e-GRO Edible Alert


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Managing Daily Light Integral to Improve Vegetable Transplant Quality

Optimizing light management is crucial for producing high-quality vegetable transplants in greenhouse environments.

As greenhouse growers gear up for the spring production season, managing light conditions becomes a critical factor in producing high-quality vegetable transplants. With varying natural light levels and the challenges posed by greenhouse structures, understanding and optimizing daily light integral (DLI) is essential for success. This e-GRO Alert focuses on the importance of DLI in vegetable transplant production, its impact on plant quality, and strategies for effective light management in greenhouse environments.

Figure 1. A greenhouse-grown tomato transplant that is robust and healthy. Photo by: W. Garrett Owen, OSU.

Understanding Daily Light Integral

Daily light integral (DLI) plays a vital role in the greenhouse production of seed-propagated vegetable transplants. Daily light integral is an integrated measurement of light intensity and photoperiod, representing the total amount of photosynthetically active radiation (PAR) received by plants over a 24-hour period, typically expressed in moles of photons per square meter per day ($mol \cdot m^{-2} \cdot d^{-1}$). Understanding and managing DLI is essential for greenhouse growers to produce robust, healthy transplants (Fig 1).

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Figure 2. Poor root growth and development often occurs under low daily light integrals as seen here in bell pepper transplants. Photo by: W. Garrett Owen, OSU.

Figure 3. Stretched and weak hypocotyls often occurs under low daily light integrals as seen here in jalapeño pepper transplants. Photo by: W. Garrett Owen, OSU.

Figure 4. Maintaining optimal daily light integrals results in compact growth with short and thick hypocotyls as seen here in bell pepper transplants. Photo by: W. Garrett Owen, OSU.

Figure 5. Maintaining optimal daily light integrals results in well developed root systems as seen here in bell pepper transplants. Photo by: W. Garrett Owen, OSU.

Impact of DLI on Transplant Quality

Low DLI conditions can significantly affect transplant quality and growth. During early spring months, ambient outdoor DLIs can range from 5 to 25 $mol·m^{-2}·d^{-1}$ for most of the United States. However, light transmission into the greenhouse can be reduced by 60% or more due to glazing material, infrastructure shading, overhead equipment, and hanging baskets. Under low DLIs, seedlings often experience uneven or delayed germination, increased production time, poor root growth (Fig. 2), stretched and weak hypocotyls (Fig. 3), and increased susceptibility to damage during handling and transplanting. Conversely, maintaining optimal DLI levels (10 to 15 $mol·m^{-2}·d^{-1}$) for vegetable transplant production offers several benefits, including reduced production time, compact growth with short and thick hypocotyls (Fig. 4), smaller leaves, well-developed root systems (Fig. 5), and increased overall vigor and stress tolerance. For greenhouse growers, achieving the right DLI is crucial for producing sturdy, well-developed transplants that can withstand the stresses of transplanting and establish quickly in the field, greenhouse, or home garden.

