Comparison of Plant Performance Grown Under Different Greenhouse Supplemental Lighting

THE UNIVERSITY OF BRITISH COLUMBIA

Study Compiled By
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Introduction

The greenhouse industry in British Columbia has revenues over 270 million dollars in ornamental and vegetable sales (Statistics Canada, 1997). An important component in many greenhouses is the lighting system especially in areas that receive few hours of sunshine during certain seasons. For example, Vancouver International Airport receives an average of only 65.5 hours per month of sunlight during the months of November to February and Agassiz receives only 58.7 hours per month during the same months (Environment Canada). With few hours of sunlight during the winter months in the lower mainland, supplemental lighting is an option to elevate irradiation on plants. Supplemental lights have reflectors; good reflectors direct most of the light from the lamp to the plants. Some greenhouses are currently using reflectors manufactured by Poot Lighting Systems. This study compared the performance of plants grown under greenhouse supplemental lights using a standard Poot light and to a new luminaire light produced by B.C. Light Manufacturing Inc.

Materials and Methods

The study was conducted in the research greenhouses at the University of British Columbia from the end of January to the end of March 2000. Four lamps per $10.5m^2$ of bench space were used at a height of approximately 2.2 meters. One treatment contained 400 watt lamps with PL luminaires, the other contained 400 watt lamps with BC Light luminaires and the third contained 250 watt lamps with BC Light luminaires. B.C. Light Manufacturing Inc. supplied models LU 250 and LU 400 reflectors which were compared to Poot Lighting Systems model 400 HPS. All the 250 and 400 watt bulbs used were Sylvania High Pressure Sodium of identical characteristics. All lamps and fixtures are brand new.

Lights

BC Lights LU 250 + 250 watt Sylvania High Pressure Sodium lamp
BC Lights LU 400 + 400 watt Sylvania High Pressure Sodium lamp
PL 400 HPS + 400 watt Sylvania High Pressure Sodium lamp

The crops used in the study were peppers (Capiscum annuum) and pansy (Viola x wittrockiana). The peppers were purchased as two week old plugs from Bevo Farms. The pansies were purchased as three week old plugs from Genesis Plant Propagation.

Crops

Peppers (Capiscum annuum)
Pansies (Viola x wittrockiana)

Plants were randomized and replicated under each set of lights. There were 140 peppers per treatment and 160 pansies per treatment. Half of the peppers were removed and measured from each block after 4 weeks. The other half of the peppers were potted into bigger pots and replaced to their blocks. The final measurements for both the peppers and the pansies were taken after 8 weeks of treatment.

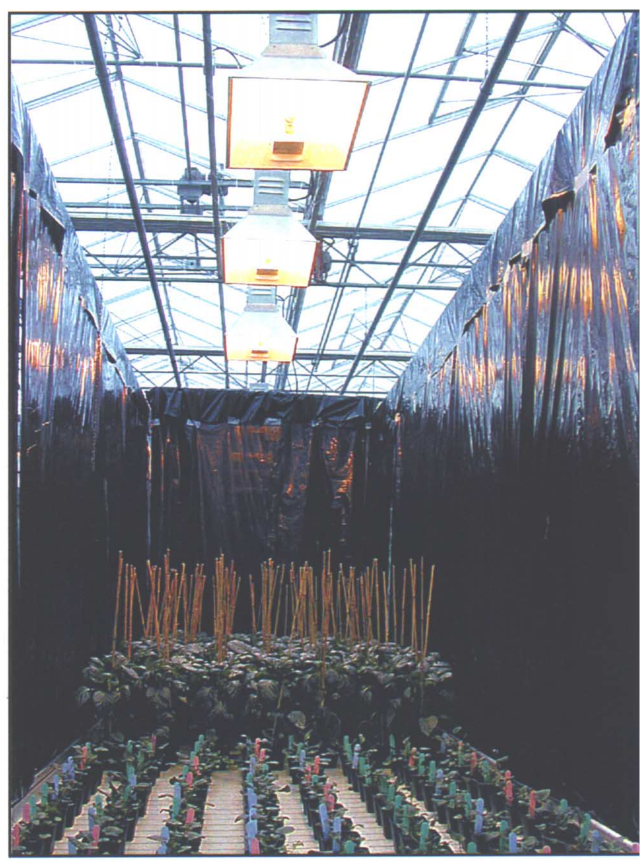


Figure 1. Supplemental lighting system design

Control software data logger (Argus Controls) recorded 21°C mean day temperature and 15°C mean night temperature from the end of January to the end of March. Black polythene sheeting of medium grade was hung to isolate the light from each fixture over the benches (Fig. 1).

