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

Conducted by

Utah State University's Crop Physiology Laboratory

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.

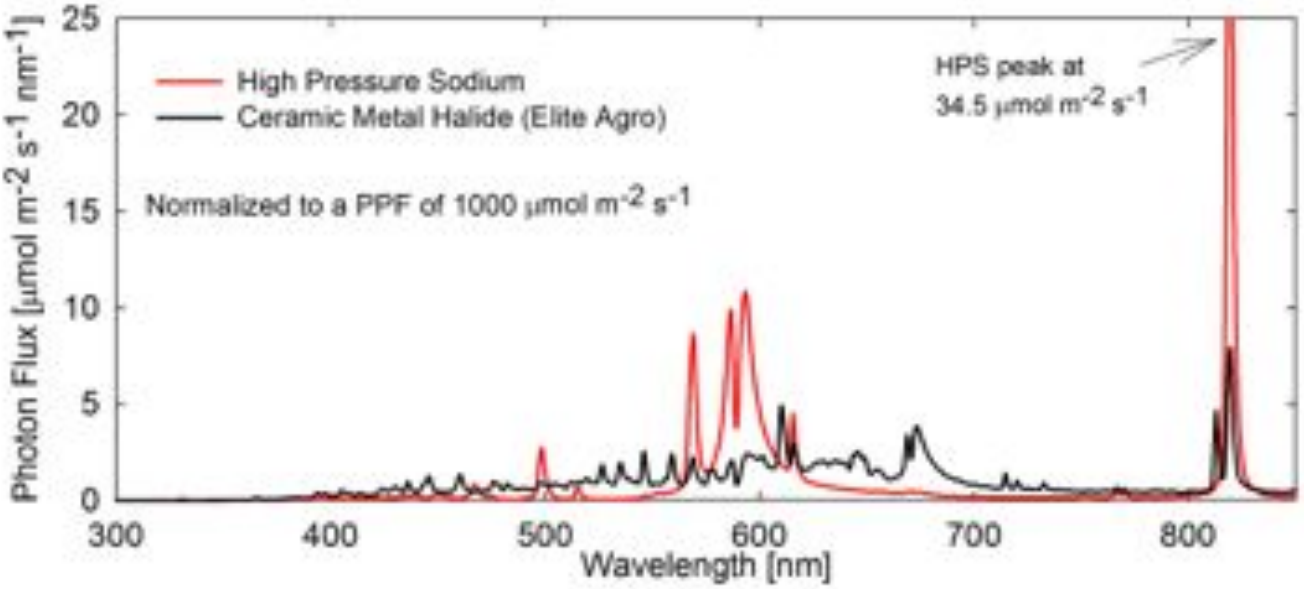
The CMH lamp has a more uniform spectral output than the other widely used lamps for plant growth lighting. This is often a significant advantage in lighting for humans, but it is not necessarily an advantage for plants, since the energy absorbed at one wavelength can be transferred to reaction centers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

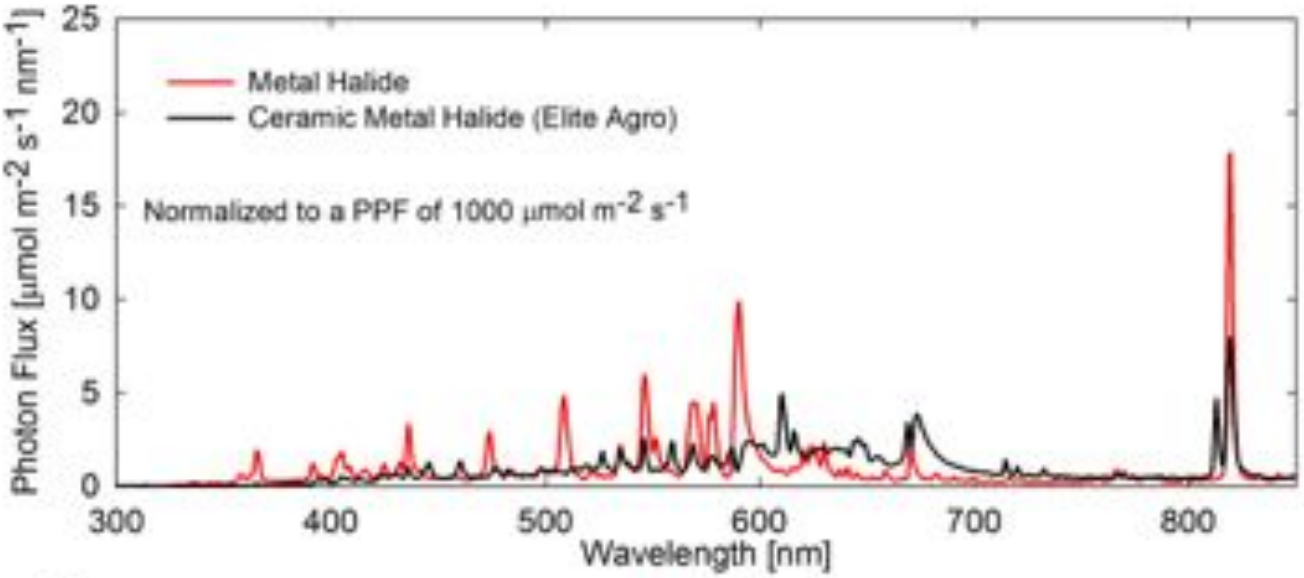
Our replicate measurements (calibrated to an NIST traceable lamp) indicate that Philips data is high in the UV/blue wavelengths. See the associated graph for details. This may be variation among lamps, but it may also be the calibration of the spectroradiometer used by Philips.

