# Evaluating the Interaction of Temperature and Photoperiod on Poinsettia Flowering

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Clemson University

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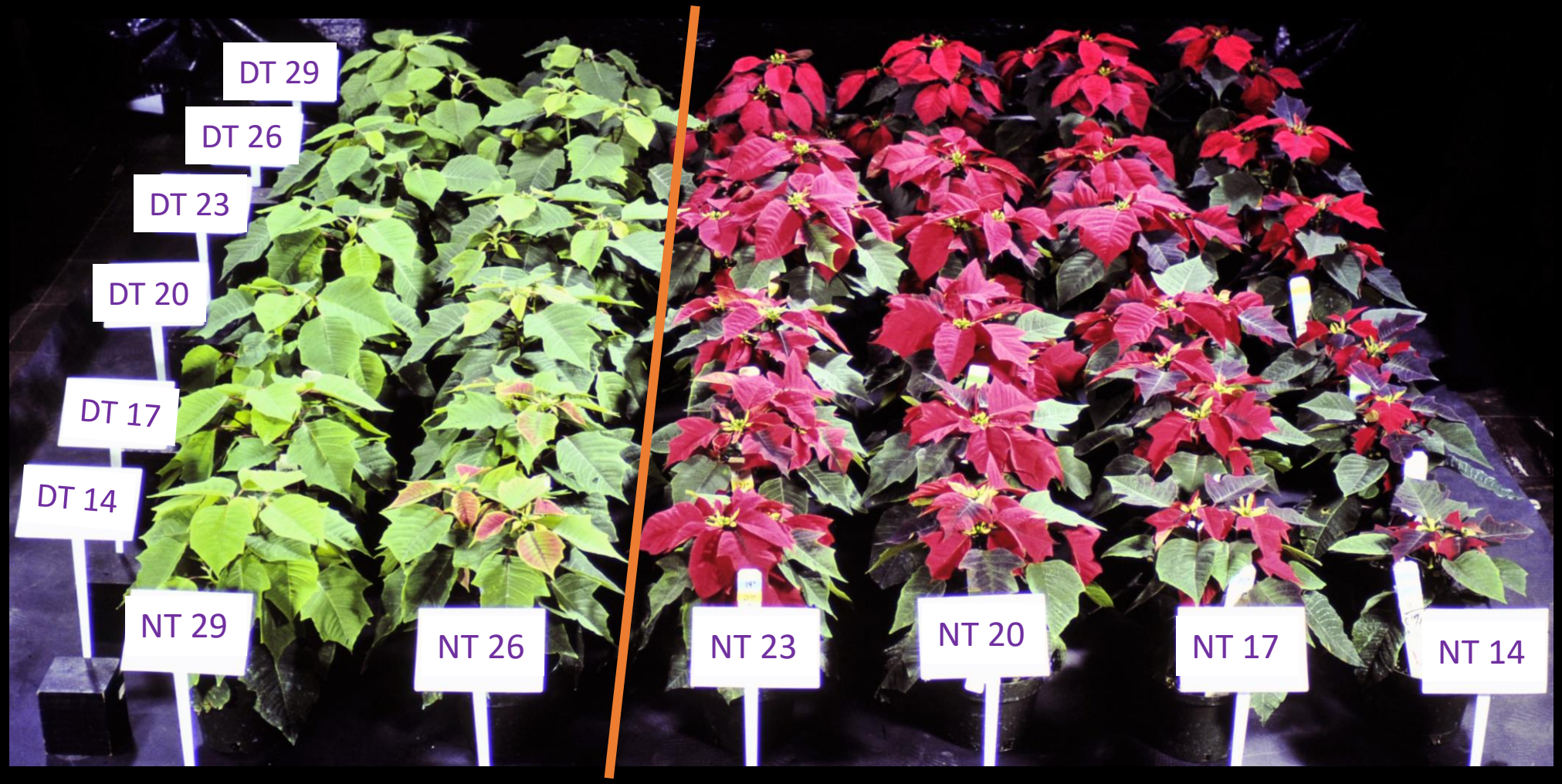
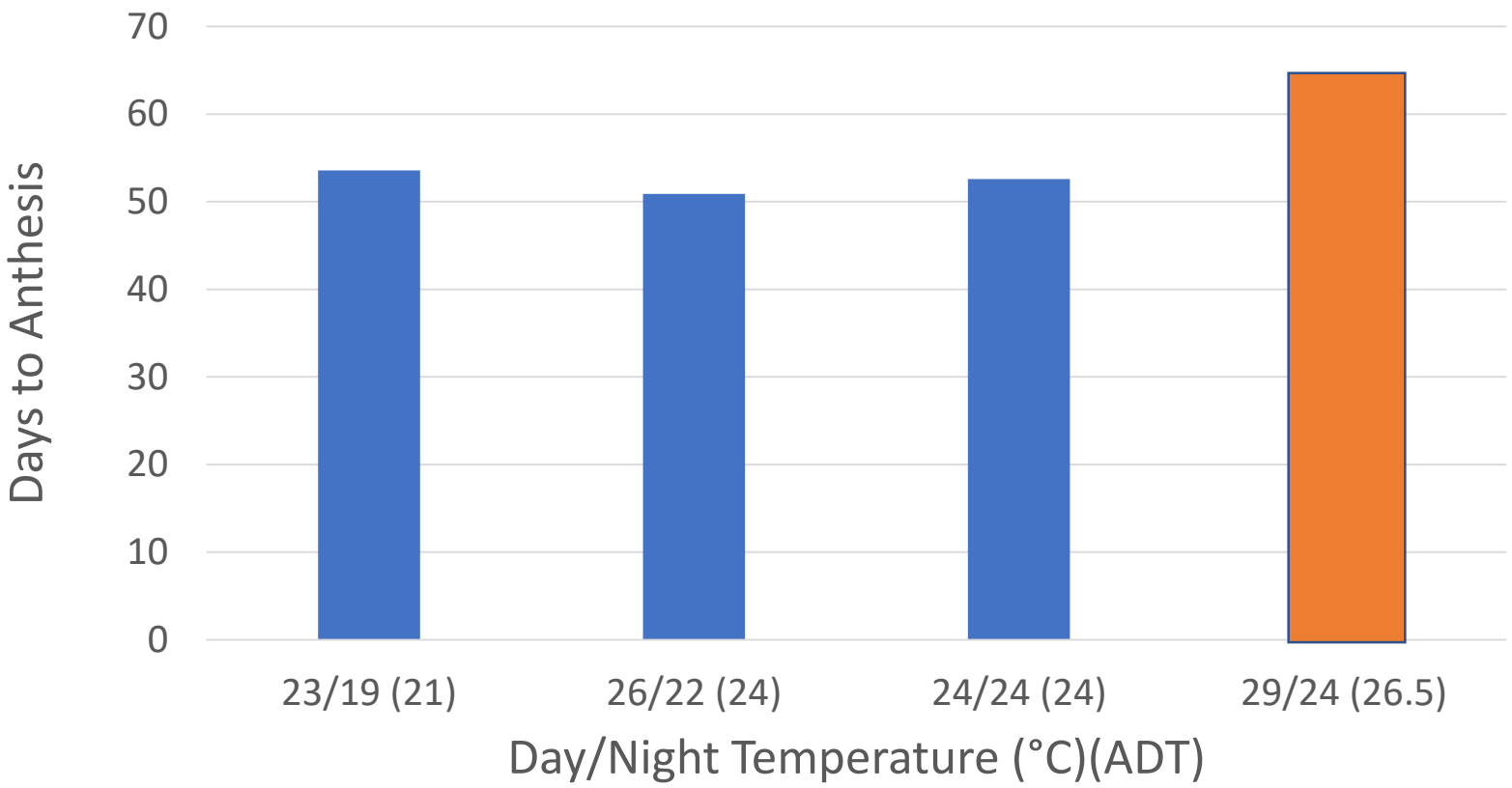
# High NT inhibits flowering




Plants grown at 14h nightlengths for entire experiment

Berghage & Heins, 1986

# High ADT inhibits flowering




Plants grown at 12h nightlengths for entire experiment

Schnelle & Barrett, 2008

# Experimental Summary

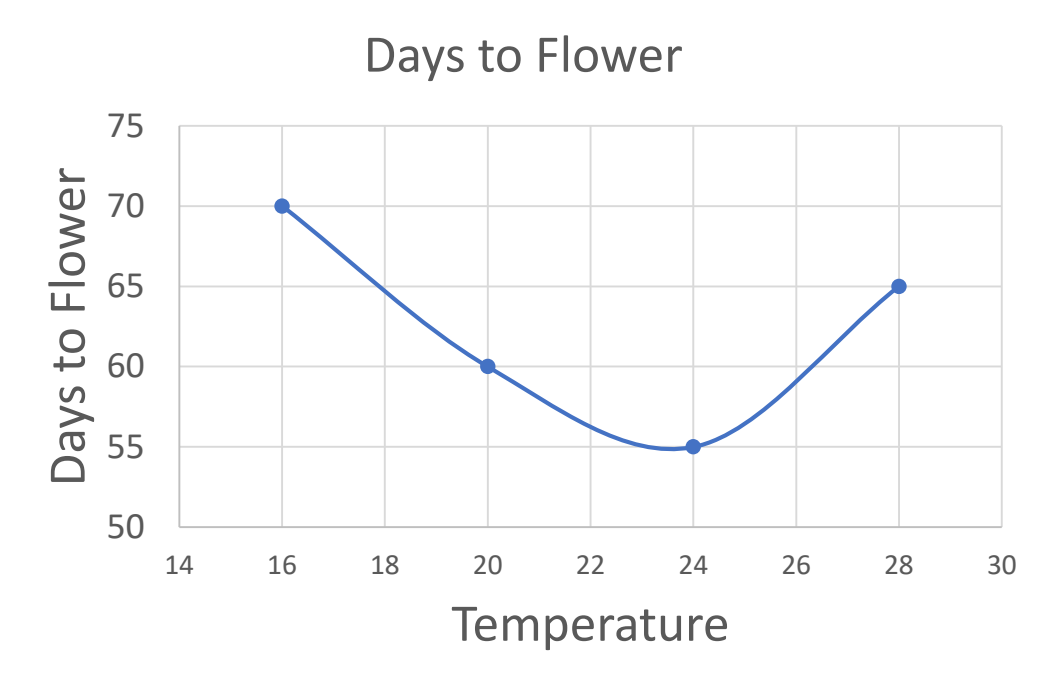
Orion -Heat insensitive
Prestige -Heat sensitive