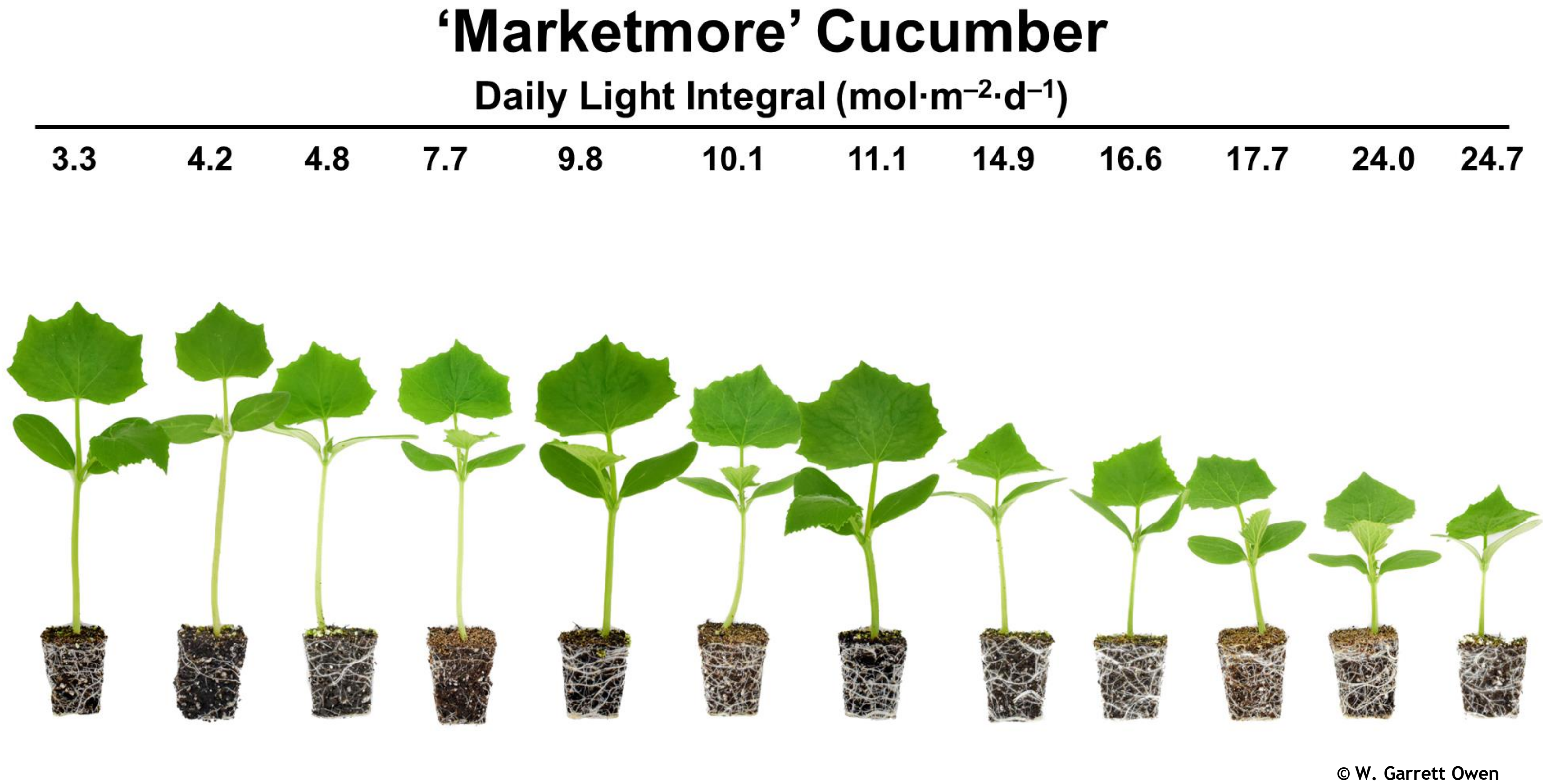

Figure 6. Depiction of ‘Marketmore’ cucumber transplants grown in 50-cell count trays under increasing daily light integrals ranging from 3.3 to 24.7 mol·m^{-2}·d^{-1}. Photos were taken 10 days after transfer to daily light integral treatments. Figure by: W. Garrett Owen, OSU.

Crop-Specific DLI Ranges for Vegetable Transplants

Understanding the optimal DLI ranges for specific vegetable crops is crucial for producing high-quality transplants. Different species have varying light requirements, which can significantly impact their growth and development. Here are the suggested DLI ranges for common vegetable transplants, grouped by DLI:

- Cucumber: 10-15 mol·m^{-2}·d^{-1} (Fig. 6)
- Squash: 10-15 mol·m^{-2}·d^{-1} (Fig. 7)
- Cabbage: 10-15 mol·m^{-2}·d^{-1} (Fig. 8)
- Lettuce: 10-15 mol·m^{-2}·d^{-1}
- Eggplant: 15-20 mol·m^{-2}·d^{-1} (Fig. 9)
- Pepper: 15-20 mol·m^{-2}·d^{-1} (Fig. 10)
- Tomato: 15-20 mol·m^{-2}·d^{-1} (Fig. 11)

Growers should aim to maintain DLI within these ranges to optimize transplant quality. However, it's important to note that these are general guidelines, and factors such as temperature, humidity, and cultivar can also influence the optimal DLI. Regular monitoring and adjustment of light conditions based on plant response will help achieve the best results for each crop.

