Plant Raisers

The challenges
The growing system
The challenges / goals

- Uniform plant growth
- Rapidly changing crop
- Thermal / shade screen control
- Optimal use of lighting
Greenhouse infrastructure

• Heating
Heating at West End Nursery

- Raised, solid benches
- Above & below bench heating
Radiant/convective heat effects

- Convective energy heats the air which in turn heats the plant
- Radiant energy heats the plant directly
- Radiant heating effect depends on:
  - Temperature & ‘colour’ of the pipe
  - Distance between the pipe and the plants
Radiant/convective heat effects

- Other sources of radiant energy
  - Sun
  - Lights
• **Move to ‘high’ light intensity**
  – High = 10,000 lux
  – Low = 4,000 lux

• **Why?**
  – Reduce cropping time
    • Increase output/m²
  – Increase scheduling accuracy / reliability
Lights at Plant Raisers

• **Added benefits**
  – Modern energy efficient fittings
  – Improved uniformity
  – Extra radiant heating
Greenhouse infrastructure

• Some shade screens save more energy than an energy screen!
  – Shade up to 70%
  – Energy screen 43%
  – WHEN CLOSED
Tomatoes with no thermal screen (week 13)
Tomatoes with thermal screen (week 13)

Time

°C

Screens - Top

Screens - bottom

Screens canopy IR
Greenhouse infrastructure

• Screens – less radiant cooling

+ 

• More radiant heat from high light intensity

= warmer plant

• Grow @ lower temperature
Controlling lighting

- **Time**
  - Simple
  - Easy to understand
  - Belt & braces

- **Outside light intensity**
  - Turn off if $> X \text{W/m}^2$
  - But what is $X$?

- **Radiation sum**
  - Turn off if $> Y \text{J/cm}^2$
  - But what is $Y$?
Controlling lighting

- Minimum on / off times - kinder to:
  - Lamps
  - Electricity supplies
  - Plants

Lumen maintenance HO 50-600W

![Graph showing lumen maintenance over hours](image)
Controlling lighting

• Remember temperature integration?

• Multi-day average radiation sum
  – Fundamentally the same as TI
  – ‘Bank’ a high light day
  – Use lights less on a following low light day
Lights + screens

• Compared to pipe heat
• Lights are instant on/off
  • Rapid changes in greenhouse temperature
• Explore strategies to help with this
  • ‘Dealer’ level settings
  • ‘Drop’ before lights turn on
  • Refine screen gap settings
So you want to save energy?

Use less water!

• Energy required to warm 1m$^3$ of air by 1$^\circ$C
• Energy required to evaporate 1 litre of water
• Excess water also increases the relative humidity
Irrigation – West End

• Ebb & flood

• Large wet surface
  – Lot of evaporation
  – Short-lived

• All or nothing control
  – Wet pots through the night
  – Passive transpiration – high RH overnight
  – High root pressure
Overhead Irrigation

• Large wet surface
  – Lot of evaporation
  – Short-lived

– Wet leaves
  – Timing of application is critical

• Fine control
  – Easier management
Are you getting what you’re asking for?

- **Aerial environment**
  - Measured temperature
  - Measured humidity

- **Set points**
  - *Calculated* heating temperature
  - *Calculated* ventilation temperature

- **Equipment status**
  - Measured pipe temperature
  - Measured vent position
  - Screen position
Equipment function

Heating

- **Calculated** heating temperature
- Measured greenhouse temperature
- Calculated minimum pipe temperature
- Calculated pipe temperature
- Measured pipe temperature

• Similar for Vents
Heating check points

If it’s not getting what it is asking for

– Check the boiler & ring main temperature
– Check the pump on/off set points
– Check the sensor - do you know where it is?
– Do you have a spare one?
– Check the pump, do you know which one it is?
– Backup mechanical thermostats
Temperature
  – Put all dry bulb temperatures on one graph
  – At least all ones with similar target temperatures

Humidity
  – Do the same

Helps with
  – Comparing relative performance of similar greenhouse compartments
  – Spotting when humidity measurements are going ‘wrong’
• **Heating systems**
  – Think about how they affect air movement within the greenhouse & crop

• **Lights**
  – Not just more J/cm²
  – A multi-functional management tool

• **Irrigation systems**
  – A vital part of energy saving

• **Daily checks**
  – The route to an easier life?
That’s all for this session

Any more questions at this stage?