Lighting plants with LEDs: a panel discussion©

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INTRODUCTION: WHY LED LIGHTS AT WALTERS GARDENS?

Day length changes and light intensity fluctuations can be challenging for growers, especially in the winter months in West Michigan. This is what led Walters Gardens to consider LED lights as a source of supplemental lighting to help improve plant quality and conserve energy.

Currently, Walters Gardens has about 12 acres of greenhouse space. About 2.5 acres of this area have high pressure sodium (HPS) lights. We had observed positive responses with HPS lights in items that we grow; however, we noticed the need to decrease our energy consumption and were intrigued by potential benefits LEDs might have on overall plant quality. Research shows that LEDs have the potential to be more energy efficient, last longer, and provide accurate wavelength specificity that can remove wavelength emissions that are not useful for plants (Randall and Lopez, 2013). Considering findings such as this, in August 2014, Walters Gardens began discussions with Philips about an alternative light source to HPS light fixtures that could enhance the quality of our perennial liner production while consuming less energy.

MATERIAL AND METHODS

LED cost analysis

The cost of the lighting units and the installation can scare a lot of growers away from installing LED lights. The light fixtures we chose to work with were the Philips GreenPower LED top lighting. We also questioned how much energy we could save with LED lights when compared to high pressure sodium lights. When looking into cost of installation, our CFO considered annual hours the lights would be operating, fixture costs, and any additional installation costs. He also looked into rebates that could help fund the cost of the project. From there, he was able to determine our return on investment. Since this would be a new installation, one important unknown to us was the longevity of the fixtures. Another important comparison to make when considering an installation is to make sure to compare LEDs and HPS at the micromole level. Are you achieving the intensity you want? We chose to pursue 80 µmol with our LED fixtures. Finally, another consideration is the amount of electricity that HPS lights convert into heat that can be useful for growers during the cold winter months. Research has shown that plants are often 2 to 3°F warmer under HPS lamps than LEDs, so there is the possibility that growers may have to increase heat when growing under LEDs than HPS lamps (Runkle, 2017). Below is a breakdown that helped us make the decision to move forward from a financial standpoint (Table 1).

MATERIAL AND METHODS

Trial department installation

After making the decision to install Philips LEDs in August 2014, we decided to install the lights in our trial department. By week two, we began experimenting with a light spectrum of DR/B MB and a light level targeting 80 µmol of light (Philips and Walters Gardens Case Study, 2015). Recent research at Michigan State University and Purdue University shows that a daily light integral of between 10 to 12 moles is necessary to produce high-quality plant plugs (Randall and Lopez, 2013). Based on this information, we decided to run these lights for 16 continuous hours and at an 80 µmol level. We knew we would be adding about 4.6 moles per day when running the lights this way during the winter

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months. Our trial department decided to focus on items like *Dianthus*, *Hibiscus*, *Lavandula*, *Agastache*, *Sedum*, and *Coreopsis*, to name a few. We looked at items that we were traditionally growing in the dark winter months and that were popular items for us. With the toplighting trial, our trial department noticed *Hibiscus* (Figure 1) and *Dianthus* (Figure 2)finishing 10-14 days quicker, more lateral branching in *Lavandula* and *Sedum*, better rooting and more compact growth in *Agastache* (Figure 3), *Leucanthemum*, and *Gypsophila* (Philips and Walters Gardens case study, 2015). Below are some photos highlighting the results of this trial.

Table 1. Walters Gardens Inc., ROI / breakeven analysis, complete I4 only.

Description	**HPS 1000W Lithonia**	**HPS 1000W Double End**	**LED 200W DR/W MB**	**Comments**
Number of fixtures	44	48	114	
Energy consumption (Watts)	1085	1108	200	1000 W light (tested by Ken Austof 10/18/16)
Demand (KW)	47.74	53.18	22.80	
Annual energy consumption (kWh)	99,203.72	110,516.35	47,378.40	
Annual energy cost	$11,904.45	$13,261.96	$5,685.41	
Annual hours in operation	2078	2078	2078	Nov - 13/Dec - 16/Jan - 16/ Feb - 16/Mar - 8
Cost/kWh	0.12	0.12	0.12	Blended rate for peak use based on analysis from Midwest Energy
Fixture cost		$315.00	$395.75	per quotes
Accessories cost		$4.00	$30.73	per quotes
Total fixture cost	$0.00	$15,312.00	$48,618.15	
Potential rebate			$8,729.00	Consumers rebate is 0.35/W saved over a year or $350 per kW
Net project cost for fixtures	$0.00	$15,312.00	$39,889.15	
Break even years			3.24	Years to payback extra cost for an LED install vs. HPS DE
ROI years			5.26	Years to payback total cost for an LED install vs. HPS DE

Figure 1. *Hibiscus* 'Cranberry Crush'. Left: LED 16 h continuous; Middle: LED 16 h; Right: high pressure sodium (HPS) 16 h. Plants under LED 16-h continuous lighting are taller with larger leaves than the other two greatments. From Round 2 of LED trials/photo taken 22 Feb. 2017.