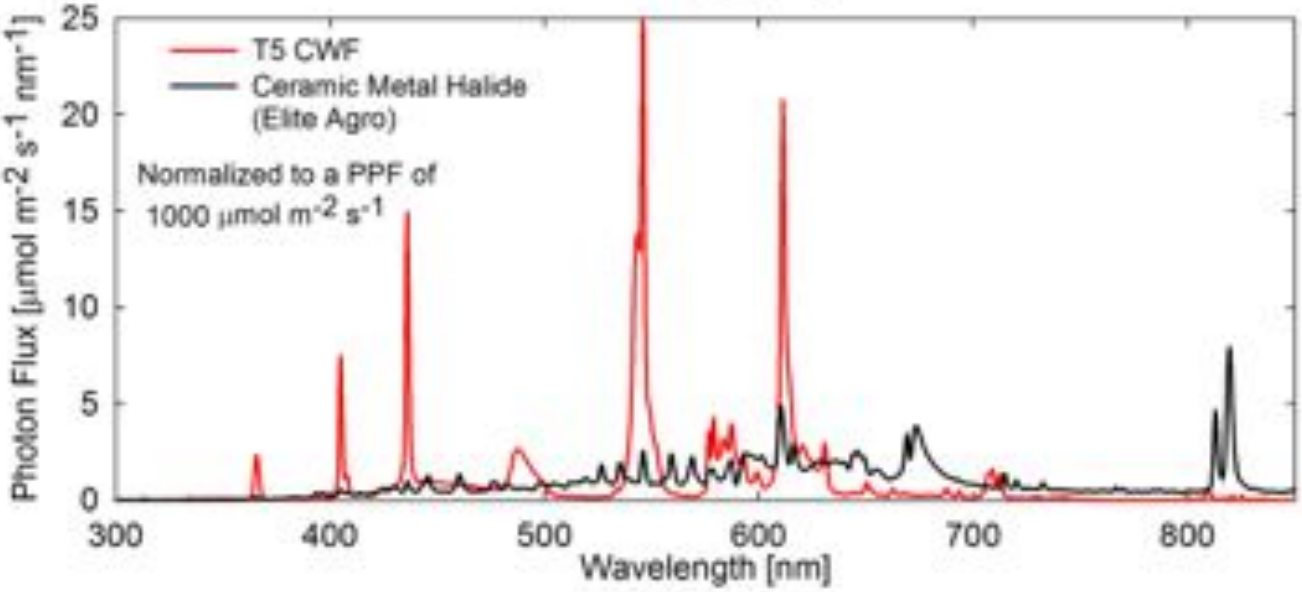
We did not conduct efficiency testing because we do not have a luminaire for this lamp. **F**inally, we have updated update our summary table on the spectral uniformity of lamps for plant growth lighting, and have added the CMH lamp to our table.

