



## Spectral Analysis of Philips Elite Agro 315W Ceramic Metal Halide Lamp

January 5, 2012

To: Cycloptics Technologies, LLC

“Thank you for sending us a ceramic metal halide Elite Agro lamp for testing. We have completed our characterization of the spectral characteristics of the lamp that you sent. The results are attached . We ran the lamp for several days to stabilize it prior to making these measurements.

The CMH lamp has 2.5 times the blue light of an HPS lamp, which is a significant advantage in growth chambers, where HPS lamps must be supplemented with 50% MH lamps to achieve adequate blue light. In our experience, the 13.4% blue light from CMH lamps would be adequate to grow all species without adding supplemental blue light (see spectral output graphs and summary table). The blue light from a CMH lamp is slightly higher than a 50/50 mix of HPS and MH lamps – AND it eliminates the problem of spectral uniformity that occurs with a mix of lamp types.

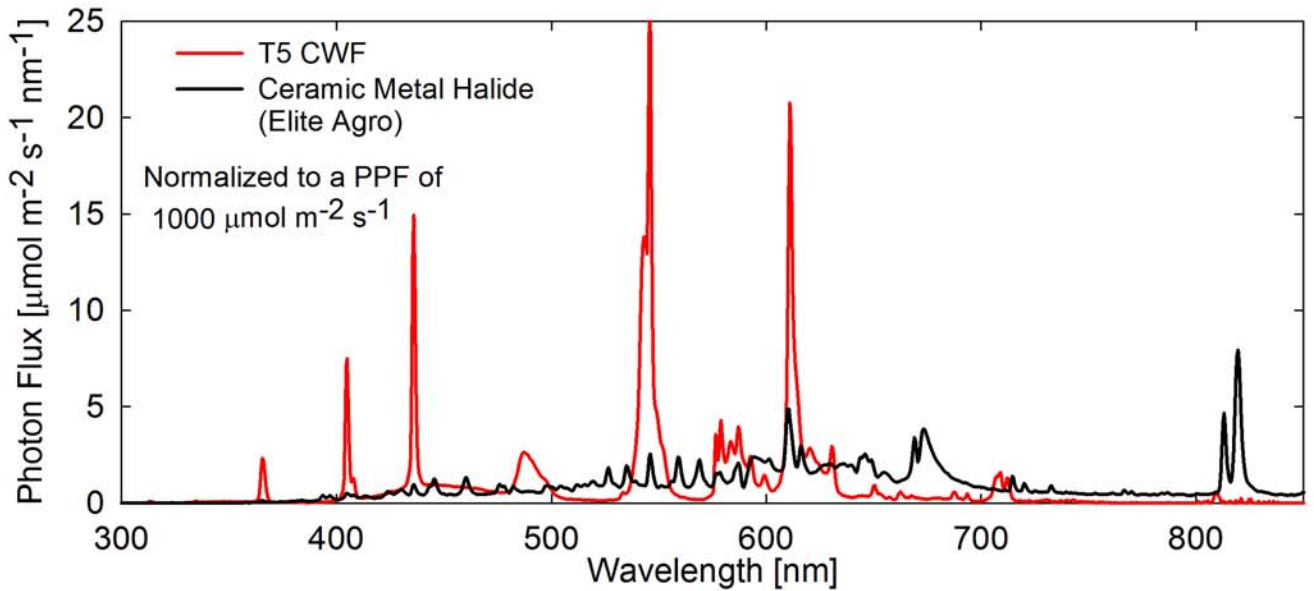
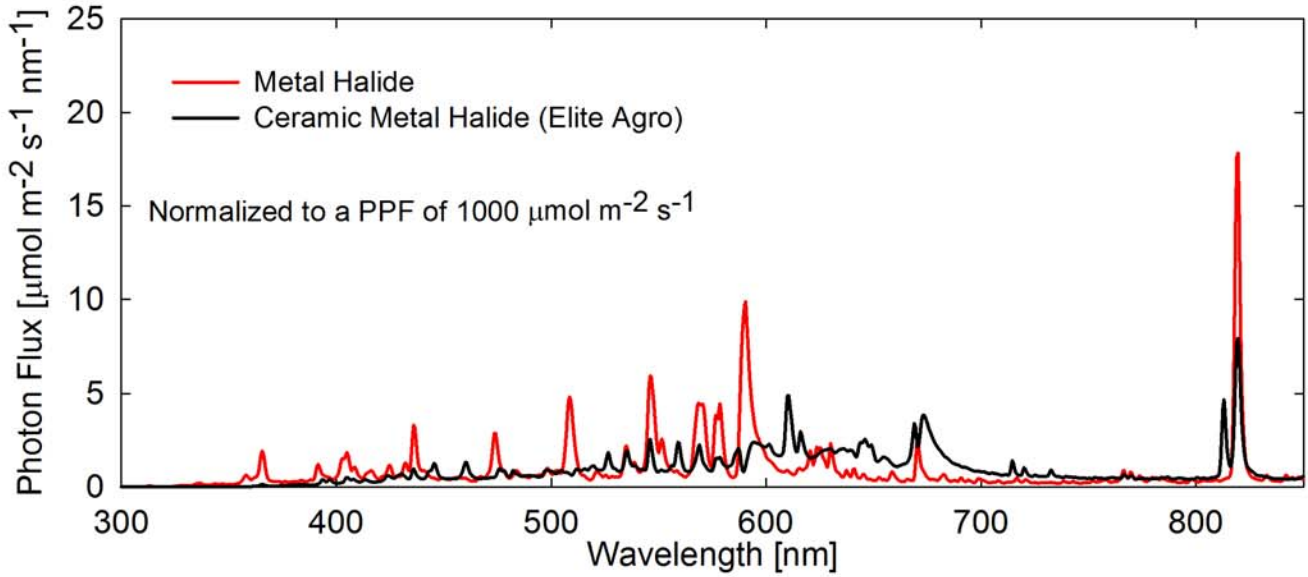
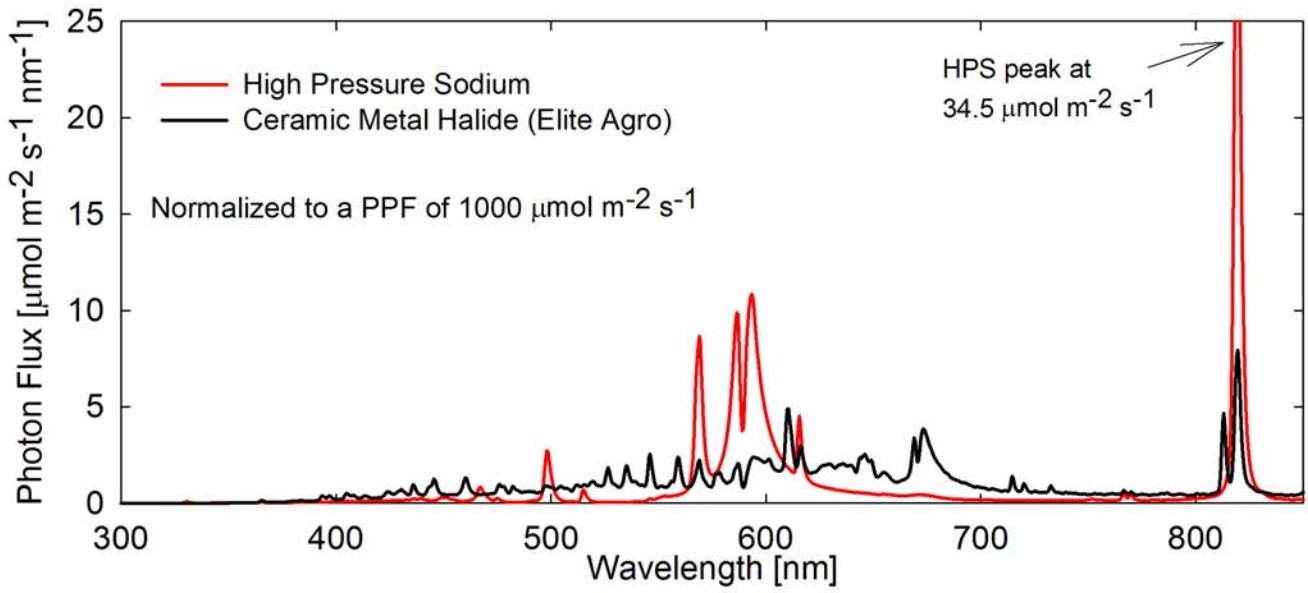
The CMH lamp has a more uniform spectral output than the other widely used lamps for plant growth lighting. This is often a significant advantage in lighting for humans, but it is not necessarily an advantage for plants, since the energy absorbed at one wavelength can be transferred to reaction centers and effectively used for photosynthesis.

