



BPOA Technical Seminar

Muck and Magic

The Potential Benefits of Diffuse Radiation

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Freiston Associates Ltd and
The University of Lincoln

Background

- The University of Reading
 - First ever boss was Harry Kitchener



Also...

- The University of Reading
 - Professor Paul Hadley aka Willie Wonka
 - Research interests were in;
 - Crop Physiology
 - Effects of light on crop growth, especially the use of lighting systems in horticulture, and
 - The development of spectral filters to control crop growth;
 - Luminance
 - Solartrol
 - UV Interacting Materials
 - Heat Reflective Films



Then...

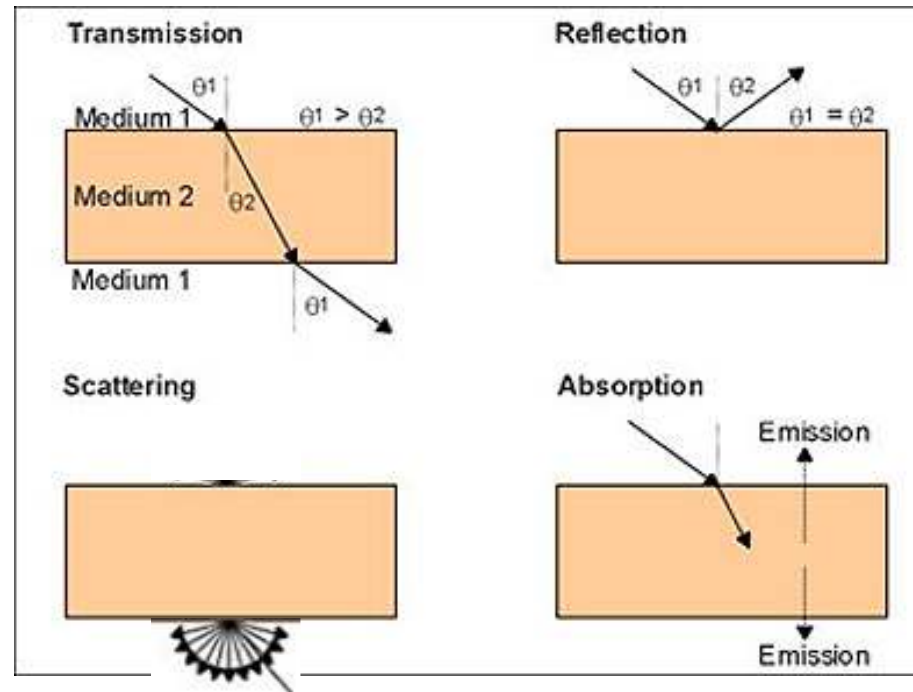


Now..... back working with...

- Willie Wonka and the Morris Man!
- HDC CP138: An Lighting Guide for UK horticulture, with Phil Davis.
- Developing a project on optical coatings for greenhouses, including diffuse glass