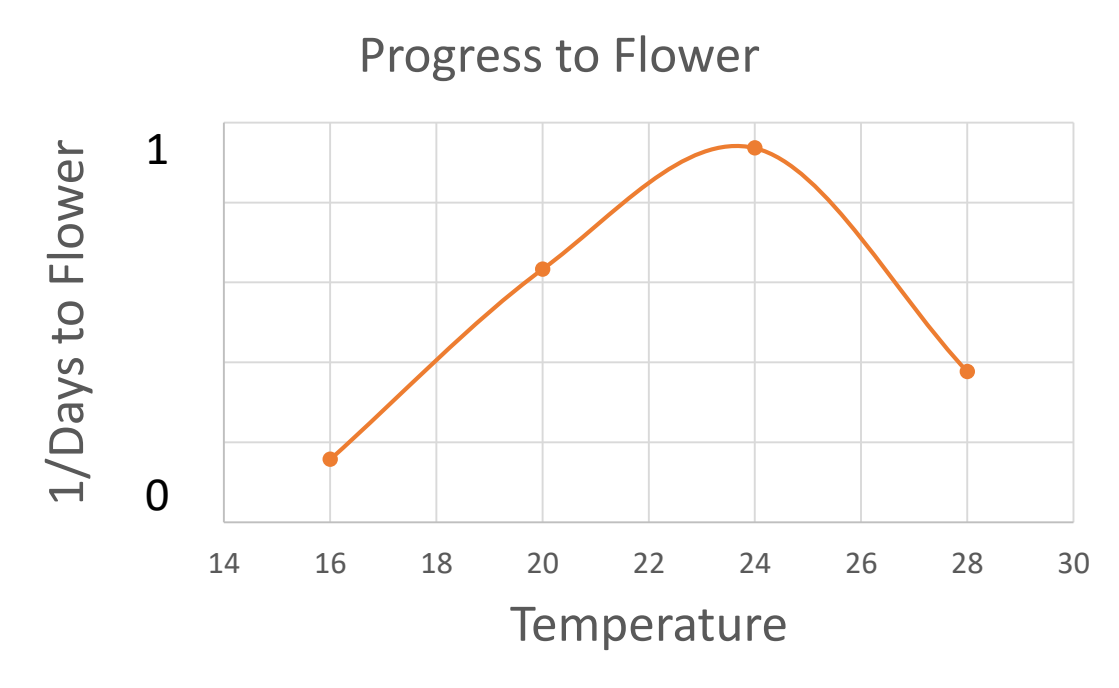
| 20°C, 8-hr night | Treatments applied for 17 days | 24°C/20°C, 14-hr night |
|---|---|---|

| Day Temperature (°C) | Night Temperature (°C) | | | |
|---|---|---|---|---|
| | 16 | 20 | 24 | 28 |
| 20 | 20/16 | 20/20 | 20/24 | 20/28 |
| 24 | 24/16 | 24/20 | 24/24 | 24/28 |
| 28 | 28/16 | 28/20 | 28/24 | 28/28 |

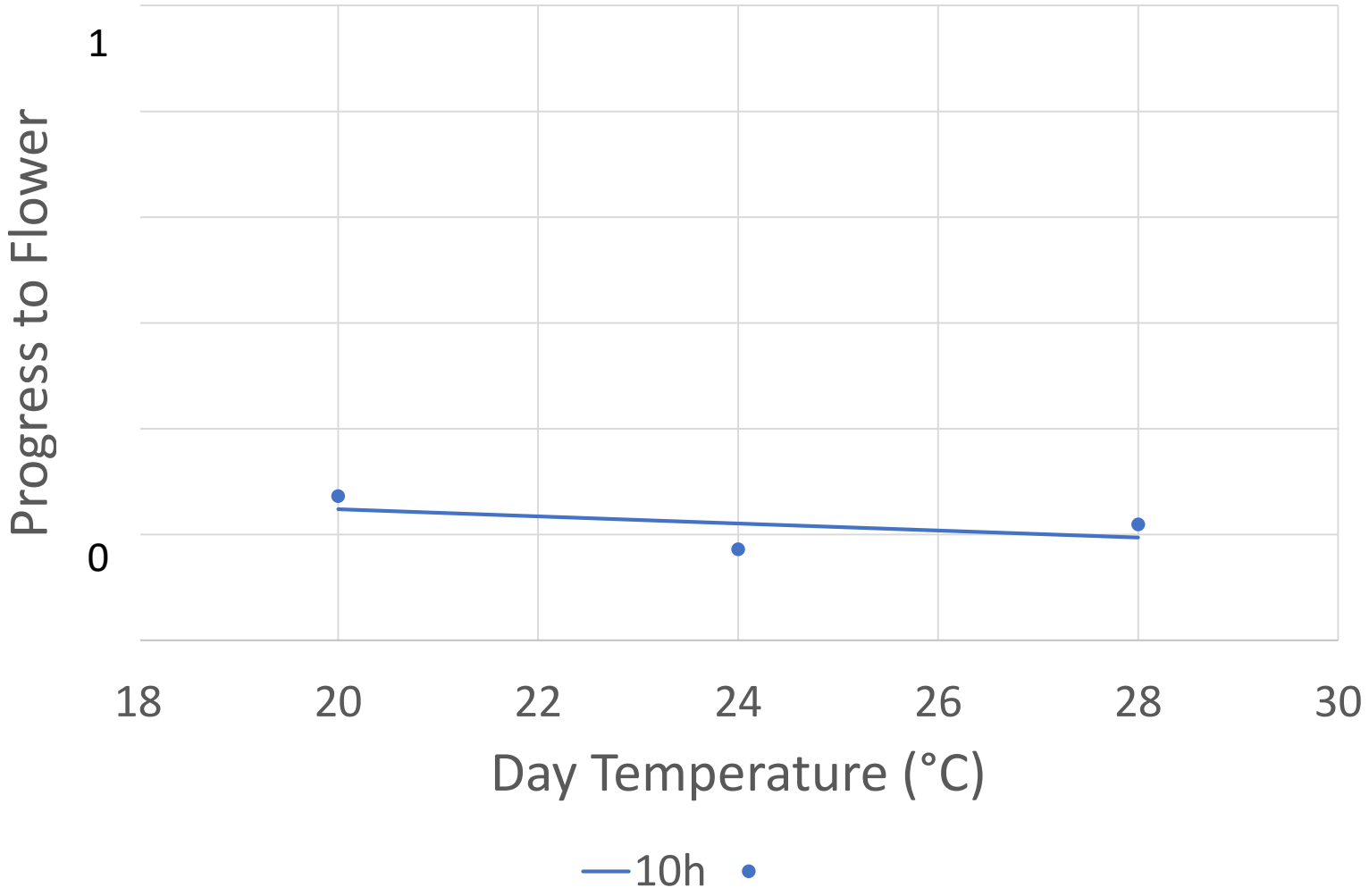
10-hr night
11-hr night
12-hr night
13-hr night
14-hr night

= 60 Temp. x Photoperiod Treatments


Days to Flower
Days to Flower
75
70
65
60
55
50
14
16
18
20
22
24
26
28
30
Temperature

