USING AND MAINTAINING HIGH-PRESSURE SODIUM IN GREENHOUSES

Roberto G. Lopez gives top tips on deploying, servicing and cleaning HPS light fixtures for supplemental lighting on ornamental and vegetable crops.

BY ROBERTO G. LOPEZ

Greenhouse growers, especially those in northern latitudes, often use supplemental (also known as photosynthetic or assimilation) lighting to produce uniform, consistent and high-quality crops year-round.

Light-emitting diode (LED) fixtures are now about 40% more energy-efficient than the double-ended high-pressure sodium (HPS) fixtures [bulb (or lamp), reflector (or luminaire), and ballast], but per photosynthetic photon, the initial cost of LED fixtures, is approximately 3 to 10 times more than HPS fixtures.

Recent surveys indicated that only 2% to 5% of growers have installed LED fixtures for supplemental lighting. Therefore, most greenhouses that utilize supplemental lighting still rely on HPS fixtures **(Figure 1)**.

In this article, I will focus on the use and maintenance of HPS fixtures.

Where HPS lighting stands today

Traditionally, high-intensity discharge (HID) fixtures including HPS and metal halide (MH) were used for supplemental lighting as they were 25% to 30% efficient at converting electrical energy into photosynthetically active radiation (PAR).

The mogul-base HPS fixtures had electromagnetic ballasts and bulbs were single-ended (lamp attach to a single socket). About 13 years ago, electronic ballasts became available. These fixtures are typically smaller, cooler, quieter, lighter and best of all, they are 10% to 15% more energy-efficient then their magnetic ballast counter parts. Additionally, the efficiency degrades

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ESSURE LAMPS

at a slower rate than with magnetic ballasts.

The efficacy of HPS lamps increased considerably (by >65%) about nine years ago with the introduction of 1,000-watt double-ended (attached to the socket at both ends) fixtures.

Research by Bruce Bugbee at Utah State University has reported that the slow start and steady output of electronic ballasts likely contributes to the increased longevity of double-ended HPS fixtures. These fixtures emit a photosynthetic photon flux (PPF) of around 1,840 $\mu mol \cdot s^{-1}$ and have an efficacy between 1.7 and 1.8 $J \cdot s^{-1}$.

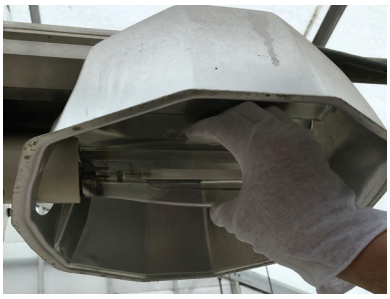
According to manufacturers, the life expectancy of double-ended HPS bulbs is 10,000 to 15,000 hours to 90% initial light output. Therefore, if your fixtures run 2,000 hours per year, the lamps would need to be replaced in 5 to 7.5 years.

Research findings

In 2008 the Light Research Center (LRC) at the Rensselaer Polytechnic Institute (RPI) reported that most LED horticultural fixtures could not replace HPS fixtures on a one-for-one basis while still maintaining the original PPF. Therefore, approximately three times as many LED fixtures would be needed to provide the same PPF as one HPS fixture.

It is important to remember that each year, the efficacy of LED fixtures increases, and now some light manufacturers do offer LED fixtures that are 650 watts and are a one-for-one replacement for an HPS fixture.

The LRC also found an increase in shading from some LED fixtures compared with HPS due to the size and quantity of the luminaires needed to provide the same PPFD in a greenhouse as an HPS installation. Across the fixtures tested at RPI-LRC, the shading from LEDs reduced sun light in the greenhouse by 13% to 55% compared with



Figures 2a & 2b. Flickering or dim HPS bulbs should be replaced. When installing new bulbs, always use a white glove to prevent leaving fingerprints on the bulb.

a 5% reduction from HPS fixtures.

When to use HPS lamps

Installing, maintaining and operating HPS lamps are a major investment for greenhouse operations. However, most of the up-front costs associated with the fixtures can be calculated and weighed against the potential benefits (ie. yield gains for vegetables or shorter crop turns for young plants).

Even though you have made a large capital investment in these fixtures, there is typically a four-to-six-month period (April to September) depending on your location when the benefit provided by supplemental lighting is minimal and they should be turned off (this is also a great time for maintenance and replacement).

From October until March, the total quantity of light received per day, the daily light integral (DLI), can be a limiting factor in the production of greenhouse crops in northern latitudes. Therefore, the greatest benefit from supplemental lighting occurs at night or during cloudy days from this time period in the north and November to February in the south.

