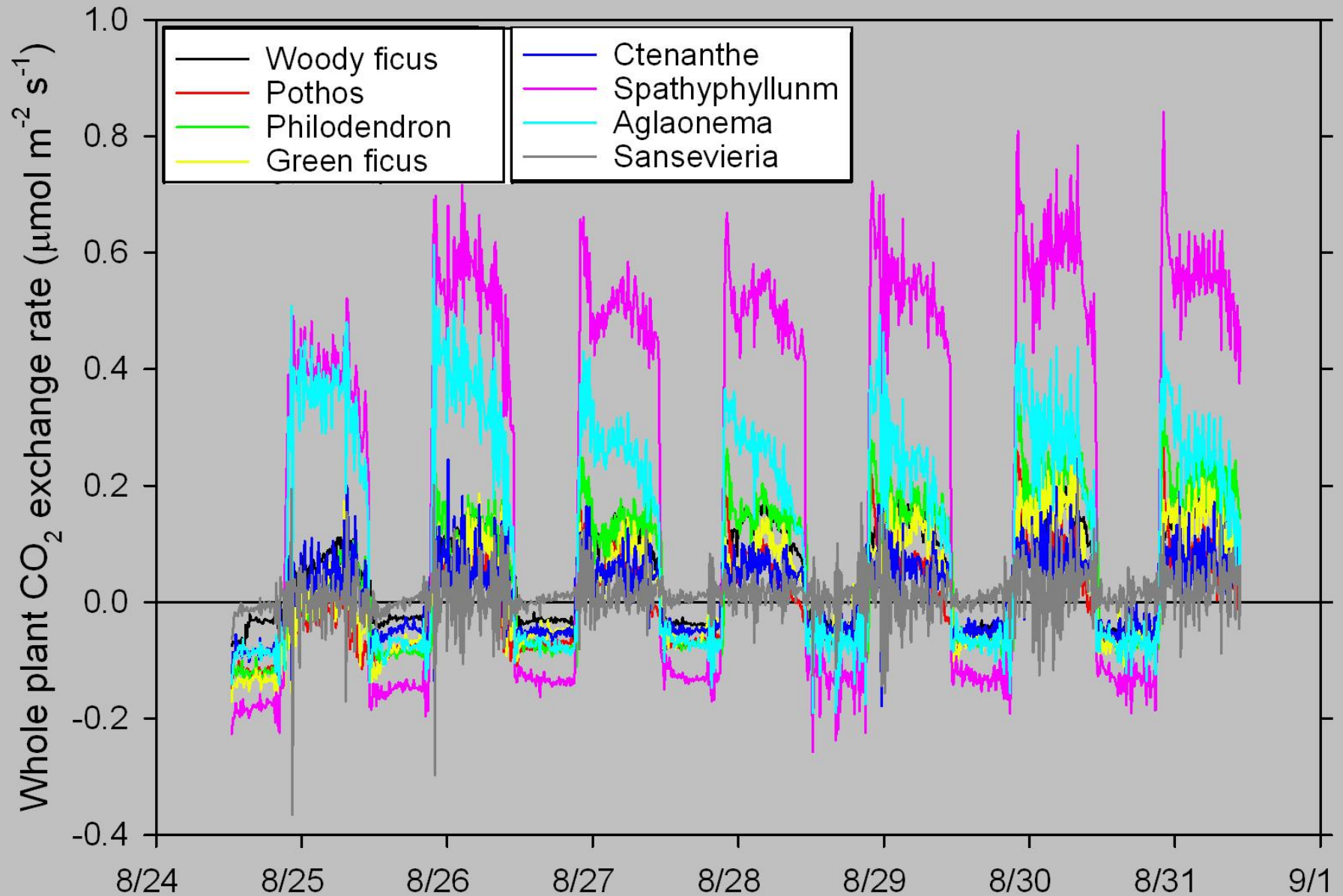
Total amount of carbon removed (fixed) from a certain size of space

