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The Lighting Intensity of New Brunswick™ Innova® 42R Incubator Shaker Photosynthetic Light Bank

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Introduction

The New Brunswick Innova 42R Incubator Shaker can be purchased with an optional photosynthetic light bank that can be installed at different heights to provide varying intensities. The Innova 42R photosynthetic light bank is equipped with six Sylvania® Gro-Lux® T8 bulbs. Each T8 bulb is 15 Watts at 325 lumens with an average lifespan of 7500 hours. While lumens on a bulb spec sheet indicate the total amount of light emitted by the light bulb, not all of the light emitted can be used for photosynthesis. The amount of light available for photosynthesis is termed photosynthetic active radiation (PAR), it represents the amount of light available between 400 to 700 nm and can be defined in terms of energy units as (W/m^2). However, lumen and PAR typically represent the property of the emission source (light bulb), not the actual amount of light measured at a given distance. The light intensity measured at a given distance is typically reported in the standard unit of illuminance (LUX, lm/m^2) and the light intensity at a given distance within PAR range is reported as photosynthetic photon flux density (PPFD, µmol photons/m^2s).

The purpose of this short protocol is to measure, record, and report LUX readings received from two different height settings of the photosynthetic light bank. The measurements will be taken at nine different locations on the shaker platform to mimic nine 1 L flask cultures. The PPFD values will also be reported.

Materials and Methods

Required equipment and accessories

> New Brunswick Innova 42R Incubator Shaker with photosynthetic light bank, factory installed
> 6 x T8 fluorescent bulbs 15 watt each (Sylvania Gro-Lux)
> Hand-held Spectrometer with SD card (MK350, UPRtek Corp.)
> Digital Light Meter (EA30 EasyView™, Extech Instruments)

Method

Photosynthetic light bank light intensities will be taken from nine points on the Innova 42R platform (18 in x 18 in) in replicates of six. The intensities will be taken from approximately 16 in (40.6 cm) and 12 in (30.5 cm) from the light source.

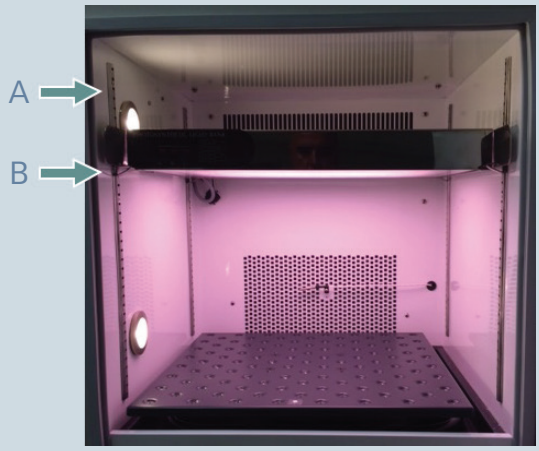


Figure 1: Image of the Innova 42R chamber highlighting the adjustable photosynthetic light bank with the heights marked for this protocol:
A: 16 in above the platform
B: 12 in above the platform

The light spectrum emitted by the photosynthetic light bank will be recorded using the MK350 spectrometer. This spectrum may be used for the calculation of results.

Measurements of the light intensities will be taken with the Extech EA30 EasyView Digital Light Meter and reported in LUX initially. A table will be developed to convert lux measurements into PPFD. The conversion from LUX to PPFD will be made using the conversion factor published by Sylvania for the Gro-Lux light bulbs [1].

The Innova 42R photosynthetic light bank has a function of turning selected lights on and off, only the full light intensity (A, B, and C on) will be measured in this protocol. Each switch controls two bulbs and the resulting PPFD is proportionate to the number of bulbs being used.