Keep in mind that supplemental lighting requires much higher light intensities than photoperiodic lighting, which needs 2 to 3 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (10 to 20 footcandles) and is usually delivered as a night break of four hours from 10 p.m. to 2 a.m. For example, most young plant growers provide supplemental light intensities of 70 to 90 $\mu mol \cdot m^{-2} \cdot s^{-1}$ at plant height. Much higher intensities of 120 to 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ are recommended for vegetables **(Figure 1)**.

During peak season, young plant production of ornamentals (January and February), DLIs in the greenhouse can range from 2 to 8 $mol \cdot m^{-2} \cdot d^{-1}$ in the north and 6 to 14 $mol \cdot m^{-2} \cdot d^{-1}$ in the south.

Research at Michigan State University indicates that not only do you produce high-quality young plant with supplemental lighting, but more importantly crop timing can be reduced by up to 50% depending on the species when the DLI is maintained between 10 to 12 $mol \cdot m^{-2} \cdot d^{-1}$ for ornamentals and 12 to 15 $mol \cdot m^{-2} \cdot d^{-1}$ for vegetables.

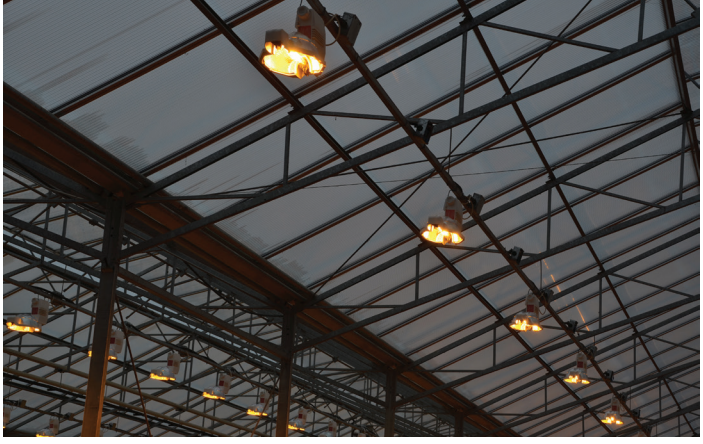


Figure 1. Northern greenhouse operation using supplemental lighting from high-pressure sodium lamps to provide 150 $\mu mol \cdot m^{-2} \cdot s^{-1}$ to their cucumber crop.

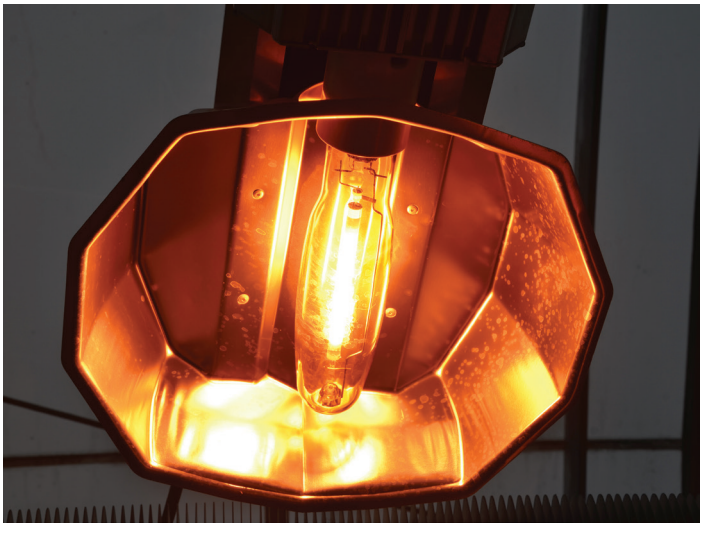


Figure 3. Reflector and bulbs with dust, finger prints and water spots

How many hours should an HPS lamp be on in order to achieve the target DLI of 12 to 15 $mol \cdot m^{-2} \cdot d^{-1}$? The amount of time the bulbs are on is just as important as the amount of supplemental instantaneous light they provide. Table 1 gives some examples of how supplemental DLIs ranging from 3 to 19 $mol \cdot m^{-2} \cdot d^{-1}$ may be achieved.

HPS fixture and lamp maintenance

What is the life expectancy of an HPS bulb? As stated before, under normal operating conditions, replacing bulbs is recommended after 10,000 hours for mogul-base fixtures and 10,000 to 15,000 hours for double-ended fixtures. The number of times that a lamp is turned on or off will also affect the life of the bulb.