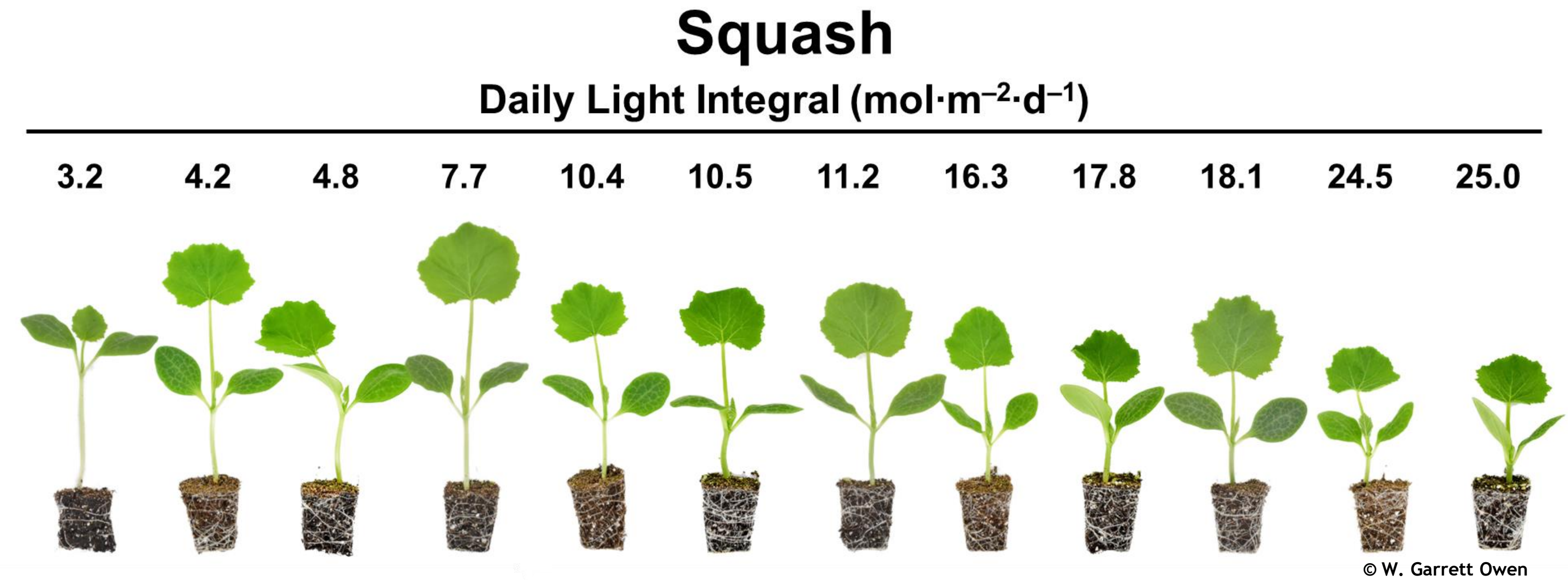

Figure 7. Depiction of straight neck squash transplants grown in 50-cell count trays under increasing daily light integrals ranging from 3.2 to 25.0 mol·m^{-2}·d^{-1}. Photos were taken 7 days after transfer to daily light integral treatments. Figure by: W. Garrett Owen, OSU.