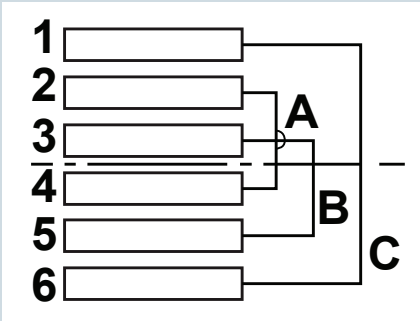
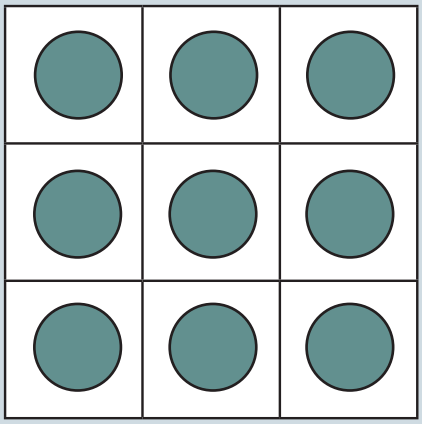


Figure 2: Diagram of the light control pattern

Instructions

> Install the Innova 42R photosynthetic light bank toward the top of the chamber and measure the distance to the platform (~16 in)
> Using the UPRtek MK350 Light Meter, take a spectral reading and report
> Install nine 1 L clamps onto the Innova 42R platform being used for this experiment and place the sensor from the Extech EA30 Digital Light Meter in the middle of the clamp; once the sensor is in place, remove the cap, record six readings, and then replace the cap
> Move the sensor to the next location and repeat the process until readings from all nine positions have been completed
> Move the clips to lower the position of the Innova 42R photosynthetic light bank to ~12 in from the platform and repeat the measurement process described above for each of the nine positions



Back Left	Back Center	Back Right
Center Left	Center	Center Right
Front Left	Front Center	Front Right

Figure 3: Diagrams of the locations on the platform for the measurement of light intensities

Results and Discussion

The graphical representation of the spectrum emitted from the Innova 42R photosynthetic light bank is reported in Figure 4.

The conversion of lux readings into PPFD is dependent upon the light source emission spectrum. Conversion factors are typically determined by the light bulb manufacturers; for this protocol we used the conversion factor of 0.029 which has been determined by the manufacturer of the Gro-Lux bulbs [1].

The spectrum analysis shown in Figure 4 clearly indicates that the light bulbs installed in the Innova 42R photosynthetic light bank were designed for photosynthetic applications as the majority of light emitted is within PAR range (400 – 700 nm). Less light emitted outside of the PAR range indicates high energy efficiency, as there is very little wasted energy in terms of unusable light emission outside of the photosynthesis range.

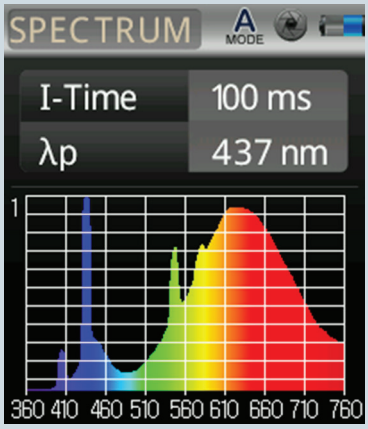


Figure 4: Spectral analysis of the installed photosynthetic light bank in the Innova 42R Incubator Shaker

A

2400	2650	2390
2890	2990	2810
2650	2810	2610

B

70	77	69
84	87	82
77	82	76

Figure 5:
A: Average light intensities in lux at 16 in distance from the platform
B: PPFD values based on the manufacturer's conversion factor

A

3200	3480	3200
3320	4180	3320
3200	3630	3200

B

93	101	93
96	121	96
93	105	93

Figure 6:
A: Average light intensities in lux at 12 in distance from the platform
B: PPFD values based on the manufacturer's conversion factor

Ordering information

Description	Order no. International	Order no. North America
New Brunswick™ Innova® 42R 1.9 cm (3/4 in)	M1335-0006	M1335-0000
New Brunswick™ Innova® 42R 2.54 cm (1 in)	M1335-0016	M1335-0014
Photosynthetic light bank, programmable Innova® 42R only	M1335-0300	M1335-0300

Literature

[1] Osram Sylvania, Frequently asked questions, Specialty Applications; (How can I evaluate the effect of different light sources on plant growth?). 2005; www.sylvania.com
[2] Encyclopedia Britannica, lux. 2015; http://www.britannica.com/EBchecked/topic/352255/lux
[3] Nick Klase, About PAR. 2015; http://www.bmlhorticulture.com/about-par/
[4] University of Guelph, Solar radiation and irradiance, 2008; https://www.uoguelph.ca/plant/courses/pbio-3110/lectures/lec05_08_000.pdf

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