LED in Labs - Plant Growth

Martin Howes
Energy Co-ordinator
Department of Plant Sciences,
University of Cambridge
Email: meh73@cam.ac.uk
Outline

- Background
  - Department of Plant Sciences
  - Energy & Plant Growth
- 1) LEDs in Plant Growth Rooms
  - Biological Testing
  - Energy
- 2) LEDs in Algal Incubator Shakers
- Conclusion
The top University of Cambridge users of electricity, ranked by usage per m² (kWh/m²):
Facilities range from individual trays and algal incubation shakers to growth cabinets and rooms to greenhouses.

Artificial lighting is used for maximum control.

A significant portion of departmental electricity costs are for lighting and for chilling to counter the waste heat emitted by lights.
Plant research is dependent on high quality lighting.

For plant growth, Photosynthetically Active Radiation (PAR) light is needed.

Plants can use light between 400-700nm in wavelength.

The key is to deliver the right light intensity (amount of photons) of the right wavelength to the plants.
1) LEDs in Plant Growth Rooms

- Typical ‘day load’ is 8kW per room, not-including chilling provision.

- Trials began in 2012 with funding from the Energy & Carbon Reduction Project.

- We want a close match for the fluorescent lighting.
1) LEDs in Plant Growth Rooms
Light Intensity & Coverage

- Isophote maps show intensity of PAR 5cm above the surface of the growth tray under different light treatments.
1) LEDs in Plant Growth Rooms
Light Spectrum Delivered

Electromagnetic spectra showing relative intensity of different wavelengths for the different light treatments
1) LEDs in Plant Growth Rooms

Biological Testing

- Experiments used mainly Arabidopsis, wheat, tobacco and tomato.

- Results imply that despite the differences between the spectra of fluorescent lighting and LED lighting, plant growth is determined by overall intensity.
1) LEDs in Plant Growth Rooms
Energy & Current Status

- An LED array type has been decided upon to refit two whole Plant Growth Rooms with.
- From trials, a >50% reduction in electricity required to light rooms is expected. A conservative 4kW reduction per room would equate to over £60,000 saved per year.
- Further savings will come from reduced demand for chilling and reduced expenditure on light replacement.
2) LEDs in Algal Incubator Shakers

- Infors Incubator Shakers are fully climate-controlled chambers for cultivating algae.

- Each unit costs around £6000 per year to run in electricity and tube replacement costs.
2) LEDs in Algal Incubator Shakers - Biological Testing

No significant differences have been found in algal growth between LEDs and fluorescent lighting.
2) LEDs in Algal Incubator Shakers
- Energy

Relationship of light PAR generated by the unit and the power used for the lights alone - Lab 220

- LEDs are:
  - Over twice as efficient.
  - Capable of producing nearly double the light intensity.
2) LEDs in Algal Incubator Shakers
   - Energy

- Unit capability is improved.
- LEDs emit less heat which reduces chilling demand. A further ~55W is saved under normal operating conditions.
- Expected lifespan of the LEDs is 10x better than the tubes (10-20 years instead of 1-2 years).
Conclusion

- LED technology is maturing quickly. It is efficient, powerful and flexible.

- Switching to LED cannot adversely affect research. It requires an ‘application-first’ approach.

- Refitting can improve the capability of existing equipment and reduce maintenance costs.

- Significant reductions in electricity consumption and expenditure are expected.
Thank You

Questions?

Martin Farley  
S-Lab Project Co-ordinator  
King’s College London  
martin.farley@kcl.ac.uk

Martin Howes  
Energy Co-ordinator  
Department of Plant Sciences  
University of Cambridge  
meh73@cam.ac.uk