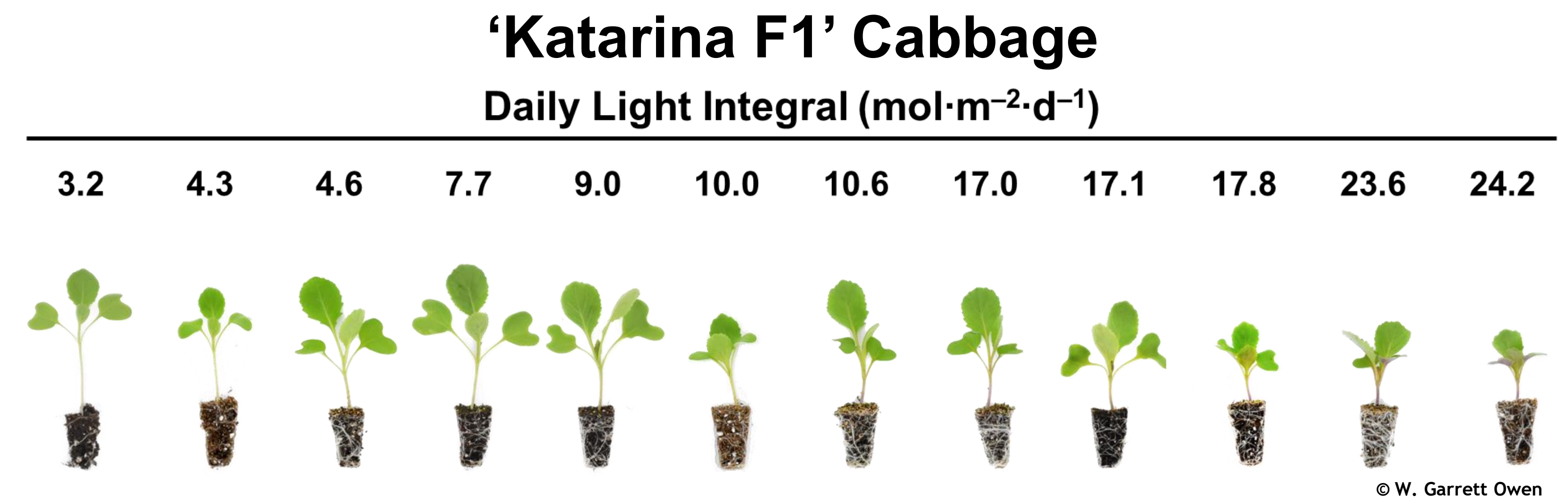

Figure 8. Depiction of 'Katarina F1' cabbage transplants grown in 126-cell count trays under increasing daily light integrals ranging from 3.2 to 24.2 mol·m^{-2}·d^{-1}. Photos were taken 10 days after transfer to daily light integral treatments. Figure by: W. Garrett Owen, OSU.

