**Question and Comment log from Plant Biology 2020 session: "<u>Blue, Red, Green, and Far-red: Making Sense of Light Quality and Plant Growth"</u>**

**Speakers: Patrick Friesen, Romina Sellaro, Shuyang Zhen, and Marc van Iersel**

*Added more response after session aired

**<u>Comment #1:</u>**
Patrick Friesen: Light quality is measured with a spectroradiometer or spectrometer. Light intensity (PPFD) is measured with a quantum sensor.

**<u>Question #1:</u>**
Tina Agarwal: when you say cool white T5 LED then can we use those for cold treatments? What is "Cool" mean here?

Patrick Friesen: Tina, cool refers to the colour temperature, higher (5000K) is cooler, than 3500K which is warmer.

Tina Agarwal: Thanks Patrick!

**<u>Question #2:</u>**
Fedor Kuzminov: Are you developing any tunable lights (so we can adjust the spectrum at will)?

Patrick Friesen: Yes, we also offer other options with more spectral control, please contact me directly about this.

**<u>Comment #2:</u>**
Galileo Araguirang: Green light doesn't inactivates cryptochromes! One of the redox forms of FAD which is a cofactor of cry absorbs green light :)

Romina Sellaro: The FAD− form of flavin (biologically active cryptochrome) absorb green light, causing it to be converted to the reduced state FADH−. This reduction is consider to returns the cryptochrome to a biologically inactive state. In addition, cryptochromes have been proposed to act as reversible blue/green photoreceptors.

**<u>Question #3:</u>**
Tina Agarwal: How do we contact you for other spectrums? Great question Fedor!

Patrick Friesen: patrick.friesen@biochambers.com

**Question #4:**
Paulo: Patrick is there a rational/logical protocol for determining the right light for a plant that you do not know too much about light quality demand?

Patrick Friesen: Great question. Look to the literature, but if its a relatively obscure plant, a broader spectrum is generally safer for "normal" plant growth.

**Question #5:**
David Horvath: How close does a plant have to be to another plant for them to "see" each other? I know that under field conditions, weeds can impact crop growth even without direct shading.

Romina Sellaro: Plants can sense small changes in light conditions such as the reflection of far-red light by nearby vegetation, which slightly reduces the red/far-red ratio before being shading among neighbors. The distance depends on the structure of the canopy that is nearby, it can be meters.

**Comment #3:**
Jerry Cohen: Modern chambers make it pretty easy to conduct light quality experiments with a new species. We use chambers with Heliospecta programmable lighting.

**Question #6:**
Hongtao Zhang: @Romina My guess about the main reason of the diurnal changes in Red/Far-red ratio in the field is that plants absorb red light differently during the day, is that correct? If so, what controls the diurnal light usage patterns in plants?

Romina Sellaro: The diurnal changes in the red / far red ratio in the field are mainly due to changes in the angle of inclination of the light due to the movement of the sun, so the atmosphere changes the radiation that reaches the earth at different times of the day. And It also changes the angle of incidence of the light on the leaves and that contributes to changing the proportion of the reflected light.

**Question #7:**
Ying Guo: Shuyang: What is the effect of far-red you applied on temperature?

Shuyang Zhen: @Ying we maintained chamber air temperature constant at 25 C. But, we did not measure leaf/canopy temperature.

Ying Guo: Shuyang: Thanks for your answer. I am just curious if the temperature will be impacted after applying far-red light

Shuyang Zhen: @Ying with far-red substitution, leaf temperature may drop a bit compared to that under same PPFD of 400-700 nm photons, because far-red photons are lower energy and more poorly absorbed.

Ying Guo: Thanks!@shuyang

Marc van Iersel: Far red is not likely to affect leaf temperature much. It is not absorbed very well and the photons have low energy.

**Question #8:**

Demissew Teshome: Anyone who could suggest how to convert light measurement (in my case using StellarNet sensor) into PAR or PPFD, please?

Marc van Iersel: What units do you get from the StellarNet sensor?

Demissew Teshome: I think it's watts/m2 for every wavelength 226.00  5.4385E+002 … something like this for every wavelength

Marc van Iersel: There are standard equations to convert energy to photons as a function of wavelength. Please see https://en.wikipedia.org/wiki/Photon_energy. It should be simple to set up a spreadsheet to do those conversions.

Patrick Friesen: Here is a link to a calculator where you can convert your watts $m^{-2}$ $s^{-1}$ data to micro mol photons $m^{-2}$ $s^{-1}$ at each wavelength (to get PPFD):

https://www.apogeeinstruments.com/content/PPFD-to-Illuminance-Calculator.xls

**Question #9:**

Javier Moreno: @Shuyang: are filtering out red photons from FR-LED lights? how do you rule out that the improving effect in photosynthesis is due to FR photons and not the residual R photons of those FR-LEDs?

Shuyang Zhen: The far-red LEDs contained a very small tail of red photons. We did not filter those photons out, but the increase in red photons are way too small to explain the effect on photosynthesis.

Marc van Iersel: In addition, Shuyang plotted her data as a function of PPFD, as well as total photon flux. Those graphs show clearly that the effect cannot be caused by the small amount of PPFD provided by the far-red LEDs. In addition, Shuyang and I have shown that adding far-red light increases the quantum yield of photosystem II. That would not happen if the result were simply from additional PPFD, since that would decrease the quantum yield.

**Question #10:**
Lyudmila Sidorenko: Question for Marc, why plants look green?

Marc van Iersel: Plant are green because they reflect slightly more light than other colors. That same property allows green light to penetrate leaves more deeply.

Two nice papers on this topic:

Ichiro Terashima, Takashi Fujita, Takeshi Inoue, Wah Soon Chow, Riichi Oguchi, Green Light Drives Leaf Photosynthesis More Efficiently than Red Light in Strong White Light: Revisiting the Enigmatic Question of Why Leaves are Green, *Plant and Cell Physiology*, Volume 50, Issue 4, April 2009, Pages 684–697, https://doi.org/10.1093/pcp/pcp034

Brodersen Craig R., Vogelmann Thomas C. (2010) Do changes in light direction affect absorption profiles in leaves? *Functional Plant Biology* **37**, 403-412. https://doi.org/10.1071/FP09262

From an evolutionary perspective, I suspect it is the plant's best interest to not absorb green light very effectively. If leaves absorb green light very well, that light would be largely absorbed by chlorophyll that already absorbs a lot of red and blue light as well. Lower absorptance of green allows that light to penetrate a leaf more deeply, allowing deeper cell layers to contribute more to overall leaf photosynthesis.