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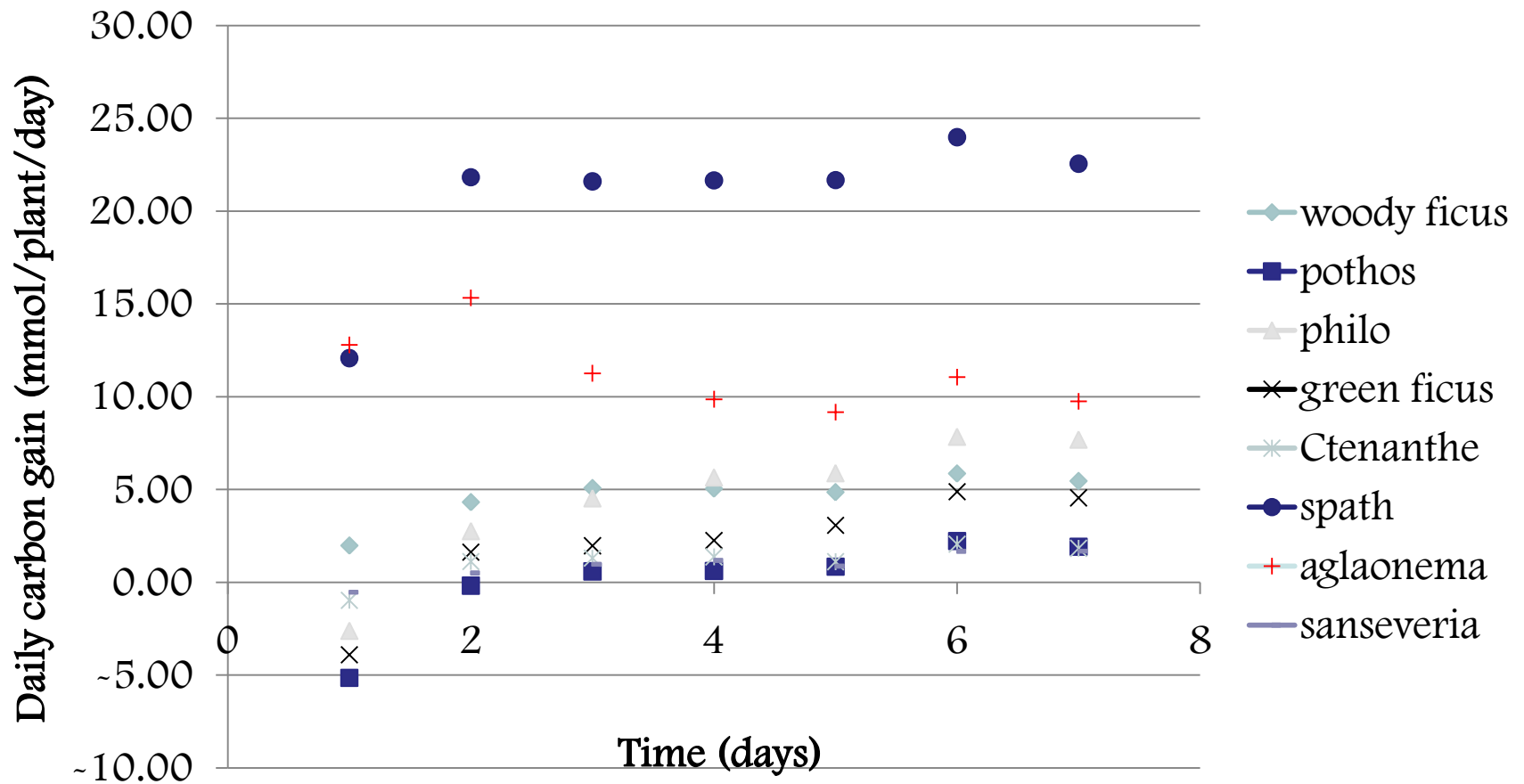
Species	Grams Carbon Fixed			Grams Carbon Fixed/ Species
	High Light	Medium Light	Low Light	
Sansevieria	17.8 (1.5gx12 plants)	22.6 (1.9gx12)	11.0 (0.9gx12)	51.4
Aglaonema	51.8 (4.3gx12)	37.0 (3.1gx12)	35.0 (2.9gx12)	123.9
Spathiphyllum	140.6 (11.7gx12)	139.2 (11.6gx12)	80.2 (6.7gx12)	360