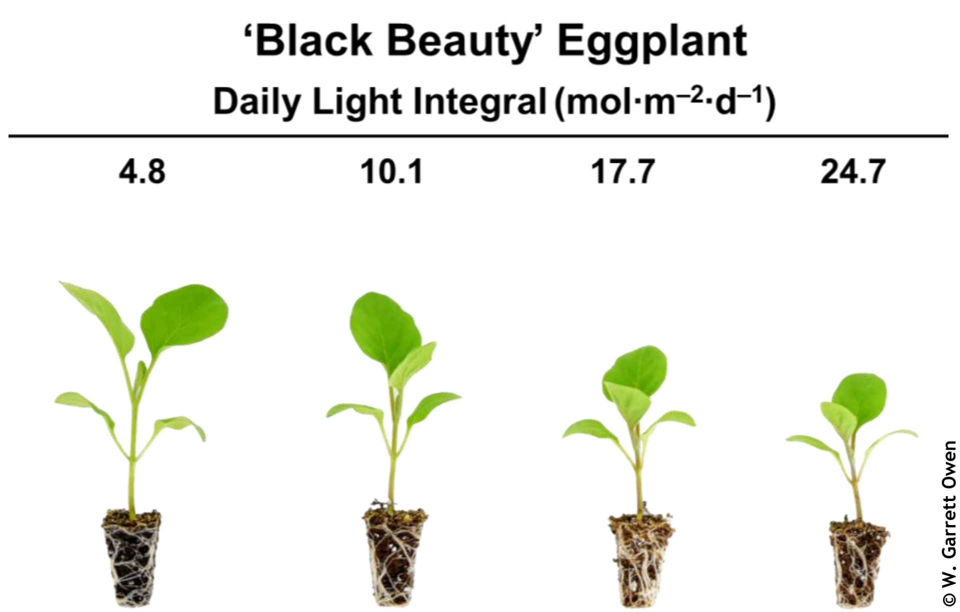

Figure 9. Depiction of 'Black Beauty' eggplant transplants grown in 126-cell count trays under increasing daily light integrals ranging from 4.8 to 24.7 mol·m^{-2}·d^{-1}. Photos were taken 10 days after transfer to daily light integral treatments. Figure by: W. Garrett Owen, OSU.

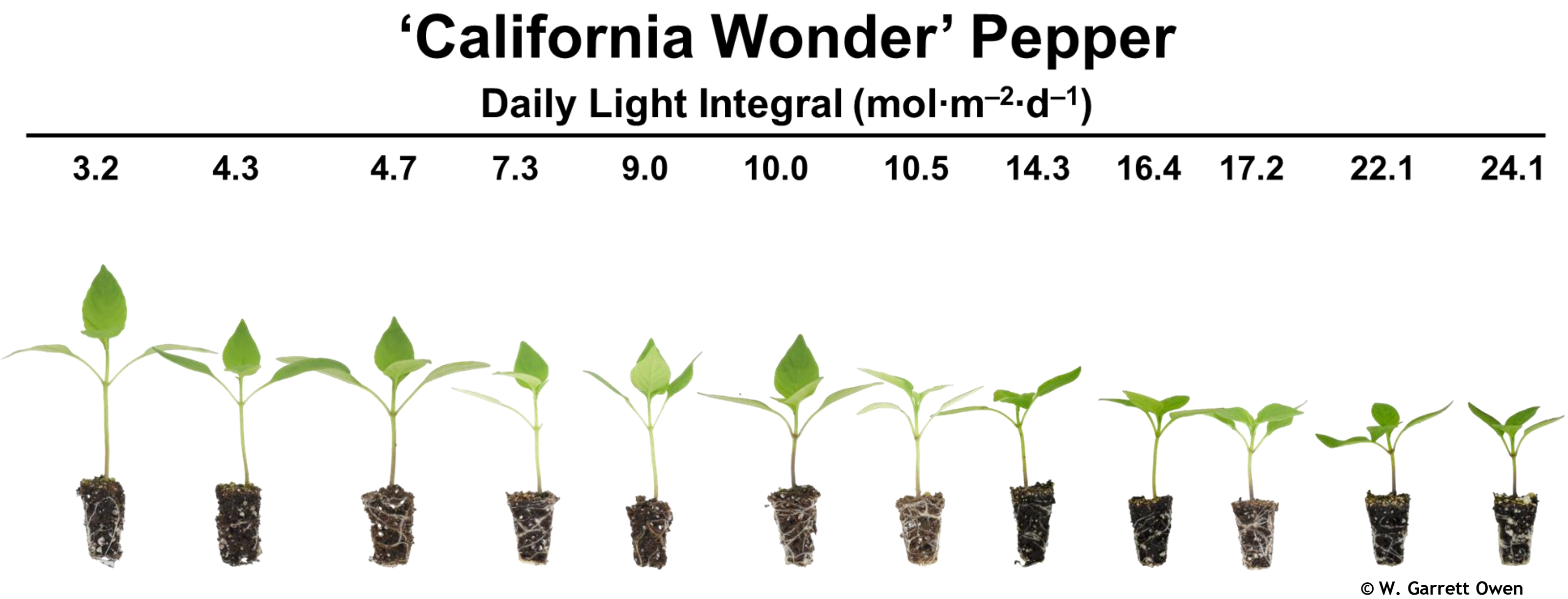

Figure 10. Depiction of 'California Wonder' bell pepper transplants grown in 126-cell count trays under increasing daily light integrals ranging from 3.2 to 24.1 mol·m^{-2}·d^{-1}. Photos were taken 10 days after transfer to daily light integral treatments. Figure by: W. Garrett Owen, OSU.