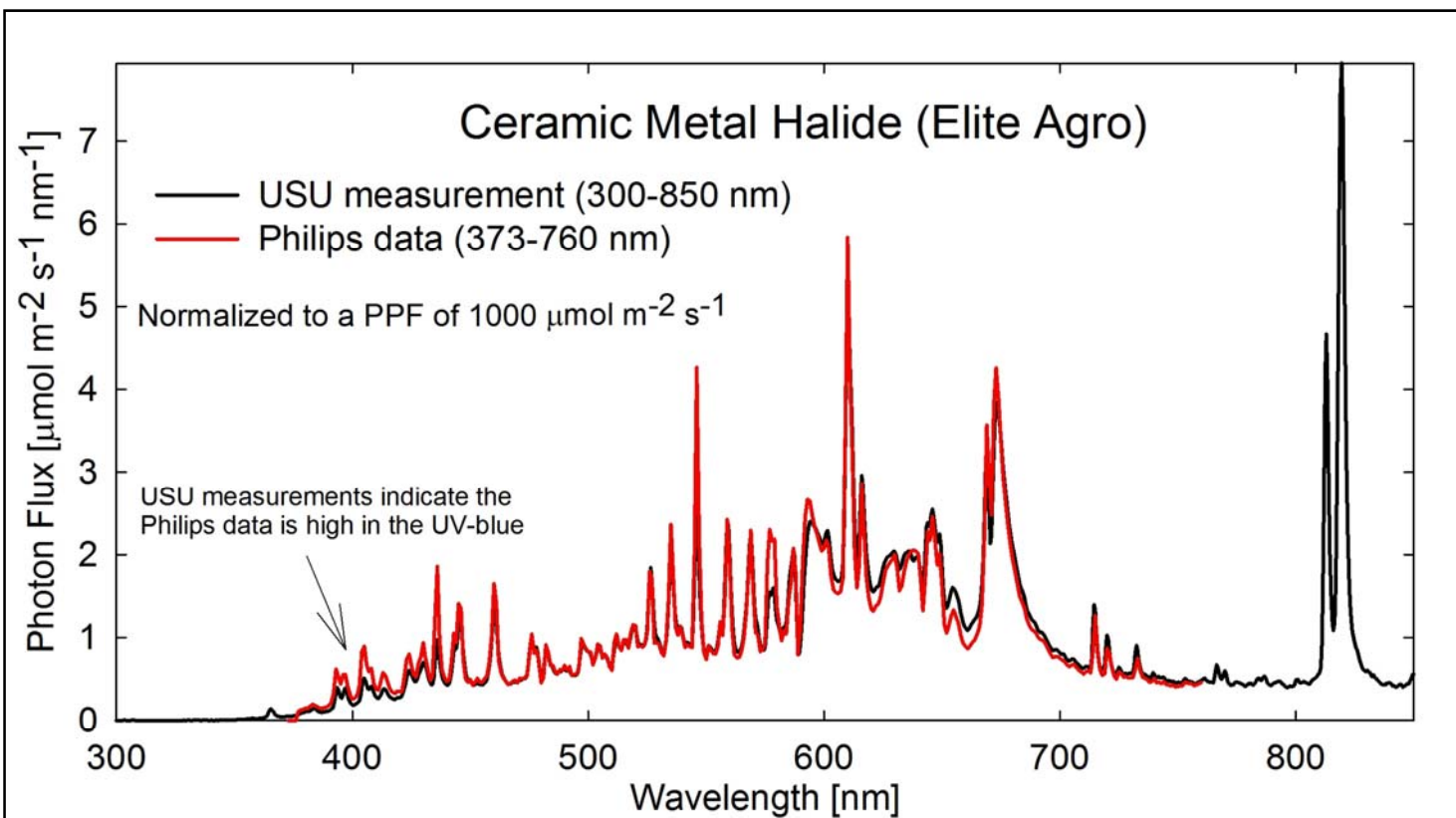
Our replicate measurements (calibrated to an NIST traceable lamp) indicate that Philips data is high in the UV/blue wavelengths. See the associated graph for details. This may be variation among lamps, but it may also be the calibration of the spectroradiometer used by Philips.

We did not conduct efficiency testing because we do not have a luminaire for this lamp. Finally, we have updated our summary table on the spectral uniformity of lamps for plant growth lighting, and have added the CMH lamp to our table.

You have my permission to use this data in talks and publications – as long as you give credit to the Crop Physiology Laboratory at Utah State University.”

**Bruce Bugbee, PhD**  
*Professor of Crop Physiology  
Director of the Crop Physiology Laboratory  
Plants Soils and Climate Department  
Utah State University*





Radiation distribution (% of PPF)					
	High Pressure Sodium	Metal Halide	T5 Cool White Fluorescent	T12 Cool White Fluorescent	Ceramic Metal Halide (Elite Agro)
UV (300-399)	0.8	7.4	2.2	2.6	1.5
Blue (400-490)	4.9	20.5	24.1	21.5	13.4
Green (491-600)	67.2	58.6	46.6	56.8	35.4
Red (601-700)	27.9	20.9	29.3	21.6	51.2
Near Infrared (701-850)	56.5	29.3	3.9	2.1	31.7

Cycloptics Technologies wishes to thank Dr. Bruce Bugbee and his staff at the Utah State University Crop Physiology Laboratory for conducting this independent spectral characterization and comparative analysis of the Philips Elite AGRO 315W ceramic metal halide lamp. It is the lamp used by Cycloptics in its All-Bright® lighting system for single tier plant growth chambers.