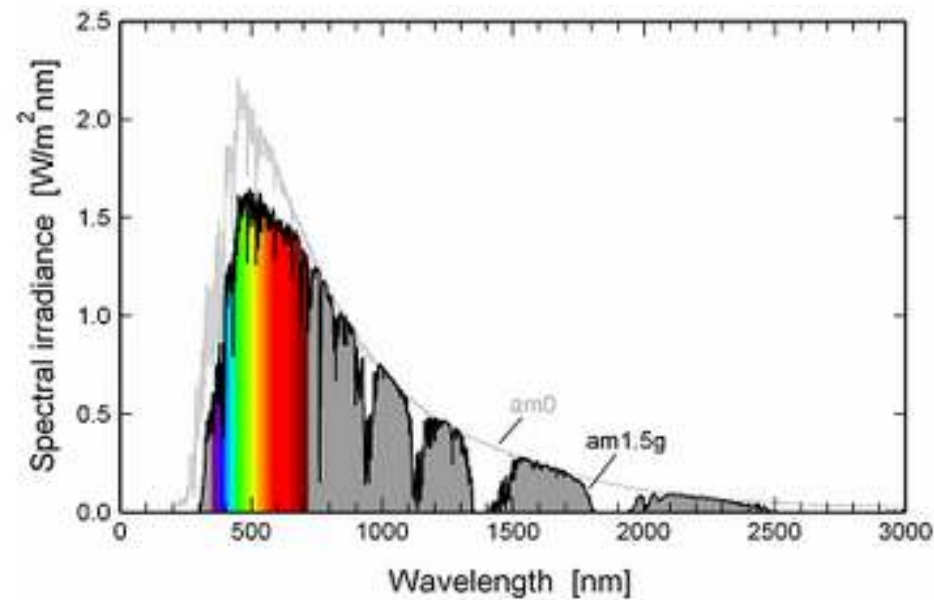


Effect of greenhouse covering



Could be directional or non directional
Several mechanisms to cause scattering,
Scattering is wavelength dependent

Photoselective Coatings

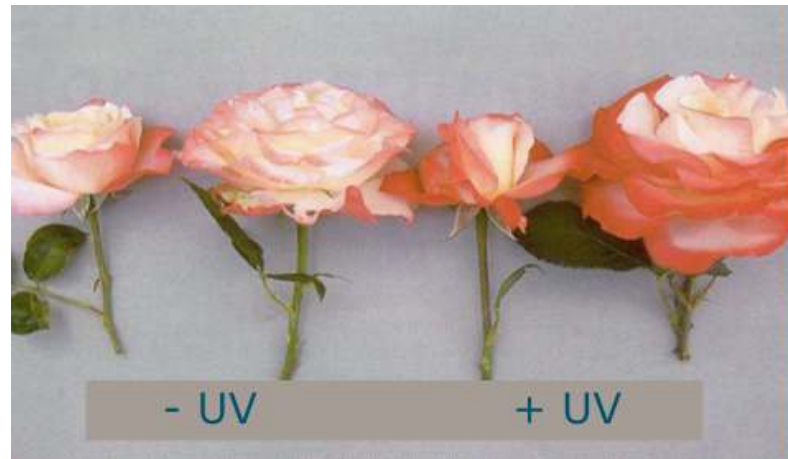


Quick reminder. The solar action spectra

Photoselective Coatings

Ultra violet

- Insect activity
- Bees
- Fungal sproulation
- Crop flavour, esp Herbs
- Flower colour
- Photoinbition



Hemming et al, 2006

Photoselective Coatings

Far Red

- Shade avoidance
 - Leaf shape and thickness
 - Flowering time
 - Stem elongation
-
- Solartrol