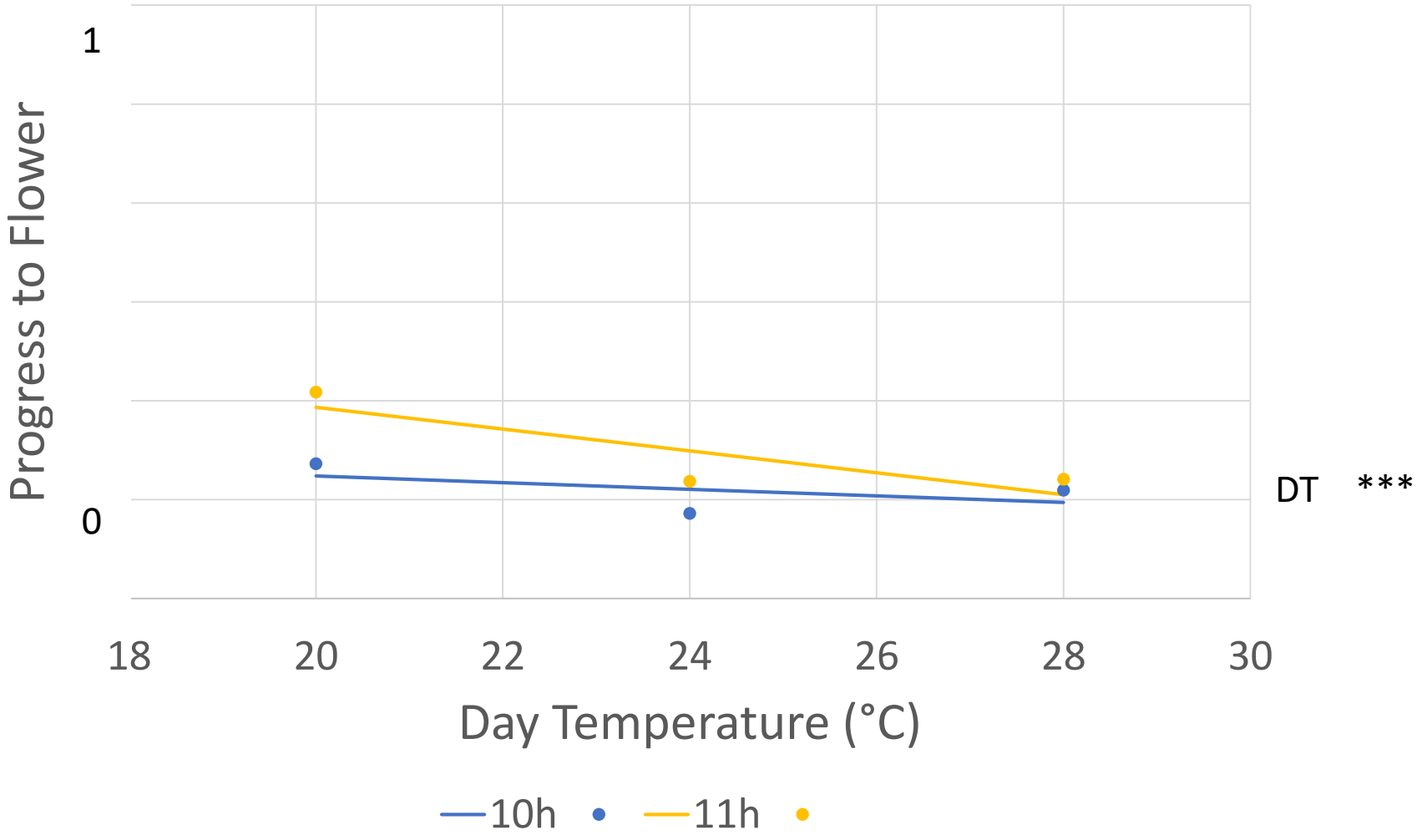

Progress to Flower
1/Days to Flower
1
0
14
16
18
20
22
24
26
28
30
Temperature

# Orion - Day Temperature



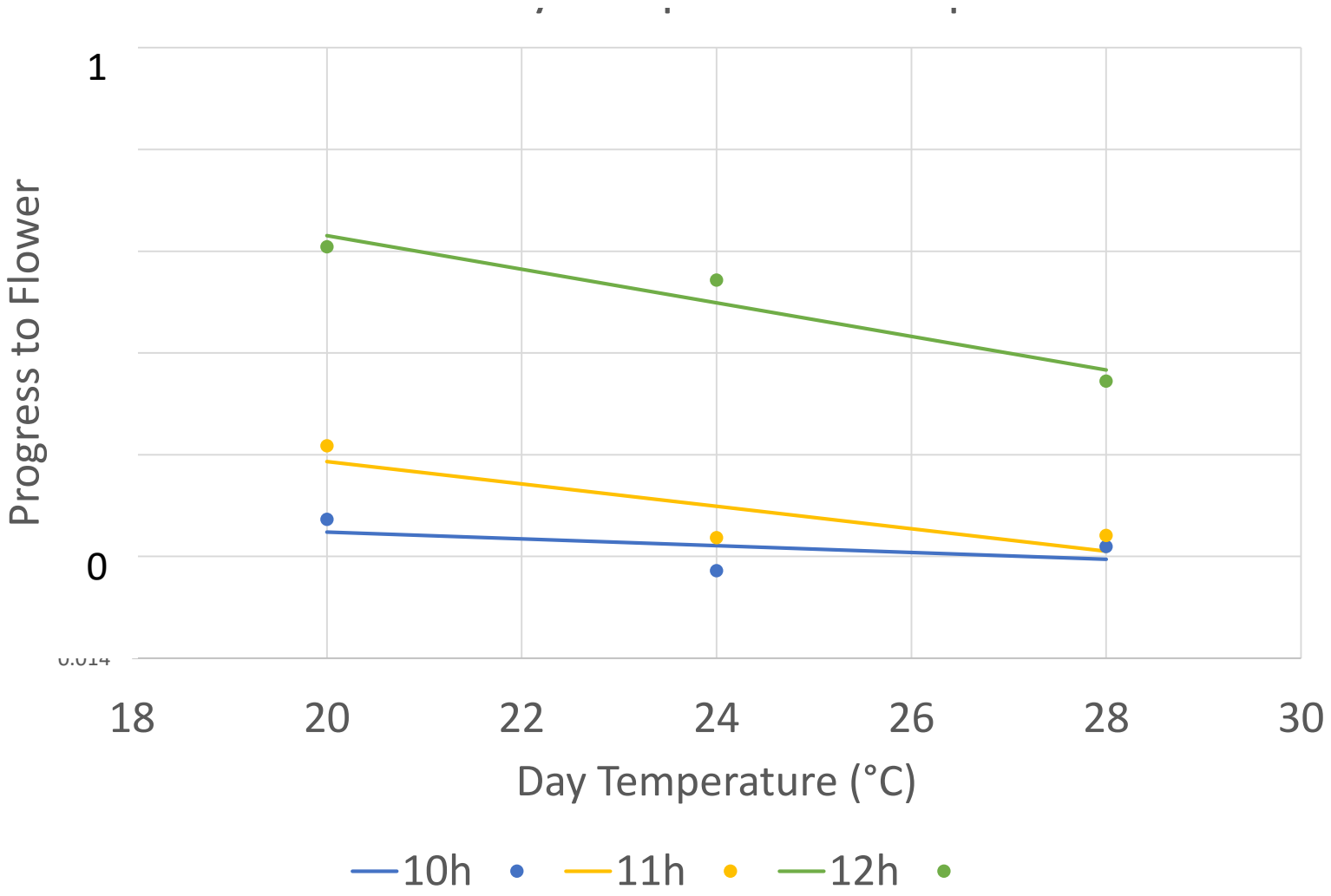

DT n.s.