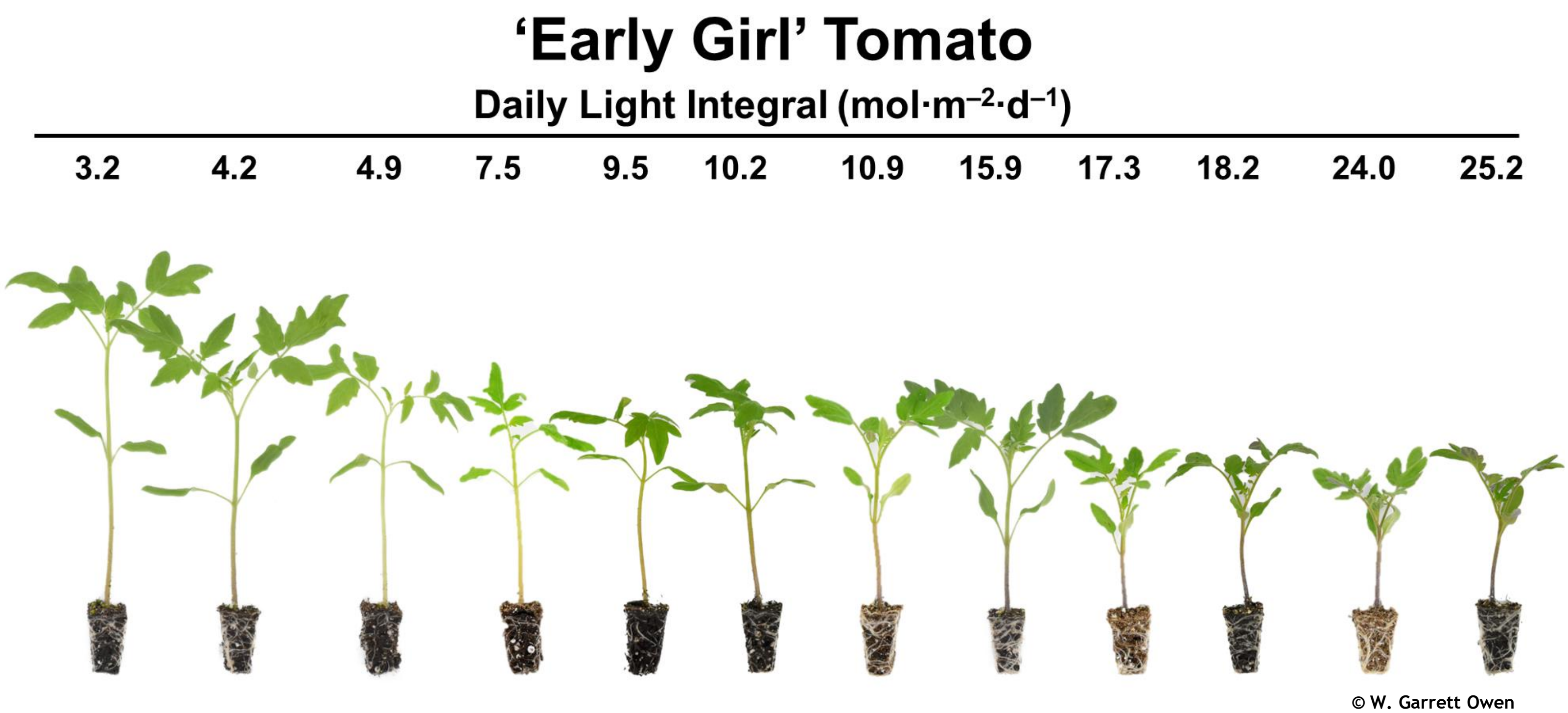

Figure 10. Depiction of 'Early Girl' tomato transplants grown in 126-cell count trays under increasing daily light integrals ranging from 3.2 to 25.2 mol·m^{-2}·d^{-1}. Photos were taken 14 days after transfer to daily light integral treatments. Figure by: W. Garrett Owen, OSU.

