BY ERIK RUNKLE

How Much Supplemental Lighting Do You Need?

From October to March, the daily light integral (DLI) can be a limiting factor in the production of greenhouse crops, particularly in the northern half of the U.S. and in Canada. Because the DLI is an accumulated value (the quantity of light delivered per square meter each day), the only way to increase it is to deliver a high intensity of light from electric fixtures for extended periods of time, typically up to 18 to 20 hours per day. This delivery of supplemental light is used to accelerate rooting of seedlings and cuttings, increase yield of fruiting crops, as well as increase plant quality attributes such as branching, stem thickness, leaf color and flower number.

Several factors need to be considered when choosing a supplemental lighting system, and arguably the most important one is to determine what light intensity you want to deliver. This article provides steps on how to do that.

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Step 1: Determine what the solar DLI is inside your greenhouse from fall through spring. Many modern greenhouse environmental control systems measure this value, although sometimes this is measured outside, not inside. If it is measured outside, then estimate the transmission percentage indoors by measuring light intensity on a sunny day outdoors, then immediately indoors, and calculate the percentage difference. Many commercial greenhouses have a light transmission of 60 to 70%. The DLI value should be reported in mol·m^{-2}·d^{-1}, or moles per day. If it is reported in a different way, work with your climate control company, a lighting professional, or a university extension educator to convert values into moles per day. Alternatively, the DLI can be estimated by following steps in this article: https://bit.ly/2r3yhWu.

Step 2: Determine your target minimum DLI. This is highly situational and especially depends on the crop. Suggested minimum DLI values for a wide range of greenhouse crops can be found in this article: https://bit.ly/2C4LvnX.

Step 3: Determine the difference between your target DLI and solar DLI when those crops are grown. For example, if the average solar DLI in your greenhouse in January is 4.4 moles/day, and if your target DLI is 10 moles/day, then your objective is to deliver supplemental lighting that delivers 5.6 moles/day.

Step 4: Once you know by how much you want to increase the DLI, determine over what time period (hours per day) you can accomplish that. There can be barriers to the number of lighting hours each day, such as if the crop(s) has a photoperiodic response, or if you have peak electricity rate periods that you want to avoid. In addition, consider how many hours each day you typically have direct sunlight from mid-morning to mid-afternoon. The utility of supplemental lighting is diminished when it is sunny outside, so you probably don't want to plan to operate the fixtures then.

LIGHT INTENSITY	HOURS OF LIGHTING PER DAY						
	8	10	12	14	16	18	20
50	1.44	1.80	2.16	2.52	2.88	3.24	3.60
70	2.02	2.52	3.02	3.53	4.03	4.54	5.04
90	2.59	3.24	3.89	4.54	5.18	5.83	6.48
110	3.17	3.96	4.75	5.54	6.34	7.13	7.92
130	3.74	4.68	5.62	6.55	7.49	8.42	9.36
150	4.32	5.40	6.48	7.56	8.64	9.72	10.80
170	4.90	6.12	7.34	8.57	9.79	11.02	12.24
190	5.47	6.84	8.21	9.58	10.94	12.31	13.68
210	6.05	7.56	9.07	10.58	12.10	13.61	15.12

Table 1. The daily light integral delivered by electric lighting depends on the instantaneous light intensity (in µmol·m^{-2}·s^{-1}) delivered at crop height and duration used each day. The values in the table are in mol·m^{-2}·d^{-1}, or moles/day.

Let's look at a few examples. If you can deliver long days to your crops, you can light them for 18 hours per day and sometimes even longer. If you don't have peak charge rates for electricity, and on an "average" day in January you receive two hours of direct sunlight (from mid-morning to mid-afternoon), then you can plan to deliver lighting for 16 hours per day. However, if you are growing a crop that needs to remain under short days, such as 12 hours per day, and if on average you receive four hours of mid-day sunlight, then you should plan to light for only eight hours per day.

Step 5: Use Table 1 to determine the light intensity needed from electric lamps to deliver your desired DLI considering how many hours you can light each day. Using the examples above and Table 1, if you want to deliver 5.6 moles/day from electric lamps and can light for an average of 16 hours per day, then your objective should be to deliver a supplemental lighting intensity of around 100 µmol·m^{-2}·s^{-1}. If you want to deliver 5.6 moles/day but can only operate fixtures for an average of eight hours per day, then the installed supplemental lighting needs to be about twice that.

Supplemental lighting is expensive to install and operate, but it's one of the best methods to increase crop quality and yield. While you want to deliver enough light to reach your production objectives, you also don't want to install more than is necessary. For many growers of ornamentals, an installed lighting intensity is between 70 and 90 µmol·m^{-2}·s^{-1}, but it is twice that (or more) for fruiting vegetable crops such as tomato. Work with professional plant lighting companies to help you evaluate what type of lighting fixture (e.g., LED or high-pressure sodium) is most economical considering the intensity of supplemental lighting you want to deliver. gpn