# Orion - Day Temperature



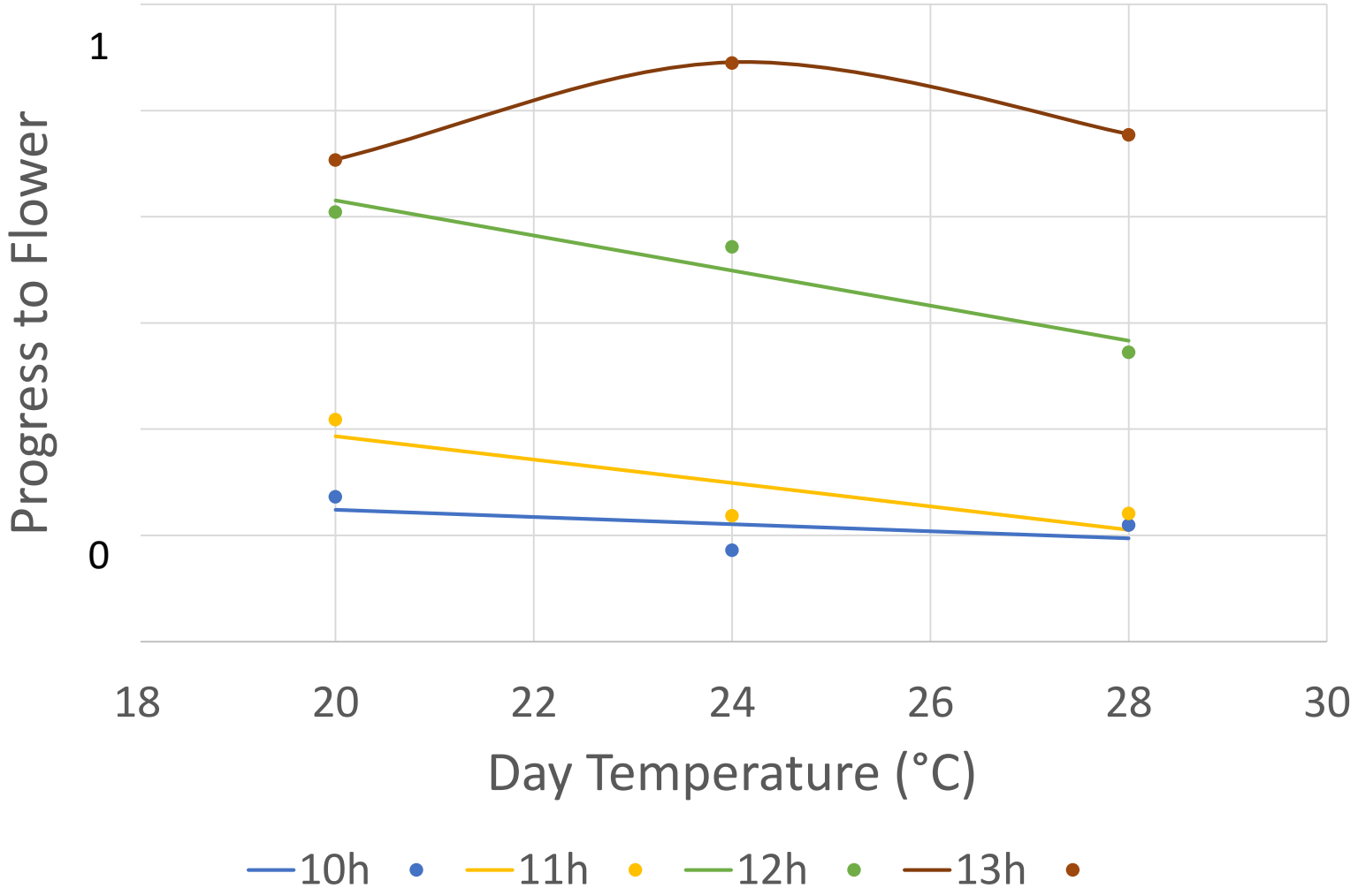

DT ***

# Orion - Day Temperature



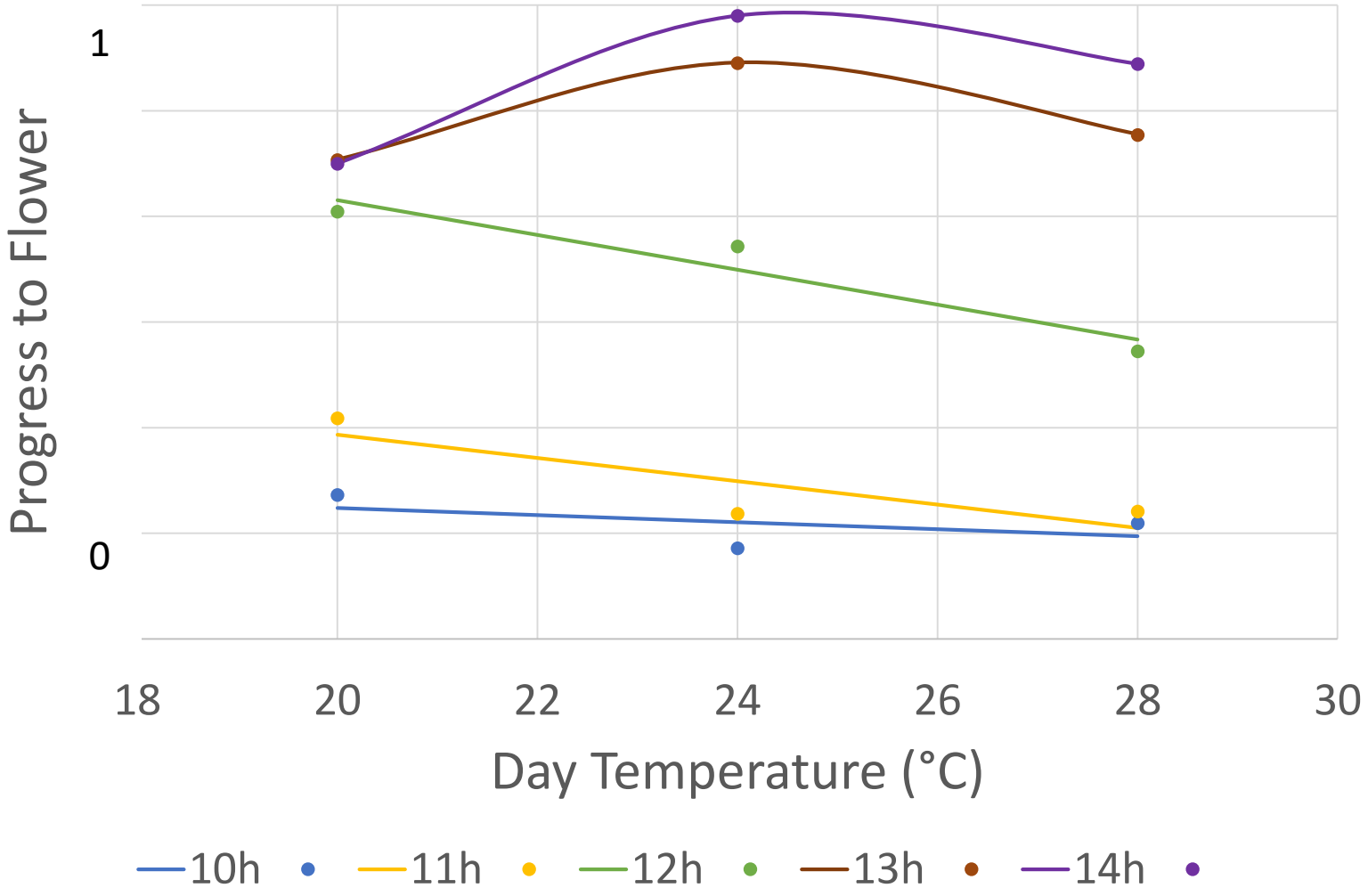

DT ***

# Orion - Day Temperature



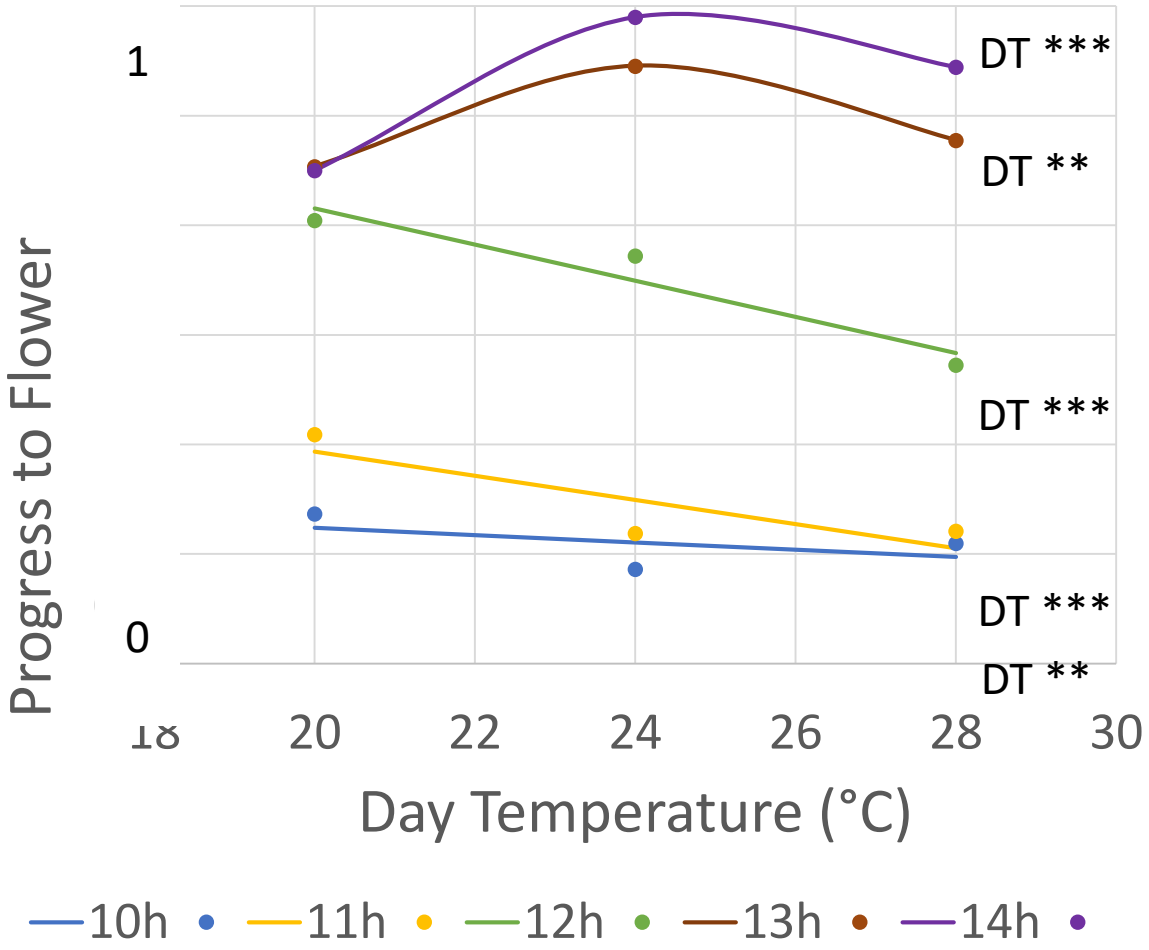

DT **

# Orion - Day Temperature

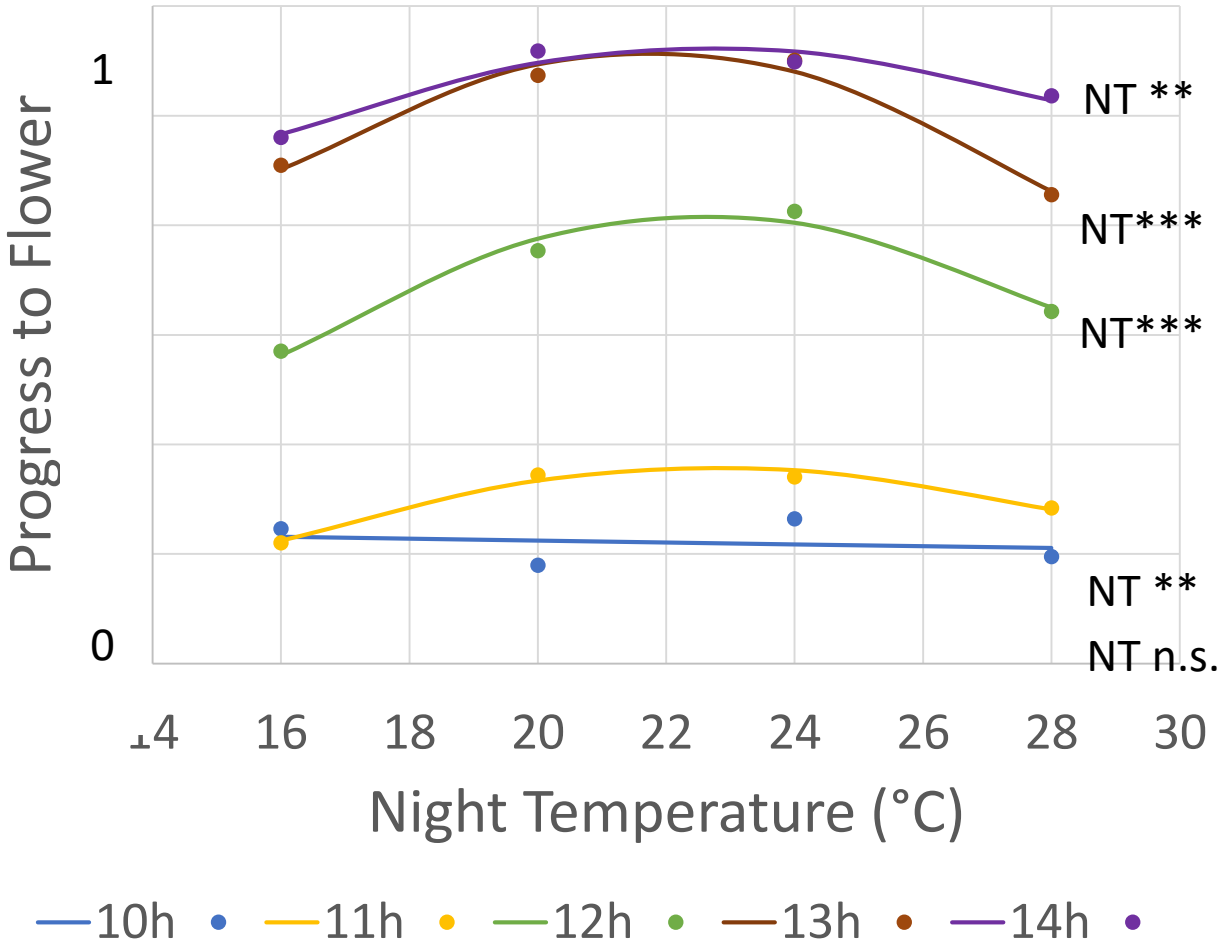



DT ***

# Orion - Day Temperature



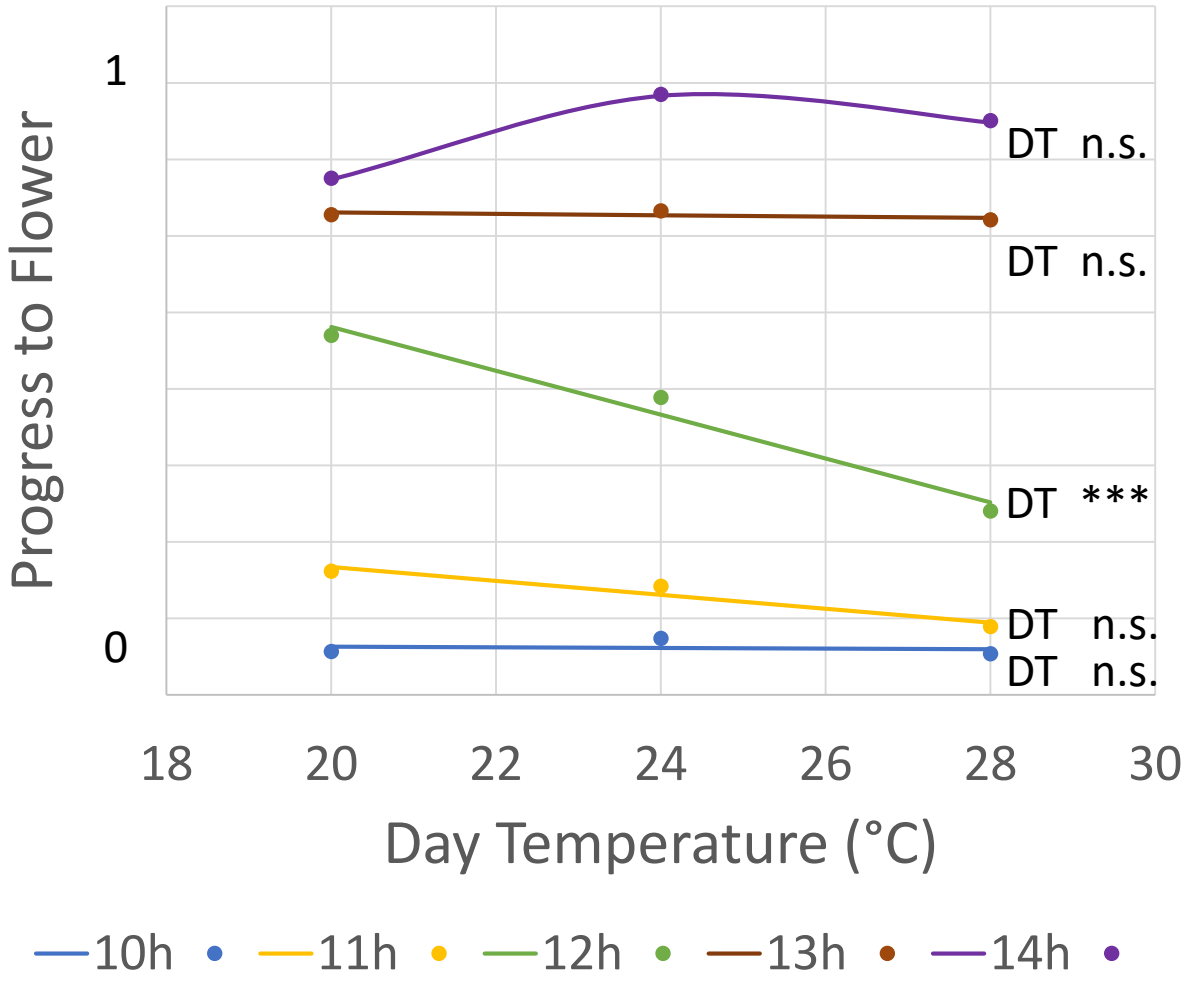

# Orion-Night Temperature



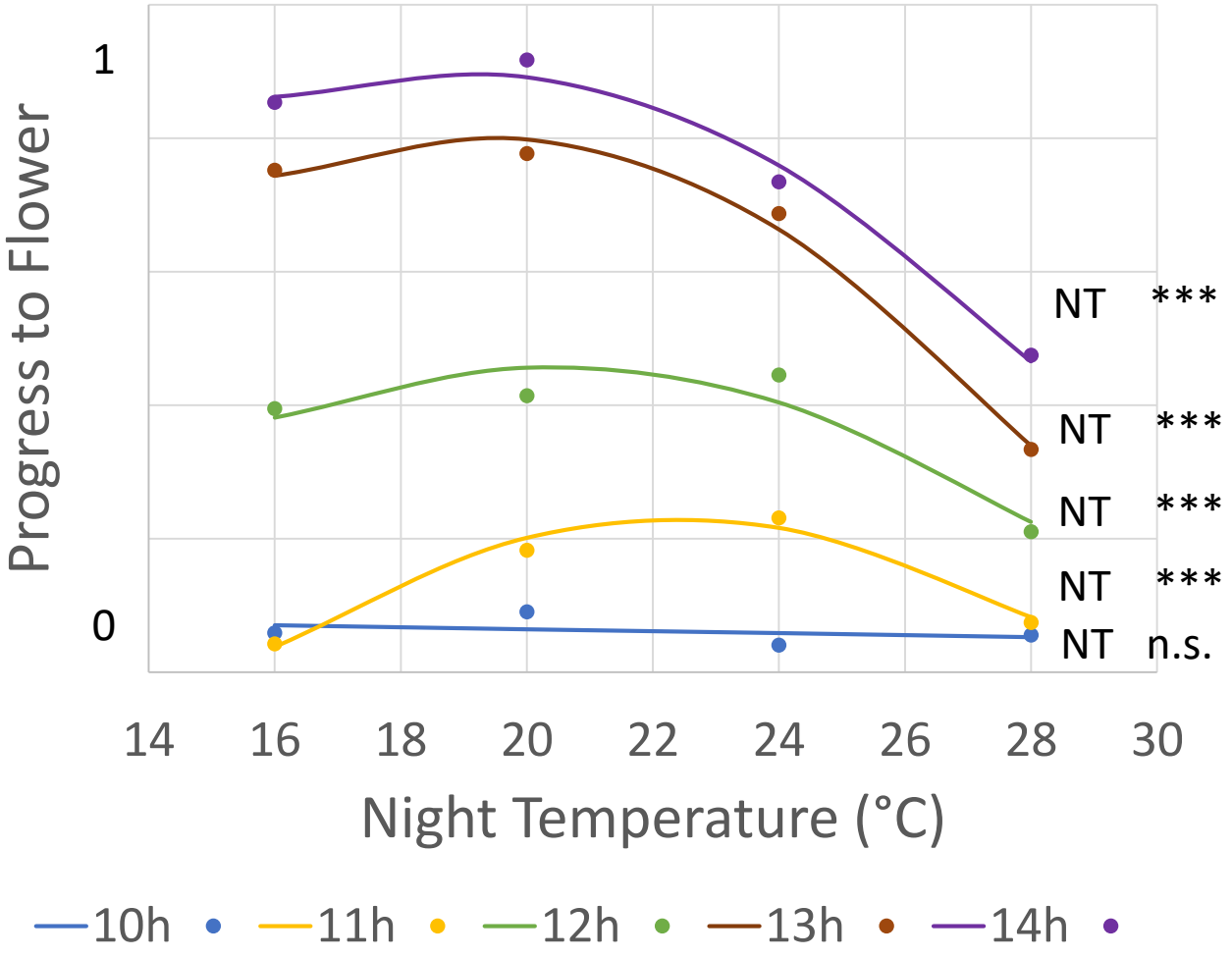
# Orion

- Heat tolerant (minimal differences in flowering from 16 to 28 °C)