In order to get the highest output form your HPS ballast, reflector, and bulbs, routine maintenance and replacement is essential. Some HPS fixture manufacturers recommend cleaning reflectors (luminaries), while other recommend a complete replacement. All recommend replacing bulbs once they have reached their

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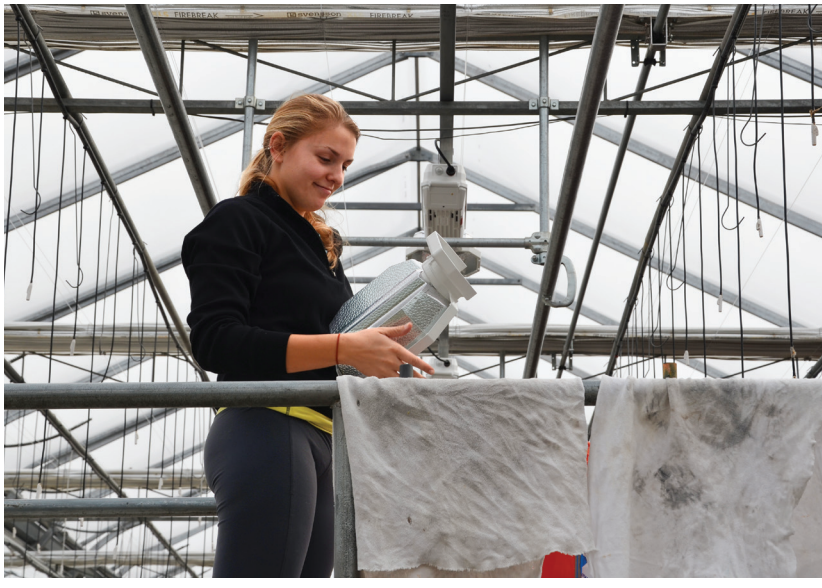
Duration (hours)	HPS intensity (µmol·m⁻²·s⁻¹)						
	75	100	125	150	175	200	225
	Supplemental DLI (mol·m⁻²·d⁻¹)						
12	3.2	4.3	5.4	6.5	7.6	8.6	9.7
15	4.1	5.4	6.8	8.1	9.5	10.8	12.2
18	4.9	6.5	8.1	9.7	11.3	13.0	14.6
21	5.7	7.6	9.5	11.3	13.2	15.1	17.0
24	6.5	8.6	10.8	13.0	15.1	17.3	19.4

Table 1. Cumulative amount of supplemental light (DLI; mol·m⁻²·d⁻¹) provided by high-pressure sodium lamps (HPS) achieved by varying light intensities and durations (hours).

maximum operating life **(Figures 2a and 2b)**.

However, let's be honest with ourselves: most growers do not do this. I was pleasantly surprised to see an operation in New York that was cleaning all of their HPS reflectors and bulbs **(Figure 4)**. I often see reflectors that are dusty, have water spots or finger prints **(Figure 3)**, or lamps that have burned out or are dim. It is estimated that light output can be reduced by 8 to 15% due to dirty reflectors alone. Therefore, I asked several HPS manufactures for their recommendations on reflector maintenance.

P.L. Light Systems says that if the HPS installation is in a clean environment, or if the reflectors are 1 to 3 years of age, it is possible to clean them with a solution of vinegar and water mixed at a ratio of 1:100. They also advise cleaning your bulbs and reflectors annually for best performance. *(Please note that not all manufactures recommend cleaning reflectors. Therefore, you should contact the manufacture of your HPS fixtures for their specific recommendations. Most manufacture can test your reflectors and tell you if*



Figures 4a & 4b. A high-pressure sodium reflector has been removed from the fixture and is ready to be cleaned.

PHOTO 4B COURTESY OF PL LIGHT SYSTEMS

it is time to replace them.)

P.L Light System HPS maintenance and cleaning checklist

1. **When cleaning reflectors** or replacing bulbs, wear eye and hand protection, unplug the HPS fixture from the main power source and allow it to cool for at least 30 minutes to prevent serious burns or injury (**Figure 2**).
2. **While you wait, check cords** for damage and replace damaged cords according to the manufacturer's instruction.
3. **Always use cotton gloves** to install or remove bulbs as the oils on your hands can create dark spots and reduce lamp efficiency (**Figure 2**).
4. **Carefully remove the reflector.** Flush the reflector with distilled water inside and out to remove environmental contaminates (dust, dirt or water spots) (**Figure 3**).
5. **Fill a bucket with a 1:100** vinegar:distilled water solution. Submerge only the reflector for a few seconds (**Figure 4**).
6. **If necessary, carefully use a very soft brush** such as a fine finger nail brush to rub off environmental contaminates on the bulb itself. Do not submerge bulbs.
7. **Rinse the reflector** in a second bucket filled with distilled water to remove cleaning solution (**Figure 4**).
8. **Rinse reflector in third bucket of distilled water** to remove any remaining residue. Otherwise hard water spots may remain. If residue is still present repeat steps 5 to 8. If this does not work, it is time to replace the reflector.
9. **Allow the reflectors to air dry** before reinstalling them on the fixture.
10. **For your safety, when cleaning reflectors always maintain the correct ratio** and never add other chemicals to the cleaning solution. For more information on correcting problems with HPS Lamps, visit **bit.ly/HPStips**. **pg**

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