To learn more about the performance and energy savings improvements you can realize by specifying All-Bright® lighting for installation in your new chambers or to upgrade existing T12 and HID single-tier chambers please contact:

**cycloptics®**

[www.cycloptics.com](http://www.cycloptics.com)

2358 Adirondack Trail

Dayton, OH 45409 USA

(937)723-9818

# Spectral Characteristics of Sunlight and Electric Lamps for Plant Biology

Measured by the Utah State University Crop Physiology Laboratory

Radiation source		UVB (%) 287-320	UVA (%) 320-400	Weighted UV <sup>1</sup> 287-390	Blue (%) 400-490	YPF/ PPF Ratio	PPE <sup>2</sup>	Red/ Far Red Ratio <sup>3</sup>	<u>630-660</u> <u>712-742</u> Ratio <sup>4</sup>	$\pm 30$ <u>660</u> <u>730</u> Ratio <sup>5</sup>
<b>Sunlight – Solar Noon</b>										
Clear	18 March	0.39	8.3	3.9	24.9	0.89	0.72	1.06	1.07	1.05
Clear	26 May	0.47	8.5	4.3	24.5	0.90	0.72	1.03	1.08	1.05
Cloudy	11 May	0.51	8.8	4.5	25.5	0.91	0.71	0.98	1.02	1.01
<b>High Intensity Discharge 1000 W</b>										
HPS (Philips)		0.01	0.8	0.3	4.4	0.88	0.87	3.3	3.7	2.9
Metal Halide (GE)		0.13	8.3	2.9	22.2	0.91	0.80	2.5	2.4	2.3
Metal Halide (EYE)		0.03	5.0	1.6	20.4	0.95	0.82	4.2	3.7	3.3
<b>LED</b>										
Warm		0.00	0.0	0.0	9.4	0.91	0.84	4.7	9.4	4.4
Neutral		0.00	0.0	0.0	17.0	0.88	0.84	5.5	5.4	4.6
Cool		0.00	0.1	0.0	24.2	0.86	0.83	5.9	6.1	4.9
<b>Ceramic Metal Halide</b>										
Philips Elite Agro		0.02	1.5	0.4	13.4	0.91	0.81	2.7	2.7	3.2
<b>VHO Fluorescent</b>										
T12 Sylvania		0.55	2.7	3.0	20.7	0.89	0.83	8.6	7.1	5.1
GE		0.43	2.8	2.2	20.4	0.89	0.83	10.3	6.4	4.7
Philips		0.50	2.0	2.0	18.0	0.90	0.83	6.9	6.3	4.4
<b>HO Fluorescent</b>										
T8 Sylvania		0.32	1.7	1.7	18.3	0.91	0.84	5.8	6.2	3.6
GE		0.30	1.6	1.6	15.3	0.91	0.84	4.0	4.5	2.3
Philips		0.40	1.5	1.9	11.9	0.91	0.85	4.0	4.3	1.9
T5 Sylvania		0.10	2.1	1.3	22.6	0.89	0.83	3.9	4.5	2.2
GE		0.11	1.8	1.2	21.8	0.88	0.83	3.9	4.6	2.1
Philips		0.11	1.9	1.3	24.3	0.89	0.82	3.9	4.4	2.1
<b>Compact Fluorescent</b>										
Sylvania – Old 27 W <sup>6</sup>		0.24	2.3	2.0	15.9	0.93	0.84	3.2	4.0	1.8
Sylvania – New 30 W <sup>6</sup>		0.10	1.9	1.4	15.7	0.91	0.84	3.4	4.1	1.8
GE 45 W		0.23	2.0	1.7	10.3	0.93	0.84	3.3	4.0	1.8
UV Black light 13 W		12.99	757	327	93.2	2.95	0.75	0/0	0/0	0/0
<b>Incandescent 100W</b>		0.02	0.8	0.6	6.4	0.94	0.65	0.6	0.7	0.7
<b>Quartz Halogen<sup>7</sup></b>		0.14	1.9	2.5	9.7	0.95	0.67	0.7	0.7	0.8

1 Biologically weighted UV using weighting factors from Flint and Caldwell (2003). Normalized to a PPF of 1000.

2 Phytochrome Photo-Equilibrium, also called PPS (Phytochrome Photo-Stationary State).

3 Measured with a Skye Instruments Red/Far Red Sensor, which has two bell-shaped curves with 655 and 735 peaks. Each curve is  $\pm 30$  nm.

4 Calculated from spectrometer to approximately match Skye Sensor; square wave with equal weighting of photons.

5 Calculated from spectrometer; square wave with equal weighting of photons from  $\pm 30$ nm.

6 27W = Old Technology with Thick Tube; 30W = New Technology with Thin Tube.

7 LICOR model 1800-02 Calibration Lamp.