Blocks were monitored for the appearance of the first open pepper and pansy flowers and the time when 50% of the pansies were in bloom. Plant height of the peppers was measured from soil level and stem diameter was measured between the first and second internodes. Peppers were grouped in bundles of five and a fresh weight was taken. The number of buds, open flowers and fruit was recorded for the pepper plants. The number of buds, open flowers, spent flowers, and apical tips was recorded for the pansies. A quality assessment of the plants was taken as plus, good quality, or minus, poor quality, based on flower/foliage colour and overall plant health.

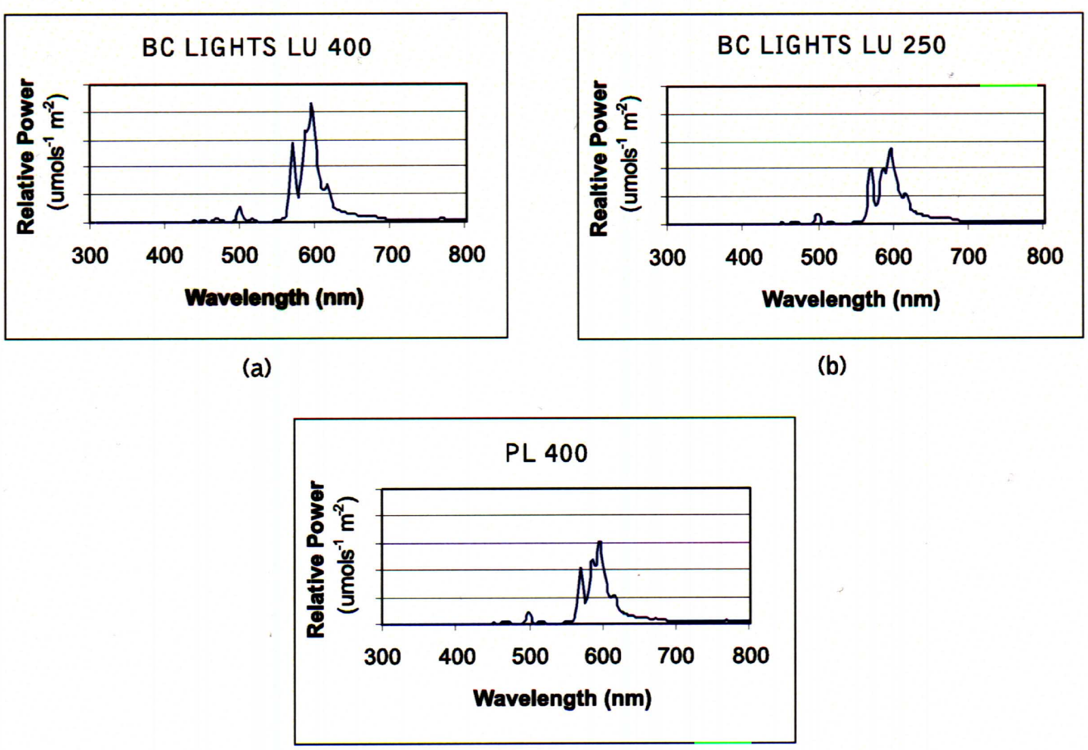
Light intensity was measured at bench level with TES Electrical Corp. 1334 light meter. The light quality (spectrum) was also measured at bench level for each treatment with a Licor LI-1800 spectroradiometer. The light quality measurements were taken at night to limit day light effects.

Data were analyzed using the computer program Systat 7.0. In each case a protected Fishers test was done to determine if there were significant differences between treatments. Significant difference was given if P 0.05.

Results

Light intensity was highest with BC Lights LU 400 (Table 1). Spectra of the three fixtures were similar (Fig. 2). The only difference was the height of the peaks and consequently the area under the graph. Area is an indication of the amount of light reaching the bench (Table 1). More light reached the bench with BC Lights LU 400 (Fig. 2a).

Figure 2. Absorbance spectrum of three different light treatment *.
*** Measured with Licor LI-1800 spectroradiometer.**



(a) (b) (c)

Table 1. Light intensity of three lamp types measured at bench level.

Light Fixture	Middle of Bench * (Foot Candles)	Edge of Bench * (Foot Candles)	Area Under Graphs (Figure 1+) (μmols $^{-1}$ m $^{-2}$)
BC Lights LU 400	745	760	7.75×10^6
BC Lights LU 250	665	608	5.63×10^6
PL 400	695	660	6.00×10^6

* Measured with TES Electrical Corp. 1334 light meter.