Far red removed

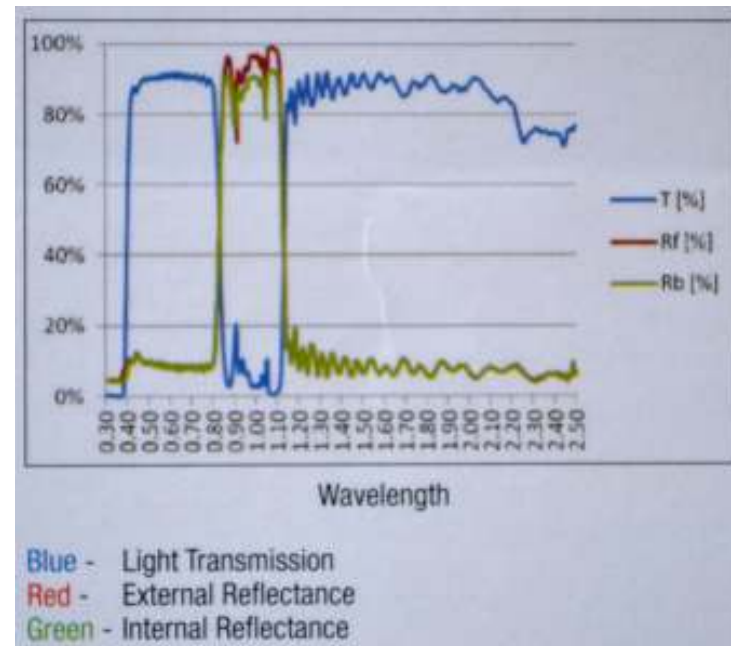
Cambridge, UK,

Photoselective Coatings

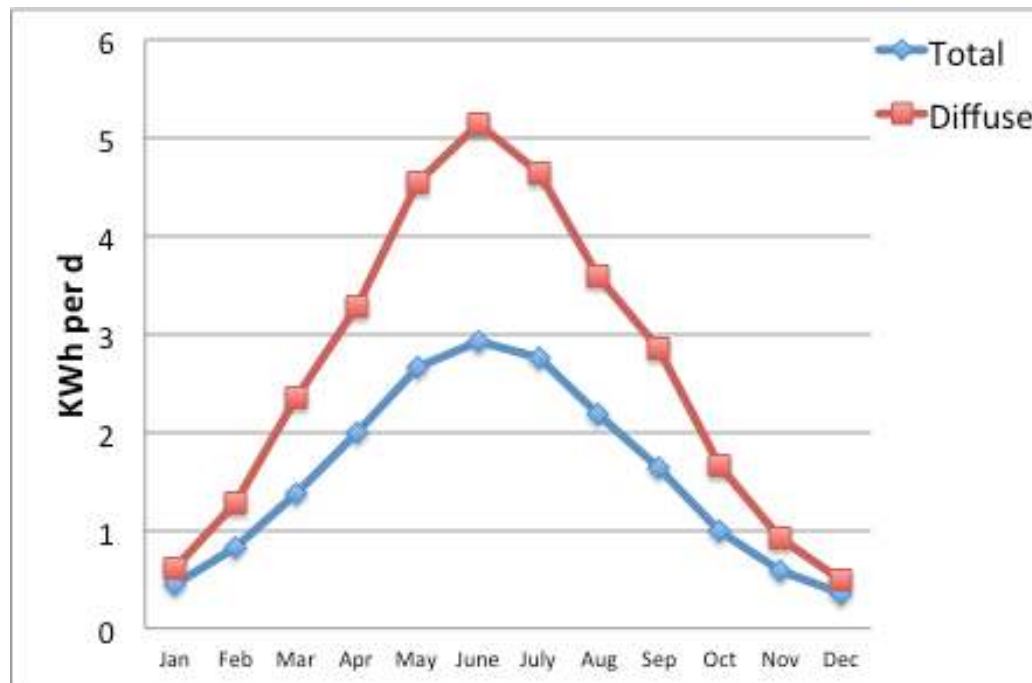
Infra red films

- Heat rejection
- Thermal control
- Quality improvements
- Less ventilation, higher CO2