- Progress to flower increases greatly from 11 to 13 h night length

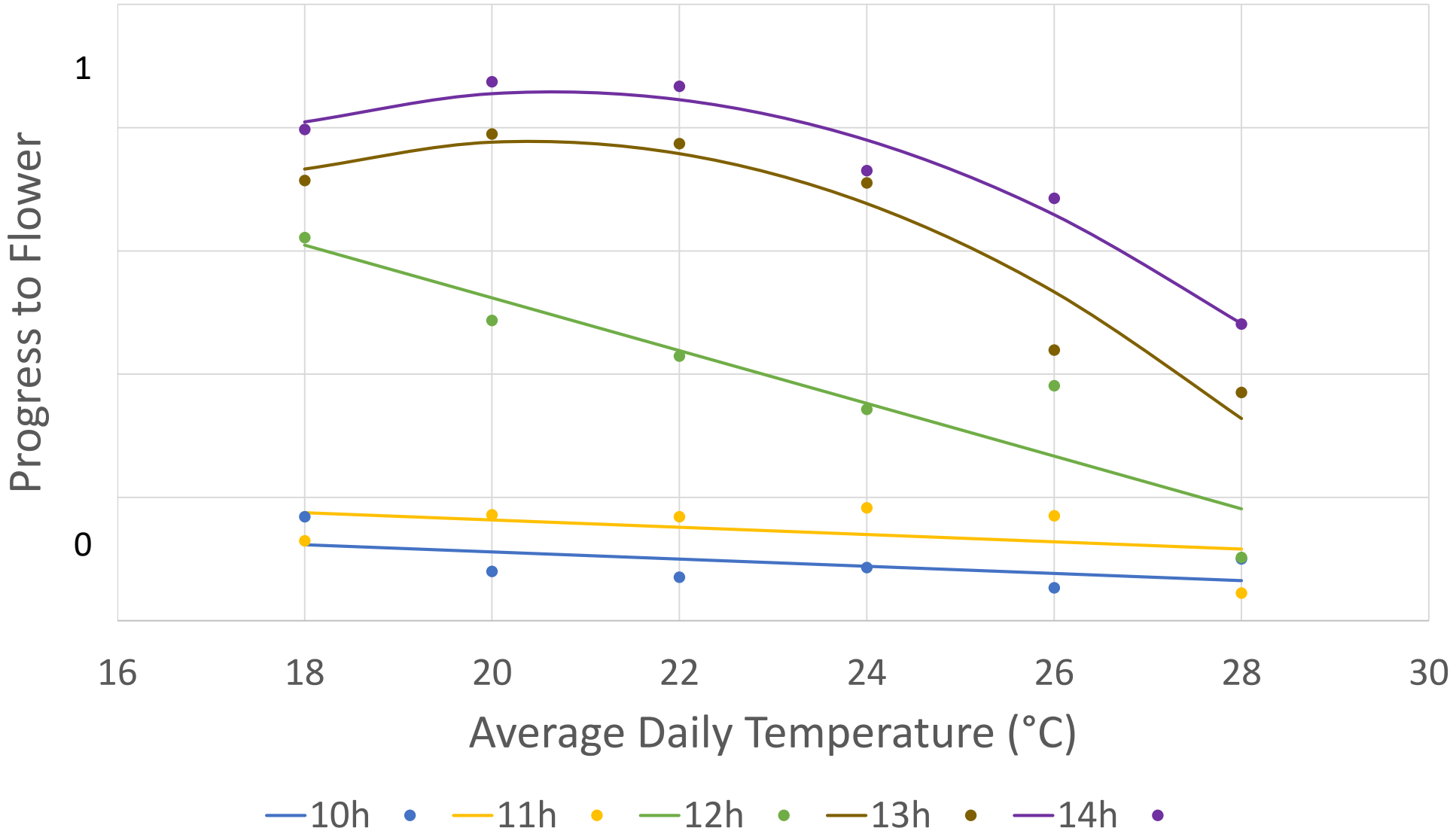
# Prestige - Day Temperature




# Prestige-Night Temperature



# Prestige – Average Daily Temperature



# Prestige

- Heat sensitive
  - At 12h nightlength, DT and NT affect flowering (ADT is significant)
  - At 13-14h nightlength, only NT affects flowering (DT non-significant)

- Progress to flower increases greatly from 11 to 13h night length and 14h is slightly faster than 13h.