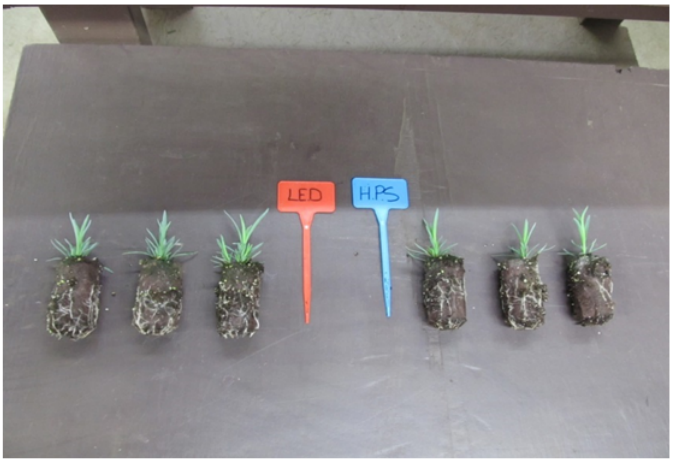

Figure 2. *Dianthus* LED on left and right is high pressure sodium (HPS).

Figure 3. *Agastache* left is high pressure sodium (HPS) and LED on right.

SUMMARY: PRODUCTION INSTALLATION

After seeing success in the trial department in the winter of 2015, we decided to install LED lights in our production area. The purplish cast created by the DR/B MB fixtures in our trial department led us to try adding white into the spectrum. With sorting staff, growing, and plant health employees needing to work under the lights, we wanted to make them as comfortable as possible. We decided to add 15% white to these fixtures and adjust to 75% deep red and 10% blue/medium blue and continue to target 80 µmol. What we learned is that one important factor to consider is that after a lighting system is installed; check that the light intensity delivers what you purchased. Also, when considering the location for the production installation, we considered how we currently were operating the lights during the early fall through late spring months.

We have seen good responses from items like *Sedum* when we grow them under 13-h HPS lights, and there are items like our warm season grasses, *Hibiscus*, and *Lagerstroemia* that we like to grow in 16-h light sections. We have also been looking at *Echinacea* and its light requirement needs during the dark months in West Michigan. With *Echinacea*, we compared 13-h lights, 17-h lights, and 24-h lights. Ultimately we decided to install the lights in an area that we would light for 16 h, since a large portion of our items under lights fell in this category. We decided to use the LED lights in a production area which entailed 10,000 sq ft of growing space. Our target for the fixtures was 80 µmol. In the production area, LED lights and HPS lights are tied into our Priva computer system. We setup trial locations in three different spots; one spot running the LED lights 16 h continually, one LED location 16 h based off of outside light conditions, and one HPS location running 16 h and lights turning on and off based off of outside light conditions. Questions are often raised on when is a good starting point when running lights based off of light intensity; consider setting growing lights to turn on when light intensity outside is less than 200 µmol for a few minutes. You could then set the lamps to turn off when the outside light intensity exceeds a higher value, like when 400 µmol has been achieved for a few minutes (Runkle, 2013). We focused on having our environmental control system achieve similar settings to this in our greenhouses.

Production trials have shown similar results to those captured by our trial department for items including *Hibiscus* (Figure 1), *Amsonia* (Figure 4), *Agastache*, *Astilbe* (Figure 5), and *Ligularia*. Below are a few photos highlighting those results.

Figure 4. *Amsonia* ‘Storm Cloud’. Left: LED 16 h continuous; Middle: LED 16 h; Right: high pressure sodium (HPS) 16 h. LED treatments have more compact growth than HPS. From Round 2 of LED trials/photo taken 22 Feb. 2017.

Figure 5. *Astilbe* ‘Amber Moon’. Left: LED 16 h continuous; Middle: LED 16 h; Right: high pressure sodium (HPS) (control) 16 h. Color on HPS is very yellow. Color under LED treatments is more desirable. From Round 3 of LED trials/photo taken 15 March 2017.

CONCLUSION

Through our study and additional research, we have learned that when considering LED lights, your potential lighting supplier should be able to provide a map of intensity and uniformity of the lights, efficacy for your specific application, and cost associated with the installation. Look into potential options for energy rebates. Based on a proposed lighting plan, it is important that your current electrical supply needs allows for the use of supplemental lighting (Poel and Runkle, 2017). The installation of LEDs at Walters Gardens utilized 15 AMP circuits and not 20 AMP like we utilize in HPS.

After evaluating the cost of the fixtures and seeing the benefits of growing items under LED continuously for 16 hours at Walters Gardens, we want to expand on this program in the winter of 2017-2018. Goals we have for this year include: validating our prior results, testing new taxa, tracking the number of cuttings per sq ft from *Hibiscus*, tracking PGR usage, evaluating overall plant quality, and tracking finish times on a larger scale.

Literature cited

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