Strategies to Increase DLI

To improve transplant quality under light-limiting conditions, growers can implement several strategies. Supplemental lighting or the addition of electrical lighting to ambient solar light is highly effective (Fig. 12). Growers can deploy high-pressure sodium (HPS) lamps, light-emitting diode (LED) arrays, or a combination of both (hybrid; Fig. 13) to boost DLI levels, especially during winter months or in northern latitudes. Maximizing ambient solar light penetration is also crucial, which can be achieved by keeping greenhouse glazing clean (Fig. 14), limiting overhead obstructions, re needed, removing whitewash during low-light seasons, and optimizing plant spacing to reduce mutual shading. If possible, removing hanging baskets suspended above the transplants can minimize shading. Additionally, using white ground cover or reflective materials on bench tops can increase light reflection to plant canopies.

Managing High Light Conditions

While low light is often a concern, there may be times when DLI needs to be decreased due to high light conditions. In such cases, growers can cease supplemental lighting, adjust the photoperiod, or use exterior shade cloth (Fig. 15) or deploy retractable shade curtains to reduce light intensity during peak hours. Applying greenhouse whitewash (Fig. 16) or seasonal shade paint on the glazing can effectively lower DLI levels. Employing evaporative cooling can help manage temperature and reduce plant stress under high light conditions. When reducing light, care should be taken not to over-shade, as this can negatively impact plant quality.

Monitoring and Adjusting DLI

Effective light management requires continuous monitoring of DLI levels.

Figure 12. Example of supplemental lighting from high-pressure sodium lamps to increase daily light integral. Photo by: W. Garrett Owen, OSU.

Figure 13. Example of hybrid supplemental lighting from high-pressure sodium lamps and light-emitting diode arrays deployed to increase daily light integral. Photo by: W. Garrett Owen, OSU.

Figure 14. Dirty twinwall polycarbonate limits ambient solar light into the greenhouse environment thereby reducing daily light integral and negatively influencing transplant growth and development. Photo by: W. Garrett Owen, OSU.

Greenhouse growers should utilize greenhouse environmental control systems or quantum sensors, data loggers with light measurement capabilities, or portable DLI meters (Fig. 17) to accurately measure and monitor light intensity, photoperiod, and daily light integral (DLI) at plant canopy level, enabling informed decisions about supplemental lighting, shading, and overall greenhouse management for optimal plant growth and energy efficiency. Regular assessment of plant quality and adjustment of lighting strategies is essential. It's important to consider the specific light requirements of different vegetable crops, as some may require higher or lower DLI ranges for optimal growth. By actively managing DLI, greenhouse growers can optimize conditions for vegetable transplant production. This results in higher-quality plants with improved post-transplant performance, whether in the field, greenhouse, or home garden.

Overall, effective management of DLI is a cornerstone of successful vegetable transplant production in greenhouses. By understanding the impact of DLI on plant quality and implementing strategies to optimize light conditions, growers can significantly improve the vigor, uniformity, and overall quality of their transplants. Whether dealing with low light conditions that require supplemental lighting or high light scenarios necessitating shading techniques, the key lies in continuous monitoring and adjustment. As we move into the peak production season, prioritizing DLI management will lead to stronger, more resilient transplants that perform better both in the greenhouse and after transplanting. This attention to light optimization not only enhances plant quality but also contributes to more efficient production cycles and potentially higher profits for greenhouse operations.

Figure 15. Exterior shade cloth utilized to limit solar ambient light into the greenhouse environment, thereby reducing daily light integral. Photo by: W. Garrett Owen, OSU.

Figure 16. Seasonal application of greenhouse whitewash utilized to limit solar ambient light into the greenhouse environment, thereby reducing daily light integral. Photo by: W. Garrett Owen, OSU.

Figure 17. Examples of portable data loggers with light measurement capabilities utilized by greenhouse growers to monitor and manage daily light integral in the greenhouse environment. Photos by: W. Garrett Owen, OSU.

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