Progress to flower at high temps and 14h nightlength =

Progress to flower at cooler temps and 12h nightlength

Night Length (h)

Day Temperature (°C)

20 24 28

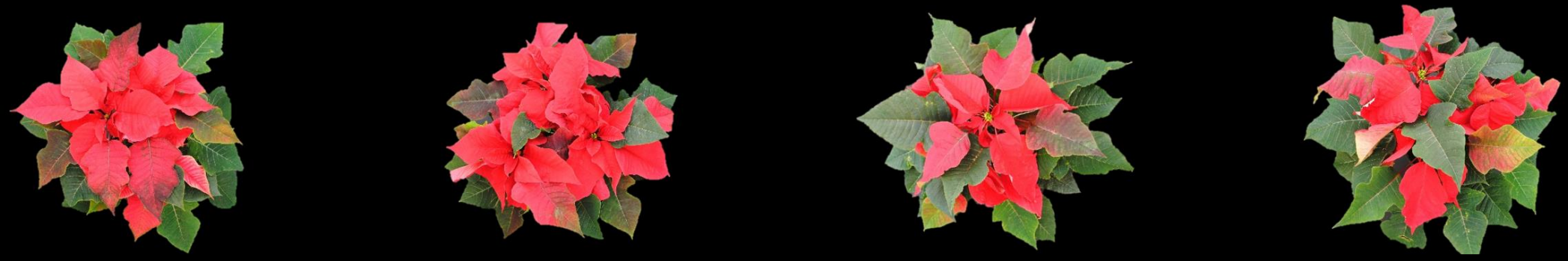
12

Night Length

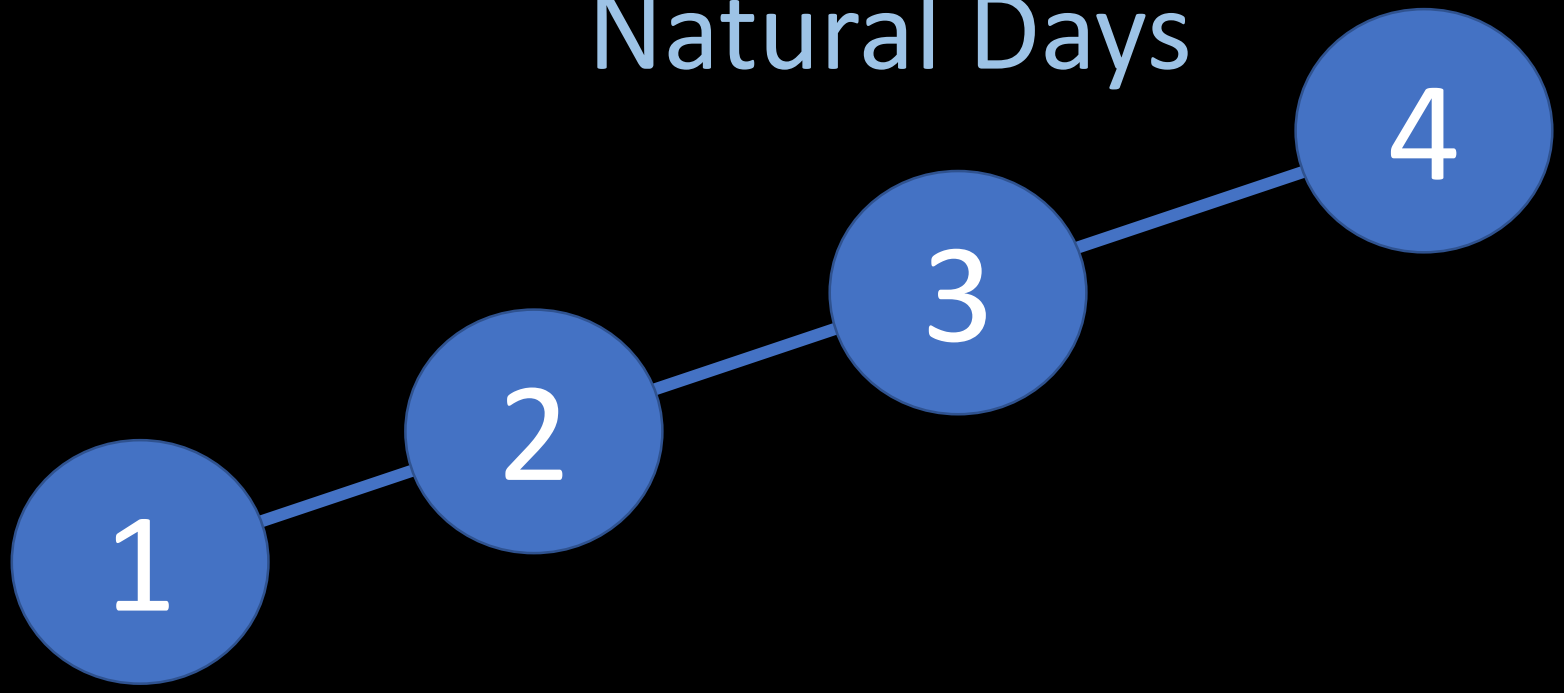
Night Temperature (°C)

16 20 24 28

14

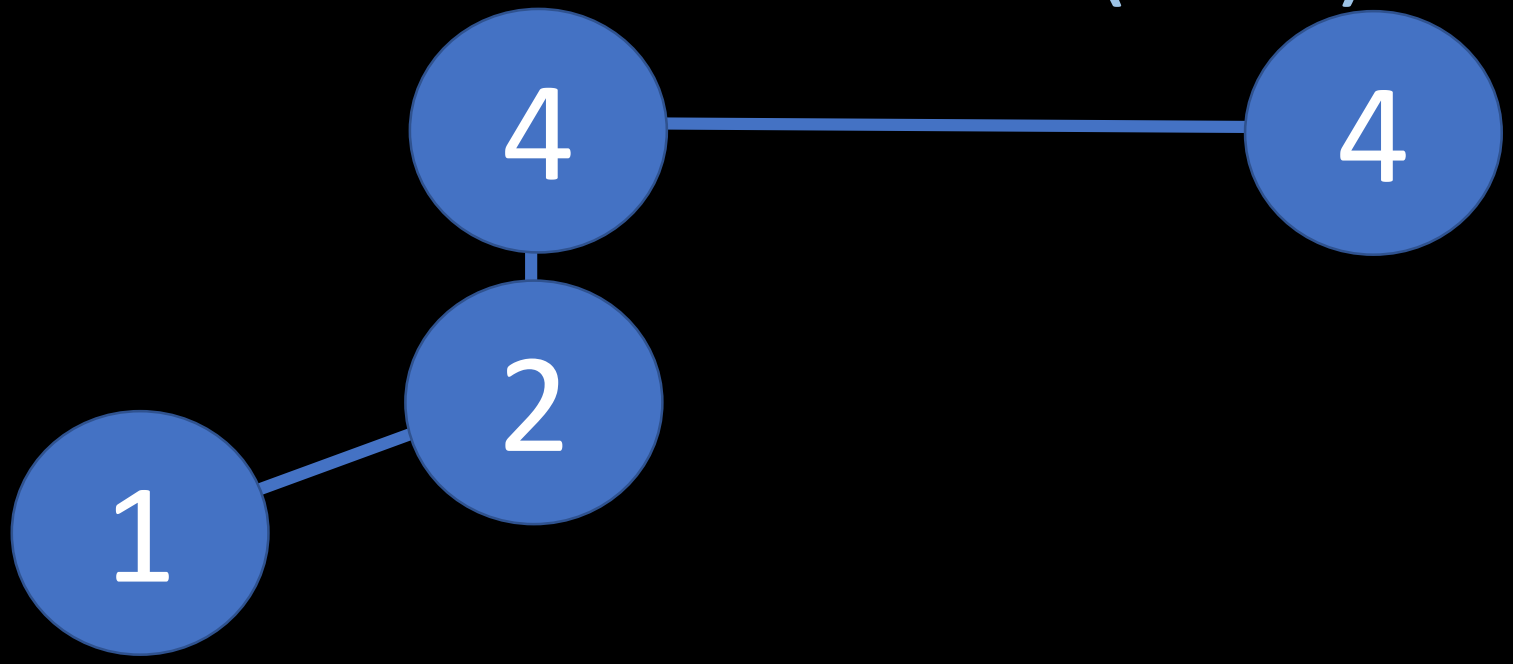


Natural Days



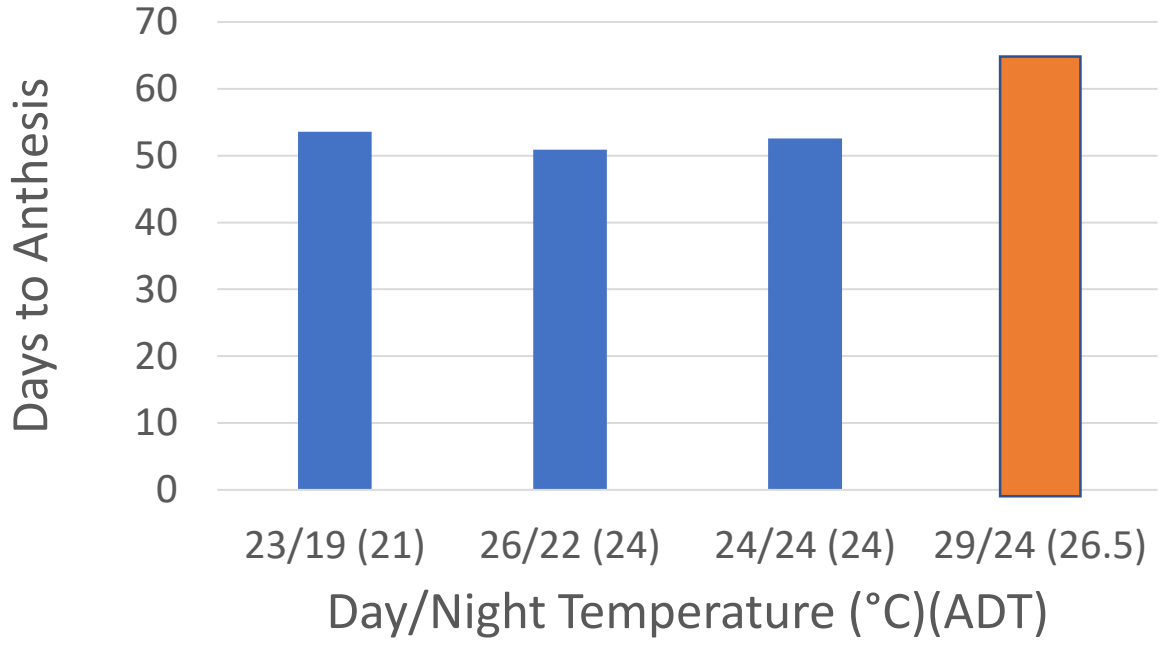

Sept. Oct. Nov.

