BioChambers
PROVIDING GROWTH TO RESEARCH.

FREQUENTLY ASKED QUESTIONS
with Dr. Patrick Friesen

FAQ QUESTION #5

How does photoperiod affect the growth and development of my plants?

Photoperiod can affect the amount of light your plants receive in a day (daily light integral, DLI, mol photons (400-700nm) m^{-2} day^{-1}), the entrainment of their circadian system, and the critical dark period required for flowering in photoperiodically sensitive plants (Imaizumi 2010, Lambers & Oliveira 2019, Runkle et al 2017). By either extending or shortening the photoperiod, you are either increasing or decreasing your DLI under a given light intensity (Photosynthetic Photon Flux Density, PPFD mol photons (400-700nm) m^{-2} day^{-1}, Figure 1).

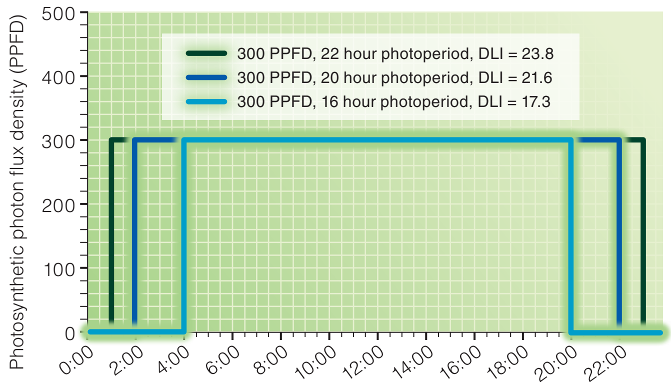

FIGURE 1
Three scenarios at the same light intensity (PPFD) of 300, showing how the daily light integral (DLI) can be changed through photoperiod adjustment.

If plants can acclimate to a given PPFD, then DLI, through photoperiod adjustment, is a robust predictor of plant growth. Higher DLIs increase growth and development compared to lower DLIs (Both et al 1997, Kelly et al 2020, Poorter et al 2019). Often there are limits to how much the photoperiod can be extended to stimulate growth; although some plants can tolerate 20-hour photoperiods, most plants become stressed under continuous light (Velez-Ramirez et al 2011). Light quality, PPFD, and photoperiod interact to push the limits of growth or become stressful, and are affected by nutrition, temperature, humidity, and CO_2 concentration (Poorter et al 2019, Roeber et al 2020). In lettuce (*Lactuca sativa* L.) and several other plant species, growth under lower PPFD and longer photoperiods is greater than higher PPFD and shorter photoperiods under equivalent DLI (Kelly et al 2020, Figure 2).

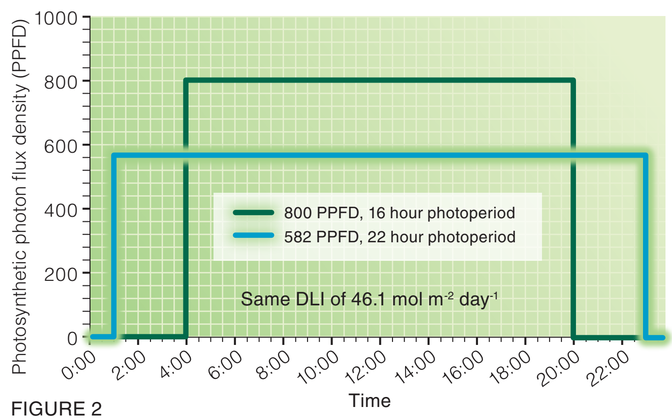

FIGURE 2
Two different light intensity (PPFD) and photoperiod scenarios resulting in the same daily light integral (DLI).

Photoperiod can also act as a cue to transition from vegetative to reproductive growth. Short-day plants take their flowering cue from the shortening photoperiod, as darkness lengthens to a given critical period. Long-day plants take their flowering cue from the lengthening photoperiod, as darkness shortens to a given critical period (Thomas & Vince-Prue 1997a). Because promotion of flowering requires uninterrupted critical periods of darkness, night interruption lighting can create short nights to inhibit flowering in short-day plants and promote flowering in long-day plants (Meng & Runkle 2016). For day-neutral plants, growth and developmental stage are often the cues to initiate flowering, and here a greater DLI may shorten the time to flower from the growth stimulus and hastened development (Mattson & Erwin 2005).

Photoperiod entrains the circadian system, allowing plants to align their metabolism and growth to the day length; anticipating when the lights will turn on, how long they will be on, and when they will turn off (Imaizumi 2010, McClung 2006). Even plants that evolved at tropical latitudes can sense and use the subtle changes in day length to help guide growth and development (Thomas & Vince-Prue 1997b). In nature, even at high latitudes, day-to-day changes in the photoperiod during the growing season are on the scale of minutes. In growth chambers, you have complete control over the photoperiod. Photoperiod control can help induce flowering when desired, however caution is required for long-day plants. Suddenly extending photoperiods can result in photoperiod stress, a response shown in plants suddenly exposed to much longer (hours) photoperiods when initially grown under shorter photoperiods, and somewhat independent of PPFD effects (Nitschke et al 2016, Nitschke et al 2017). To induce flowering safely in long-day plants it may be best to increase the photoperiod by shorter increments, using changes in day length plants experience at their natural growth latitudes during the transition to flowering as a guide.

Make sure your scheduling software can meet your application requirements. BioChambers scheduling software has virtually limitless possibilities to program multi-day changing photoperiods and/or night interruption lighting over a 24-hour period.

Some growth rooms can achieve clear sky sun like PPFD. When combined with our scheduling software, these high-light growth rooms can mimic not only clear sky DLIs, but also match PPFD over most of the day (Figure 3).

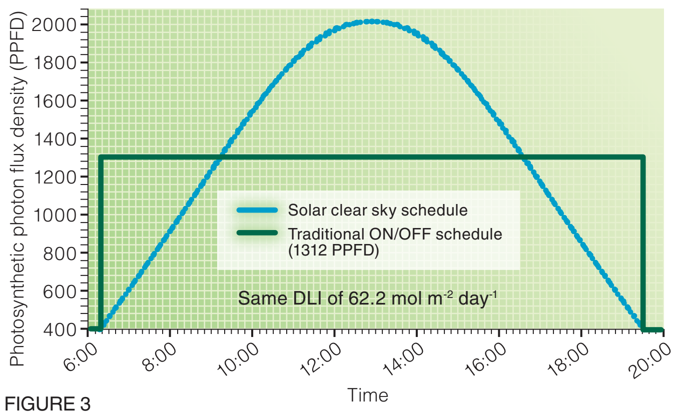

FIGURE 3

Re-creation of sunlight on a clear day vs a traditional ON/OFF schedule inside two identical BioChambers TPRB-111 walk-in growth rooms. Both rooms had the same 13 hour 10 minute photoperiod. Photosynthetic Photon Flux Density (PPFD, μmol photons (400-700nm) m^{-2} s^{-1}) was measured at 2m from the lighting system every 5 seconds for the blue circles, which are measured PPFD modeled from clear sky measurements taken from Varella et al., (2011). Green line = measured PPFD from an ON/OFF light intensity set-point that matched the DLI of the solar schedule.

Here is an article outlining the DLI requirements of several commercial plant species:

https://gpnmag.com/article/dli-requirements/

Other lighting resources:

https://www.apogeeinstruments.com/videos-and-tutorials/

https://www.canr.msu.edu/floriculture/uploads/files/sole-source-lighting.pdf

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