**Novel Red, Green, Blue LED Light Source and Whole Plant Chamber Make Photosynthetic Assessment of Small Plants Possible**

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**INTRODUCTION**

- Difficulty measuring photosynthesis on small, low-stature plants is overcome in the 6400-17 Whole Plant Arabidopsis (WPA) Chamber.
- The 6400-18 RGB (red, green, blue) Light Source, in conjunction with this novel chamber, facilitates rapid assessments of photosynthetic capacity.
- Independently controlled red, green and blue LEDs in the RGB Light Source can be used to measure photosynthetic efficiency at different wavebands and intensities.
- Various blocking techniques used to isolate above ground carbon fluxes in the WPA Chamber are demonstrated.
- Photosynthetic response of wild-type Arabidopsis thaliana (Col-0) and soybean (Glycine max cv. U98-311442) to light intensity at different wavebands are presented.

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**LIGHT SOURCE AND CHAMBER DESIGN**

- The 6400-18 RGB Light Source illuminates a 7 cm diameter area with a spatial uniformity of at least 90% of the area.
- Intensities of white light can be achieved from 0 to 2000 mmol m\(^{-2}\) s\(^{-1}\) by providing equal quanta of red, green, and blue light.
- Independently controlled red, green and blue wavelength peaks at 460, 522 and 635 ± 5 nm, respectively LEDs allow for color selection (Figure 1).
- The 6400-17 WPA Chamber encloses entire plants in a 7 cm diameter chamber (Figure 2).
- The chamber bottom seals to the growth container, either 38 mm Cone-tainers \(^*\) or 65 mm round pots, with either an o-ring or flange seal.

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**Table 1.** Pottery clay formed an effective cap to block CO\(_2\) flux from the soil. The pottery clay cap consisted of a 3 – 5 mm thick layer of clay with a 4 mm hole in the center for a plant to grow through. The soil was then covered with 3 – 5 mm thick potter clay decreased CO\(_2\) flux into the chamber by 99.8% (Table 1).

**Table 2.** The weighted absorbition (aw) for the wavebands for the three LED types showed slight variance for Arabidopsis and soybean.

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**Figure 1.** The RGB Light Source has independently driven red, green and blue LEDs that provide illumination singly and in concert. By varying the output from each type of LED, different colors of light can be produced, allowing exploration of plant response to light quality.

**Figure 2.** The RGB Light Source and WPA Chamber interface with the LI-6400XT Portable Photosynthesis System. Plant and container are sealed inside the WPA with an o-ring or flange to facilitate rapid assessment of individual plants. The top of the WPA seals to the chamber bottom with an o-ring or flange seal.

**Figure 3.** The exhaust path of the Whole Plant Arabidopsis chamber is shown with the optional Adjustable Exhaust Valve Assembly installed. A. An unrestricted exhaust path allows CO\(_2\) to flow freely into the chamber from the roots, soil and outside the container. B. Influx was decreased by restricting the needle valve 25 – 50 %, diverting 100 – 150 mmol s\(^{-1}\) off through the soil and out a small vent hole (<0.5 mm) in the container. This caused a small overpressure in the chamber of about 0.15 kPa, which is slightly higher than the normal chamber overpressure of about 0.02 kPa. Measuring the sample and reference IRGAs in the LI-640XT removed the effect of the overpressure on the CO\(_2\) concentration measurement.

**Figure 4.** Photoregulatory response of Arabidopsis rosettes to different wavebands of light were similar despite differences in absorbance. Photosynthetic response to increasing light was measured in the WPA Chamber with the RGB Light Source. To isolate above ground fluxes in the WPA Chamber resulted in measurement errors. Errors due to self-shading (data not shown).

**Figure 5.** Maximum light absorbion by Arabidopsis and soybean leaves is near the peak wavelengths of the red and blue LEDs in the RGB Light Source. The brighter output spectrum of the green LED typically for the similar photosynthetic responses, despite differences in absorbance. Arabidopsis and soybean leaf absorption spectra were measured from 400 to 700 nm using a spectroradiometer (LI-1880) with integrating sphere.

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**CONCLUSIONS**

- The WPA Chamber and RGB Light Source make possible photosynthetic measurements of small or low stature plants.
- The RGB Light Source has independently controllable red, green and blue LEDs which facilitates the exploration of photosynthetic response to light quality.
- Differences in absorbance, whole plant and leaf photosynthetic response at different wavebands were similar in Arabidopsis.
- Soybean showed slight variation in absorbance across the photosynthetic region of the spectrum and as a result had similar response to light in different wavebands.