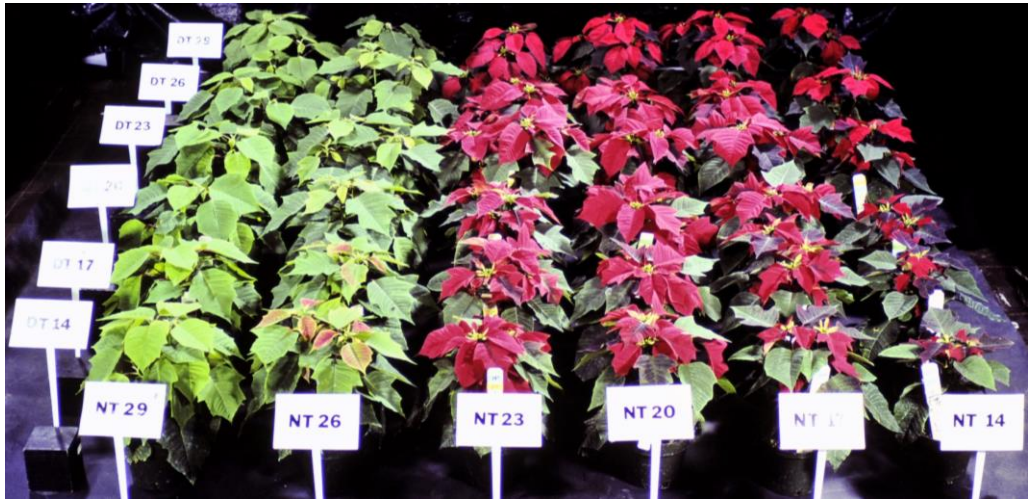
Black Cloth (14 h)




Sept. Oct. Nov.

Sept. Oct. Nov.




29 °C DT during 2 wks during initiation (12h night)

26-29 °C NT throughout initiation & development (14h night)

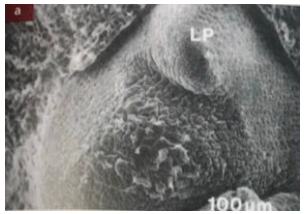
# Working Hypothesis

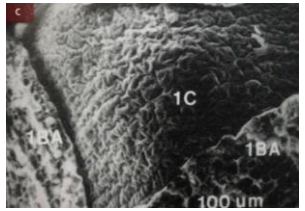
Sensitive to high DT

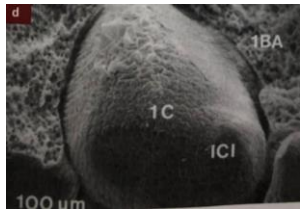
Sensitive to high NT

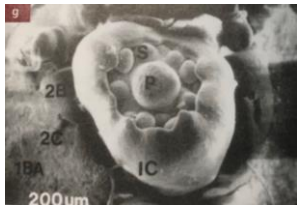
Initiation

Development



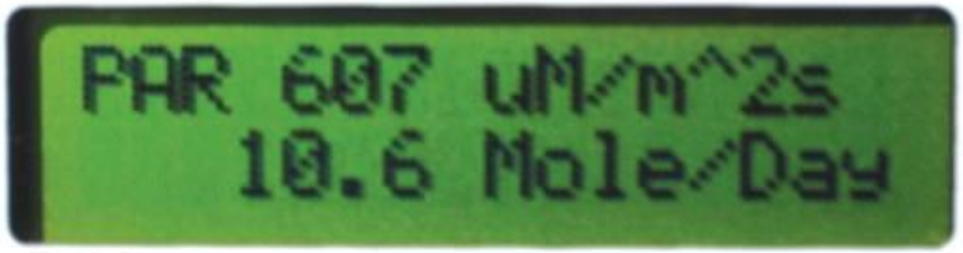



Sept. Oct. Nov.

# Measuring DLI

Model 2475 Mini Station shown

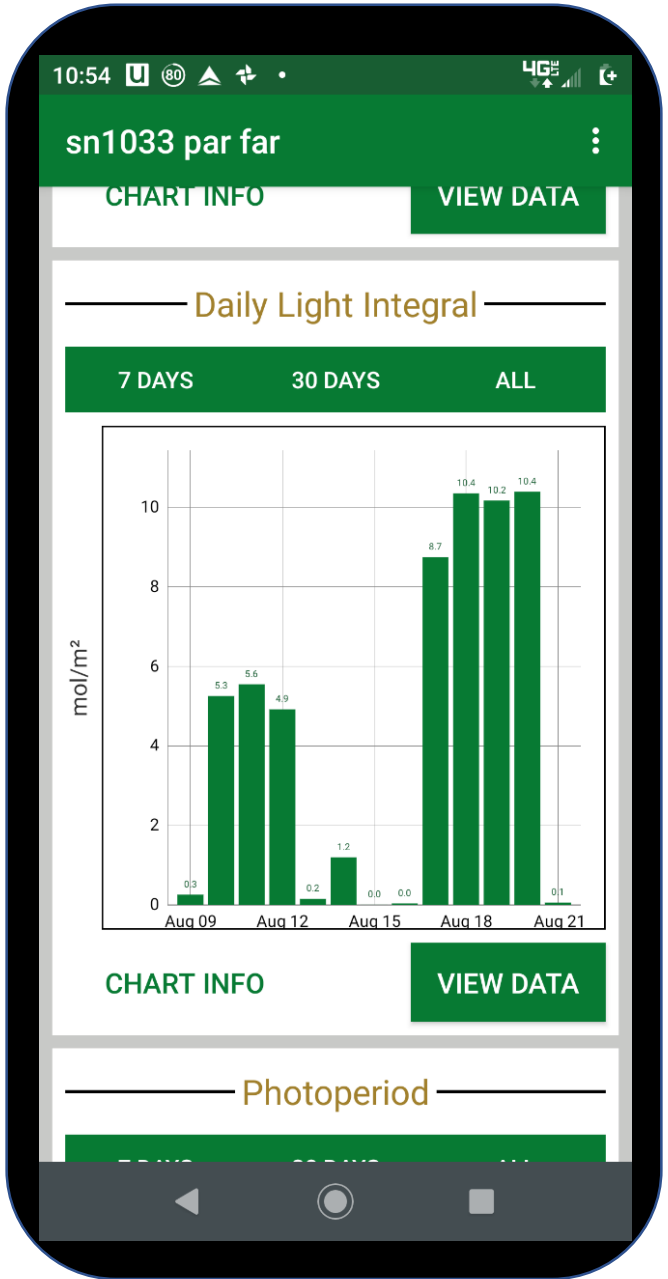
**DLI:**




**DIF:**

Spectrum Technologies

# Measuring DLI




Apogee Instruments

# Mobile Cyclical Lighting

James Faust, Paul Millar, Will Trax, Erik Runkle

Clemson University

# Mobile Lighting Systems

Photos: John Davies

# Mobile Lighting Systems

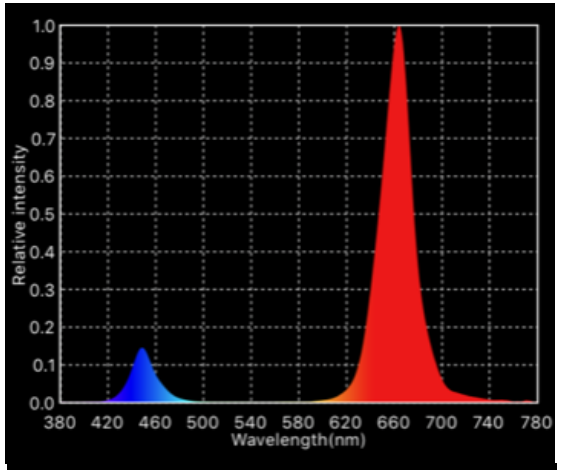
# Mobile Lighting Systems

# Species

| | |
|---|---|
| • Poinsettia ‘Orion Red’ | Obligate SDP |
| • Campanula carpatica ‘Rapido Blue’ | Obligate LDP |
| • Petunia ‘Classic Wave’ | Facultative LDP |