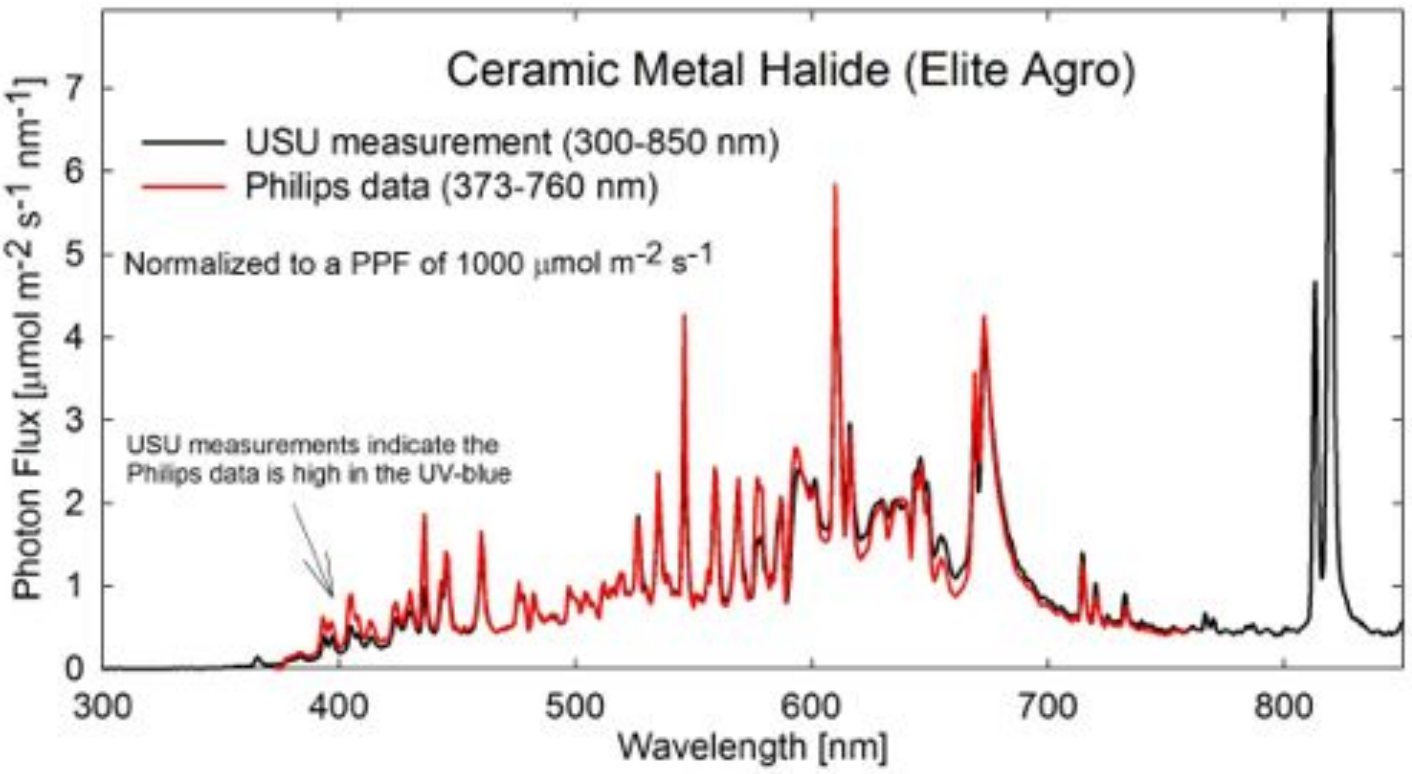
You have my permission to use this data in talks and publications – as long as you give credit to the Crop Physiology Laboratory at Utah State University. Let us know if we can help Cycloptics with future tests."

Bruce Bugbee, Ph.D
Professor of Crop Physiology
Director of the Crop Physiology Laboratory
Plants Soils and Climate Department
Utah State University


High Pressure Sodium
Ceramic Metal Halide (Elite Agro)
Normalized to a PPF of 1000 µmol m-2 s-1
HPS peak at
34.5 µmol m-2 s-1
Photon Flux [µmol m-2 s-1 nm-1]
Wavelength [nm]


Metal Halide
Ceramic Metal Halide (Elite Agro)
Normalized to a PPF of 1000 µmol m-2 s-1
Photon Flux [µmol m-2 s-1 nm-1]
Wavelength [nm]


T5 CWF
Ceramic Metal Halide
(Elite Agro)
Normalized to a PPF of
1000 µmol m-2 s-1
Photon Flux [µmol m-2 s-1 nm-1]
Wavelength [nm]



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 express its thanks to Dr. Bruce Bugbee and his staff at the Utah State University Crop Physiology Laboratory for conducting this spectral characterization and comparative analysis of the Philips Elite AGRO 315W ceramic metal halide lamp. The Elite AGRO 315W is the lamp that the company uses 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 retrofitting your T12 and HID single-tier chambers with All-Bright® lighting, or for new chambers equipped with them please visit www.cycloptics.com or call (937) 723-9818 or (937) 689-6944.

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[1] 287-390	Blue (%) 400-490	YPF/ PPF Ratio	PPE[2]	Red/ Far Red Ratio[3]	630-660 / 712-742 Ratio[4]	± 30 660 / 730 Ratio[5]
Sunlight – Solar Noon										
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
High Intensity Discharge 1000 W										
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
LED										
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
Ceramic Metal Halide										
Philips Elite Agro		0.02	1.5	0.4	13.4	0.91	0.81	2.7	2.7	3.2
VHO Fluorescent										
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
HO Fluorescent										
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
Compact Fluorescent										
Sylvania – Old	27 W[6]	0.24	2.3	2.0	15.9	0.93	0.84	3.2	4.0	1.8
Sylvania – New	30 W[6]	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
Incandescent	100W	0.02	0.8	0.6	6.4	0.94	0.65	0.6	0.7	0.7
Quartz Halogen[7]		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 ±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 ±30nm.
6 27W = Old Technology with Thick Tube; 30W = New Technology with Thin Tube.
7 LICOR model 1800-02 Calibration Lamp.