- 3M Prestige 90
- Multi layer filters

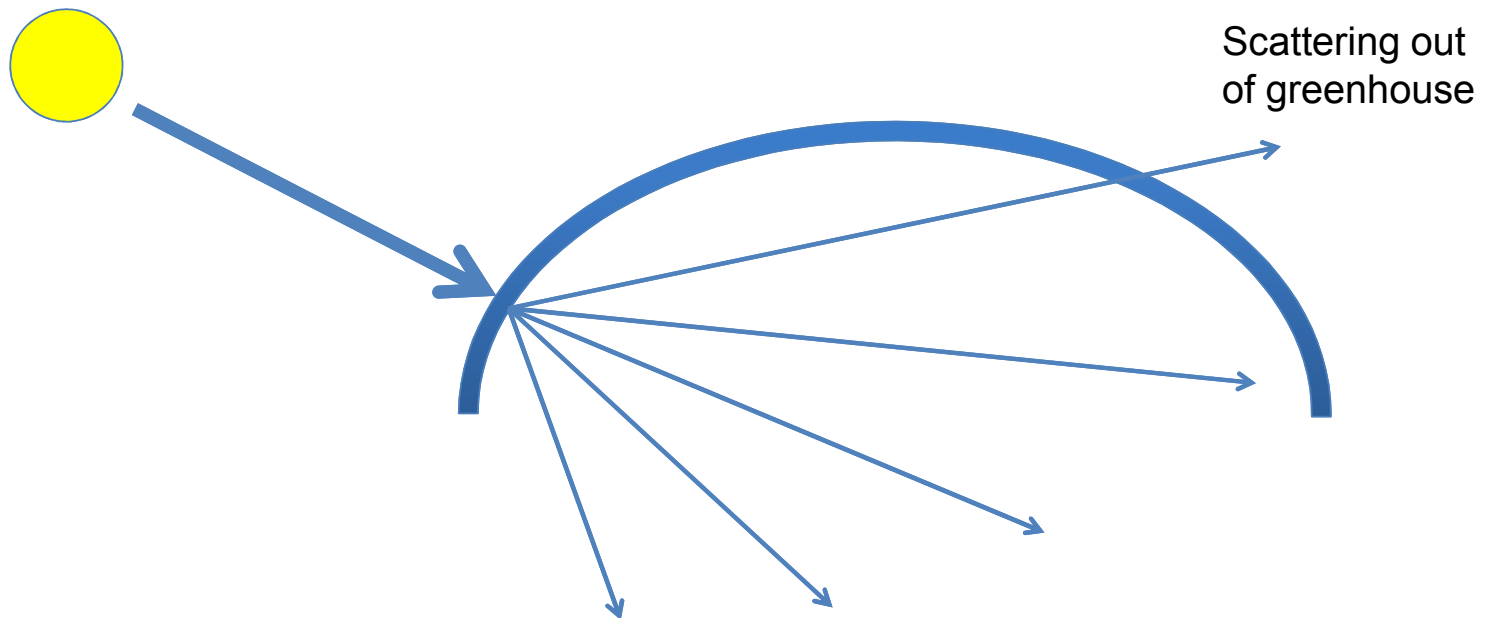


Direct and Diffuse Radiation....



Cambridge, UK,

Greenhouse Shape is Important



Flat surfaces are better, highly curves shapes will lose energy

Direct and Diffuse Radiation....

- Diffuse: Even canopy temperatures
- Less thermal stress on the top of the canopy

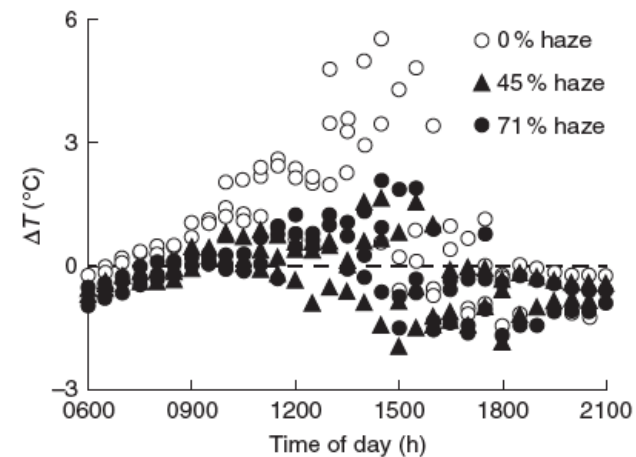
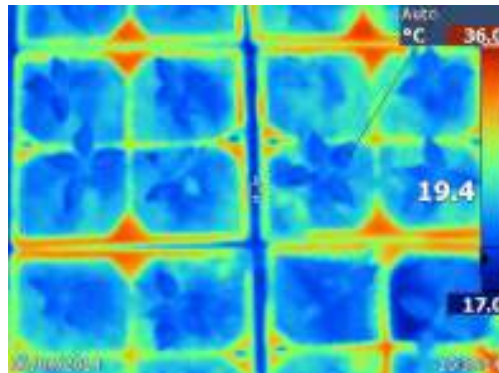


FIG. 5. Diurnal pattern of the temperature difference between leaf and air (ΔT) at the canopy top layer on three clear days (2, 4 and 5 August; average global radiation was $18.8 \pm 1.3 \text{ MJ m}^{-2} \text{ d}^{-1}$). Each symbol represents the average of measurements over 30 min on three leaves.