Grand Total 535.3 g

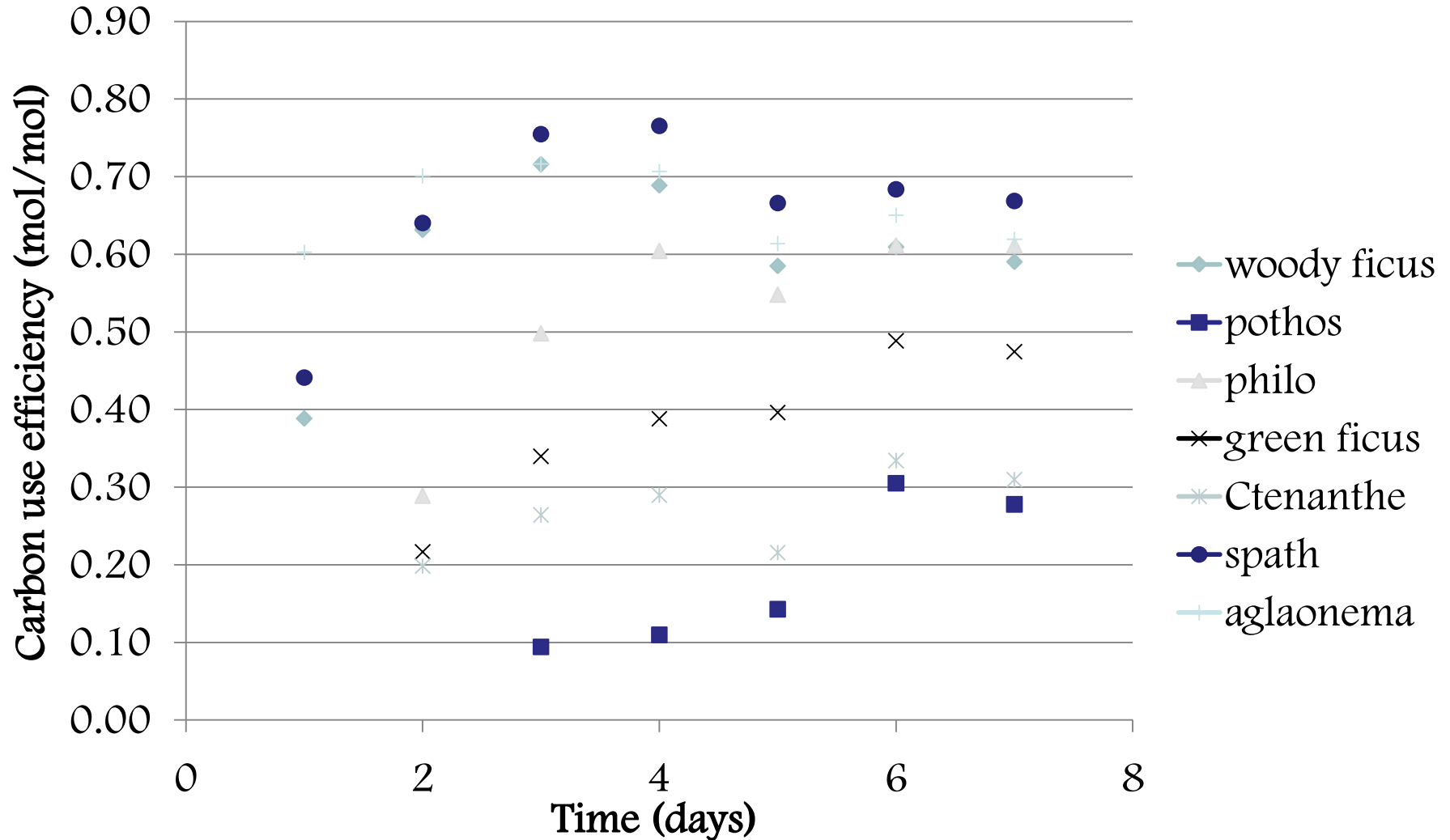
7-DAY WHOLE PLANT GAS EXCHANGE



Daily carbon gain: the net amount of carbon fixed by each plant in a 24-hour period



Carbon use efficiency: an estimate of the carbon incorporated into biomass



In situ Environment

A variety of species & sizes



Galleria 200, Atlanta GA
Foliage Design Systems

Section 1	Light level	
Species	$\mu\text{mol}/\text{m}^2/\text{s}$	Dry weight (g)
Ficus	35	33.57
Pothos	22	6.97
Podocarpus	40	19.67
Aglos	15	15.11
Section 2A		
Species		
Pothos		3.79
Aspidistra	3	3.73
Aglos	2	5.47
Aspidistra	2	6.12
Trachillia	5	18.08
Section 2B		
Species		
Pothos	2	0.8
Aglos	3	4.81
Aspidistra	3	4.24
.....		
Section 12		
Species		
Podocarpus	20	9.68
Pothos	18	5.4

total dry weight (g)
removed in one month 661.4
% carbon 265

Measurements of Photosynthesis In Situ



CONCLUSIONS

Under simulated conditions:

After 10 weeks of growth under three light levels,
216 4-inch plants of
Ficus benjamina, Pothos, Philodendron,
Sansevieria, Aglaonema, and Spathiphyllum,
fixed a total of
700 grams of carbon.

CONCLUSIONS:

In addition, since plants absorb carbon dioxide as a molecule, one might argue that what should be reported as a positive impact on the environment is the *carbon dioxide* removal, and not just carbon.

The weight of elemental Carbon is 12, while the weight of CO₂ is 44. Thus more than three times the amount of CO₂ is removed as just Carbon.

People vs. Plants...

Amount of carbon exhaled by a single human in one day:

18 mol Carbon/day or 216 g Carbon/day



Thank You:
GPGGB
NFF

