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LEDs vs. HPS Lamps: A Reality Check

Light-emitting diodes (LEDs) are perceived as the hottest technology in controlled-environment crop production and certainly their future is bright. A recent study by ReportsnReports estimated the LED market for plant applications will be $3.6 billion by 2020, a nine-fold increase from 2013. LED products for plant growth applications are reaching hobbyists and home growers, commercial greenhouse growers and entrepreneurs who envision production of high-value specialty crops in completely enclosed environments. With all of the promise and potential of LEDs though, some myths and misconceptions are being perpetuated — hence the need for a reality check.

A photon is a photon. Some companies have claimed photons emitted from their LEDs are two to four times more "effective" than photons from the sun, a high-pressure sodium (HPS) lamp or any other electrical light source. There is no data to support this assertion and in fact, published studies report photons within the photosynthetic waveband (400 to 700 nm) are essentially equally capable of driving photosynthesis, and therefore plant growth. Light intensity has a much larger effect on plant growth than light spectrum, and this is especially true when electrical lighting supplements sunlight, such as in greenhouse applications.

The efficiencies of lamps vary considerably. The efficiency of over 20 types of high-intensity lamps, including 10 LED products, was recently determined and reported online at Utah State University's website: http://cpl.usu.edu/htm/research. The study compares fixtures based on "photon efficiency," which describes the emission of photons useful to plants. The measure of efficiency is micromoles of photosynthetic photons (µmol) per joule (J) of electricity; high values indicate an efficient fixture. Some representative values from the study are shown in Table 1. HPS lamps with electronic ballasts have increased efficiency, and this efficiency is even higher with new double-ended HPS lamps. It also shows the best LED fixtures are more efficient than the older mogul-base (single-ended) HPS fixtures, while other LED fixtures are less efficient than newer HPS lamps.

The "true" virtues of LEDs. Despite the misconceptions about light spectrum and lamp efficiency, there are several desirable attributes of LEDs for plant growth applications, including:

- When LEDs are the primary or only light source, their spectrum can be changed (e.g. increased fraction of blue light) to produce crops with desirable growth characteristics, such as compact plugs and liners.
- Most LED products emit focused light, which makes them effective for lighting narrow areas such as single benches. This same characteristic also makes it challenging to create a uniform light environment in large open areas.
- LEDs can be placed closer to plants without risk of burning leaves.

As with any investment, conduct an ROI. LEDs are typically about four to six times more expensive per photon delivered than HPS fixtures, which makes a return on investment (ROI) analysis important before purchase. LED products can be cost effective when lighting smaller, narrow areas, or when the fixtures are close to the plants. The ROI is typically poor when lighting larger, more open areas. Consider your specific lighting application and perform your own financial analysis. Note that there will be no difference in electricity costs if the efficiency of two fixtures is the same. g

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Table 1. Examples of the electrical efficiencies of lamps as determined at Utah State University. Lamps with higher photon efficiency values mean they emit more photosynthetic light per unit of energy consumed.

Lamp type	Electrical input (W)	Manufacturer and model	Photon efficiency (µmol·J–1)
High-pressure sodium			
400-W magnetic	443	Sunlight Supply Sun Star	0.94
1000-W magnetic	1,004	PARsource GLXI	1.16
1000-W electronic	1,026	PARsource GLXII	1.30
1000-W electronic*	1,033	Gavita Pro 1000 DE	1.70
LED			
Red + White	423	Hydrogrow Sol 9	0.89
Red + White + Blue	304	LumiGrow Pro 325	1.29
Red + White	279	Illumitex NeoSol NS	1.40
Red + Blue	384	Lighting Science GrowAdvantage Violet	1.70

Source: http://cpl.usu.edu/files/publications/factsheet/pub__4338884.pdf.

*This is a double-ended lamp whereas the other HPS lamps are single ended (mogul-base).