LED Horticultural Lighting Report

The LRC recently conducted an evaluation of the energy and economic performance of light-emitting diode (LED) horticultural lighting systems compared with high-pressure sodium (HPS) and metal halide (MH) horticultural lighting systems.

Based on the findings from a literature review and survey conducted by the LRC, the project team developed a framework for evaluating and comparing horticultural lighting systems. The framework includes recommended testing, evaluation, and reporting methods. It allows lighting systems to be compared based on equal photosynthetic photon flux density (PPFD), which is analogous to photopic illuminance on a work surface in an architectural application. The framework includes the analysis of 11 luminaire-specific metrics and 5 application-specific metrics, which provide growers with the most accurate information regarding the performance of any given horticultural lighting system.

The LRC then used this framework to test and evaluate 13 horticultural lighting systems, including ten LED, two HPS, and one MH product. First, the lighting systems were photometrically tested. Then the LRC determined the number of luminaires and the lighting system energy requirements necessary to reach minimum PPFD and uniformity criteria in a simulated greenhouse.

Light source	Price/ fixture (US$)	Power/ fixture (W)	No. of fixtures for 300 µmol m^{-2} s^{-1} for highest LSAE	20-year lifecycle cost for 100m² facility @ $0.10/kWh (US$ × 1000)	Shading penalty relative to HPS (%)
HPS	525	1057	24	167	0
LED	911	358	66	181	49
LED	955	195	96	195	12
LED	1186	330	68	197	13
HPS	540	1069	24	199	2
LED	834	268	99	223	14
LED	765	414	80	229	53
LED	1800	374	63	234	13
LED	1100	300	90	240	9
MH	569	1042	45	326	8
LED	2400	595	70	375	9
LED	245	30	Fixture unable to provide target PPFD		
LED	383	52	Fixture unable to provide target PPFD		

The results show that intensity distribution plays an important role, illustrated by the fact that two of the tested LED lighting systems had higher luminaire efficacy than the HPS but still had a higher total power demand in the greenhouse application to meet the PPFD criterion.

The LRC found an increase in shading from the LED lighting systems compared with HPS due to the size of the luminaires and the fact that more are needed to provide the same PPFD in a greenhouse. The shading from LED lighting systems reduces daylight in a greenhouse by 13—55% compared with a 5% reduction in daylight from HPS, thus more electric energy could be needed for lighting with the LED systems, depending upon the available daylight.

The LRC also found that three of the tested LED lighting systems had lower life-cycle costs, while the remaining seven had higher life-cycle costs than either of the two 1000-watt HPS lighting systems that were tested.

The results of the evaluation show that stakeholders can be misled by considering luminaire efficacy alone. Rather, the intensity distribution and layout to reach a criterion PPFD are necessary for an accurate life-cycle cost analysis. The LRC report provides a framework that stakeholders can use to evaluate horticultural lighting systems.

The report is available at: www.lrc.rpi.edu/programs/energy/pdf/HorticulturalLightingReport-Final.pdf

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