Tomatoes; Liu et al., 2014. Ann Bot (114), 145-56

Direct and Diffuse Radiation....

- Canopy develops more leaf
- Leaves tend to be thinner but larger
- Reduced leaf burn

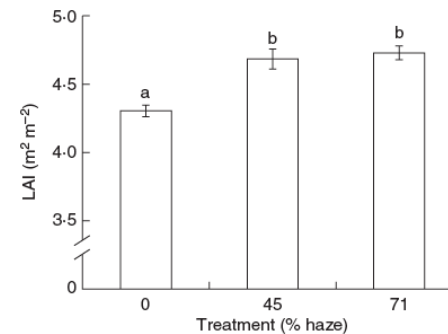


FIG. 1. Average leaf area index (LAI) in summer months. Measurements were carried out on 25 May, and 5 and 27 July. Six plants were measured at each treatment each time. Error bars show $\pm$ s.e. ($n=18$). Letters show statistically significant differences ($P < 0.05$).

Anthuriums grown at Wageningen EU, data courtesy of F. van Noort



Direct and Diffuse Radiation....

- Higher rate of canopy photosynthesis
- Liu showed +7.1% in 71% haze glass
- Higher yield, Dueck (2012) on tomatoes showed +7.8 and 9.4% yield increases under 45 and 71% haze

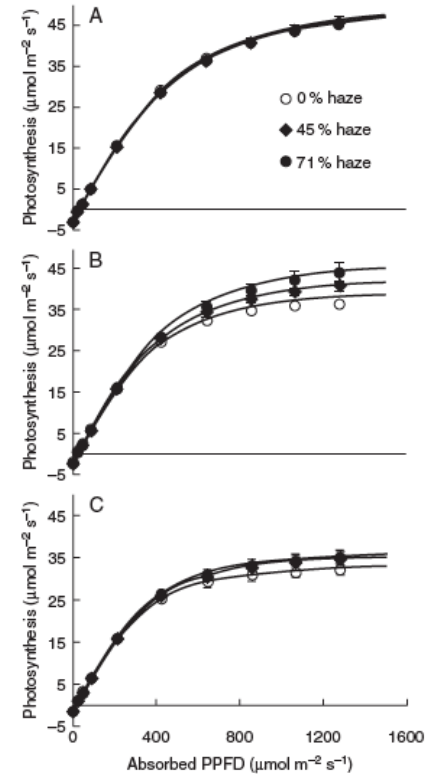


FIG. 8. Photosynthetic light response curves of leaves at the top (A), middle (B) and bottom (C) of the canopy. These measurements were taken in June. During the measurements, leaf temperature and CO_2 concentration in the measurement chamber were maintained at 25°C and $700 \mu\text{mol mol}^{-1}$, respectively. Error bars show $\pm$ s.e. (n=6).

Direct and Diffuse Radiation....

- Diffuse polythene now used for 10 years by soft fruit industry.
- Diffuse glass widely adopted for Dutch new build sites.
- What are options for UK growers?



Direct and Diffuse Radiation....

- Whitewash.
 - Has a diffusing effect also reduces PAR.
 - Little known. Optical properties, cleaning, durability, dose rates etc
- Screens. Tend to block PAR rather than diffuse.
- Opportunity for new materials
 - Highly diffuse with little impact on PAR



Direct and Diffuse Radiation....

- Represents a huge opportunity, but..
- Little known about how to apply paint based coats
- Materials technology is required, in particular materials optimisation.
- Crop responses just starting to be understood.
- Materials technology is moving fast
- We hope to publish a wide ranging review this summer.



ESG Polyvision™ Power Off



ESG Polyvision™ Power On



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Q&A