\+ Measured with Licor LI-1800 spectroradiometer.

BC Lights LU 400 accelerated flowering by one week in comparison to PL 400 (Table 2).

Table 2. Flowering response of pepper (Capiscum annuum) and pansy (Viola x wittrockiana) grown under three different lamp types.

	Number of days under supplemental lighting		
Light Fixture	1st Pepper Flower	1st Pansy Flower	50% of Pansies in Flower
BC Lights LU 400	32	32	53
BC Lights LU 250	36	34	53
PL 400	39	36	55

Pansy foliage and colour were good in all treatments however some plants showed leggy growth primarily at the end of the bench adjacent to the black plastic screen (Table 3). This illustrated the importance of lamp placement. This problem may not occur in non-experimental greenhouse production with evenly spaced lamps and no black polythene sheeting to block sunlight.

After 8 weeks under supplemental lighting, BC Lights LU 400 pansies had more flower buds and apical tips compared to the BC Lights LU 250 pansies (Table 3). There was no difference in the number of open flowers or spent flowers. BC Lights LU 250 and PL 400 plants were not different in any of the measured characteristics. BC Lights LU 400 lamps improved pansies in all 4 measured characteristics in comparison to the PL 400 plants (Fig. 2).

Table 3. Flower and foliage growth of pansy plants (Viola x wittrockiana) grown under three light types for 8 weeks in the greenhouse.

Light Fixture	# of Flowers	# of Flower Buds	# of Spent Flowers	# of Apical Tips	# of Leggy Plants
BC Lights LU 400	3	2	2	5	14
BC Lights LU 250	2	1	1	4	19
PL 400	2	1	1	4	19

Figure 3. Pansy plants after 8 weeks of supplemental lighting.
(BC Lights LU 400 on left, BCLights LU 250 in middle and PL 400 on right.)

Figure 4. BC Lights LU 400 pepper plant (left) compared to PL 400 pepper plant (right) after 8 weeks of treatment.

All pepper plants had good foliage colour and looked healthy regardless of fixture type. After 4 weeks of treatment, the BC Lights LU 400 improved pepper growth in four of the five characteristics measured (Table 4). BC Lights LU 400 plants had more open flowers and buds, a larger stem diameter, and a greater fresh weight. There was no difference in plant height. BC Lights LU 250 plants had a larger stem diameter and greater fresh weight than the PL 400 plants. Number of open flowers, flower buds, and plant height were not different. BC Lights LU 400 plants had higher values for all characteristics except the number of buds which was greater in the PL 400 plants.

Table 3. Flower and foliage growth of pansy plants (Viola x wittrockiana) grown under three light types for 8 weeks in the greenhouse.

Treatment	# of Open Flowers	# of Flower Buds	Plant Height (cm)	Stem Diameter (mm)	Plant Weight per 5 plants (g) *
BC Lights LU 400	1	13	32.4	7.3	224.5
BC Lights LU 250	0	9	31.6	6.8	205.2
PL 400	0	17	31.2	6.3	162.9

* Plant weight = Stem, leaf, fruit (not roots) mean of 5 plants

After 8 weeks of treatment, BC Lights LU 400 pepper plants showed increased growth than the BC Lights LU 250 plants in 5 of the 6 characteristics measured (Table 5). Number of flower buds was equivalent. BC Lights LU 250 plants had a greater height, stem diameter, and plant weight when compared to the PL 400 plants. PL 400 plants had more flowers. BC Lights LU 400 plants were different from PL 400 plants in 4 of the measured qualities, but showed no difference in the number of flowers or flower buds. BC Lights LU 400 pepper fruit was more mature than PL 400 fruit (Fig. 3).

Table 5. Flower and foliage growth of pepper plants (Capiscum annuum) grown under three light types for 8 weeks in the greenhouse.

Treatment	# of Open Flowers	# of Flower Buds	Plant Height (cm)	Stem Diameter (mm)	Plant Weight per 5 plants (g)
BC Lights LU 400	3	6	19	48.3	682.2
BC Lights LU 250	1	4	19	51.0	572.3
PL 400	1	5	20	47.6	457.7

Technical Summary

With BC Lights LU 400

More light reaches the bench
Accelerates flowering
Increases plant mass
Increases fruit development

BC Lights LU 250 plant performance was comparable to the PL 400 plants.

References

Environment Canada Climate Normals. http://www.cmc.ec.gc.ca/climate/normals/eprovwmo.htm. April 15, 2000.

Statistics Canada, 1997. Greenhouse sod and nursery industries. Ontario, Canada.