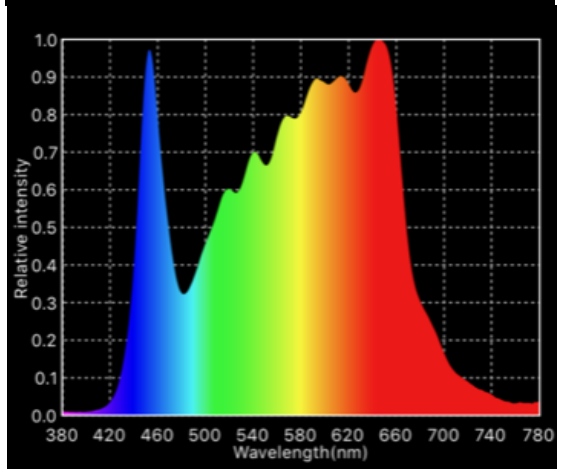
# Three LEDs

Hubbell NutriLED



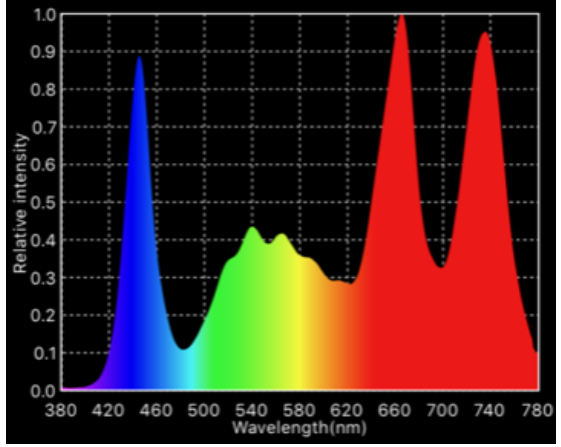

B+R

Fluence RAY44



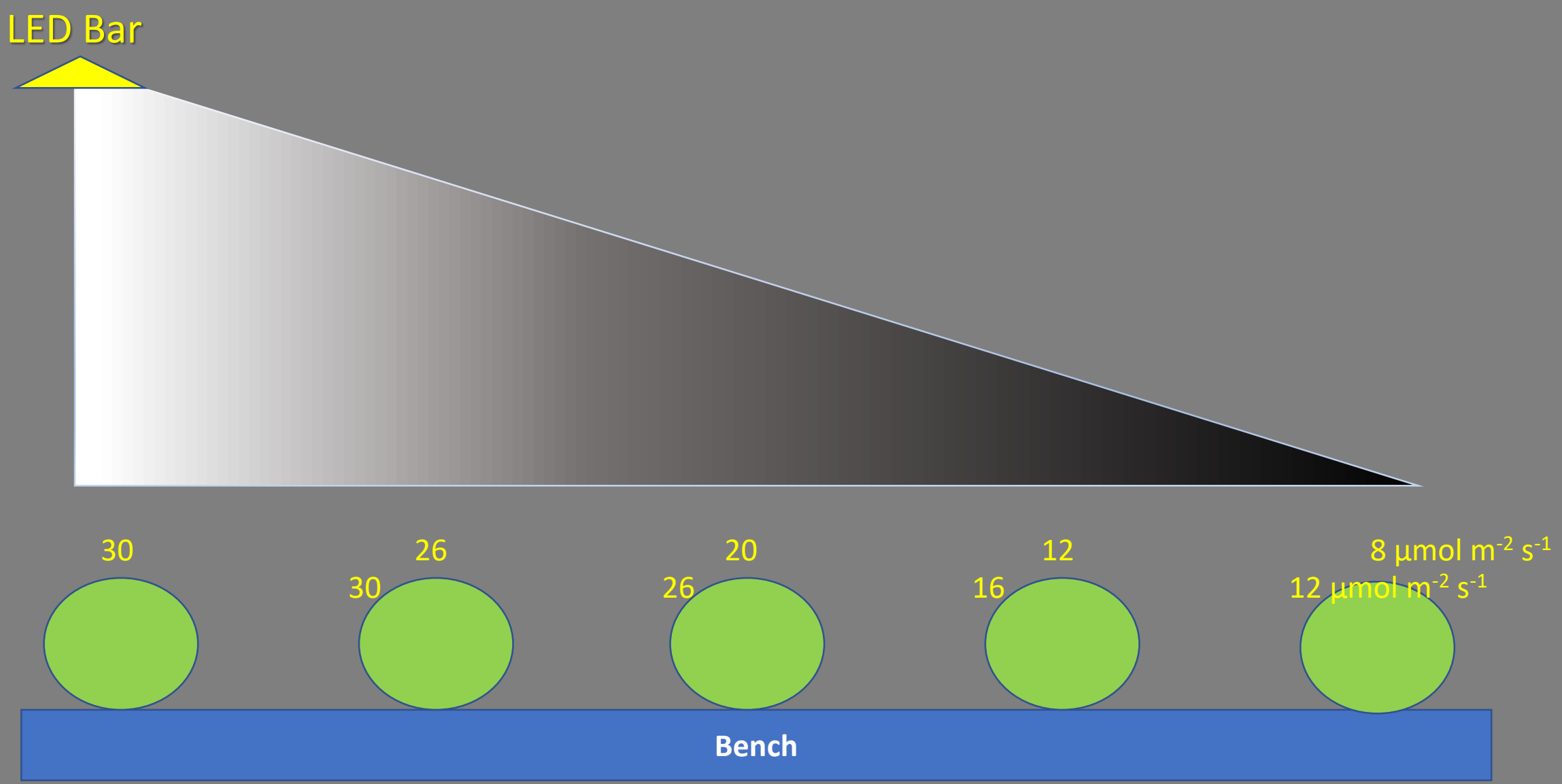

W

Fluence Custom

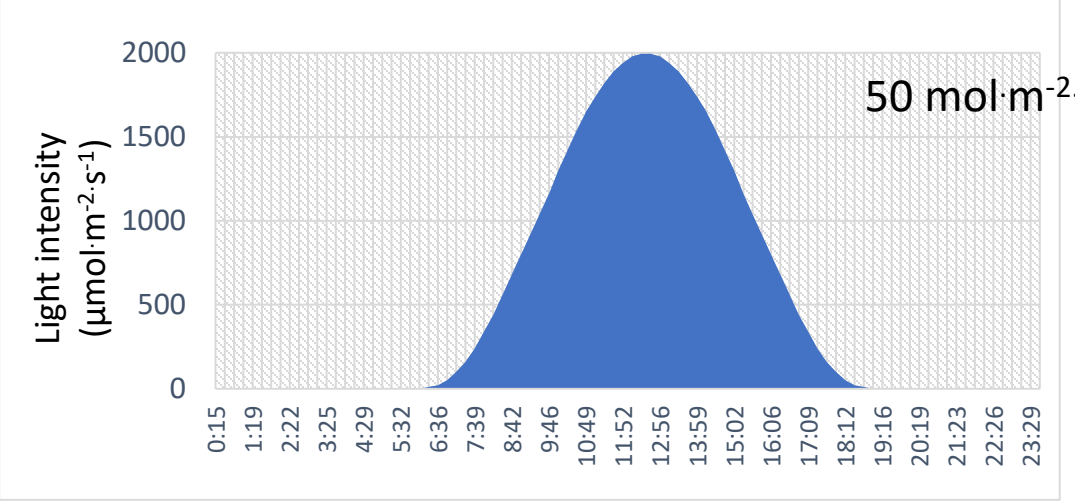



W+R+FR

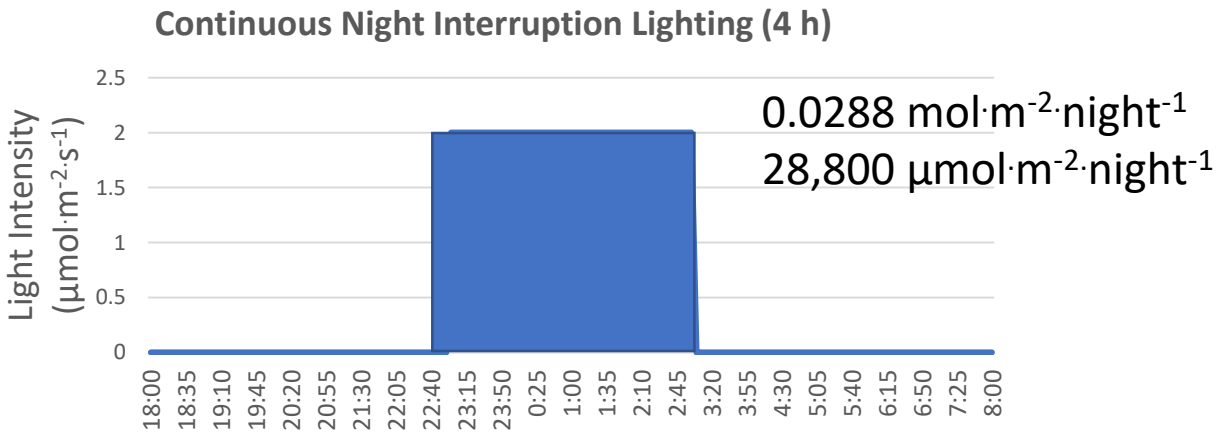
# PPFD Treatments

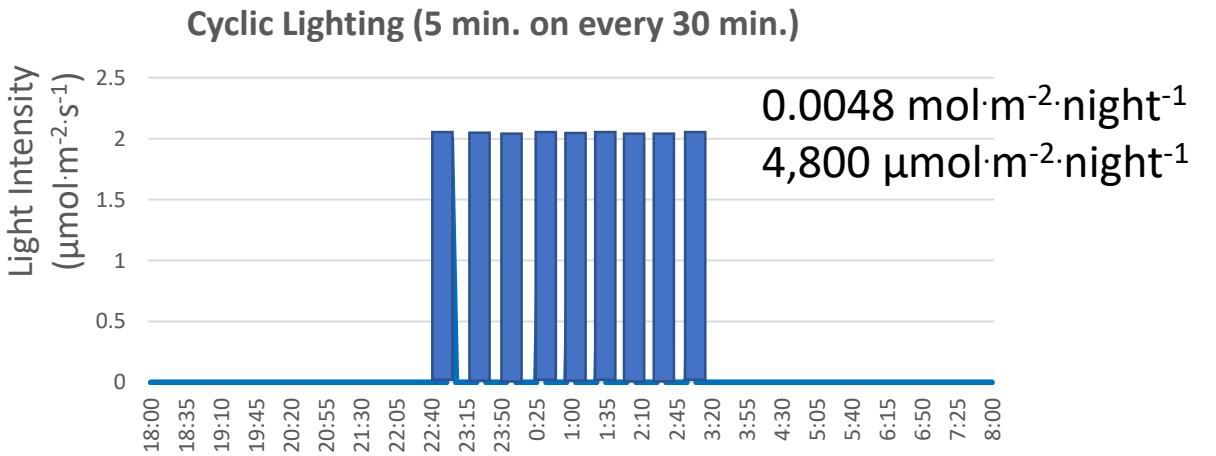


# Daily Light Integral (DLI)



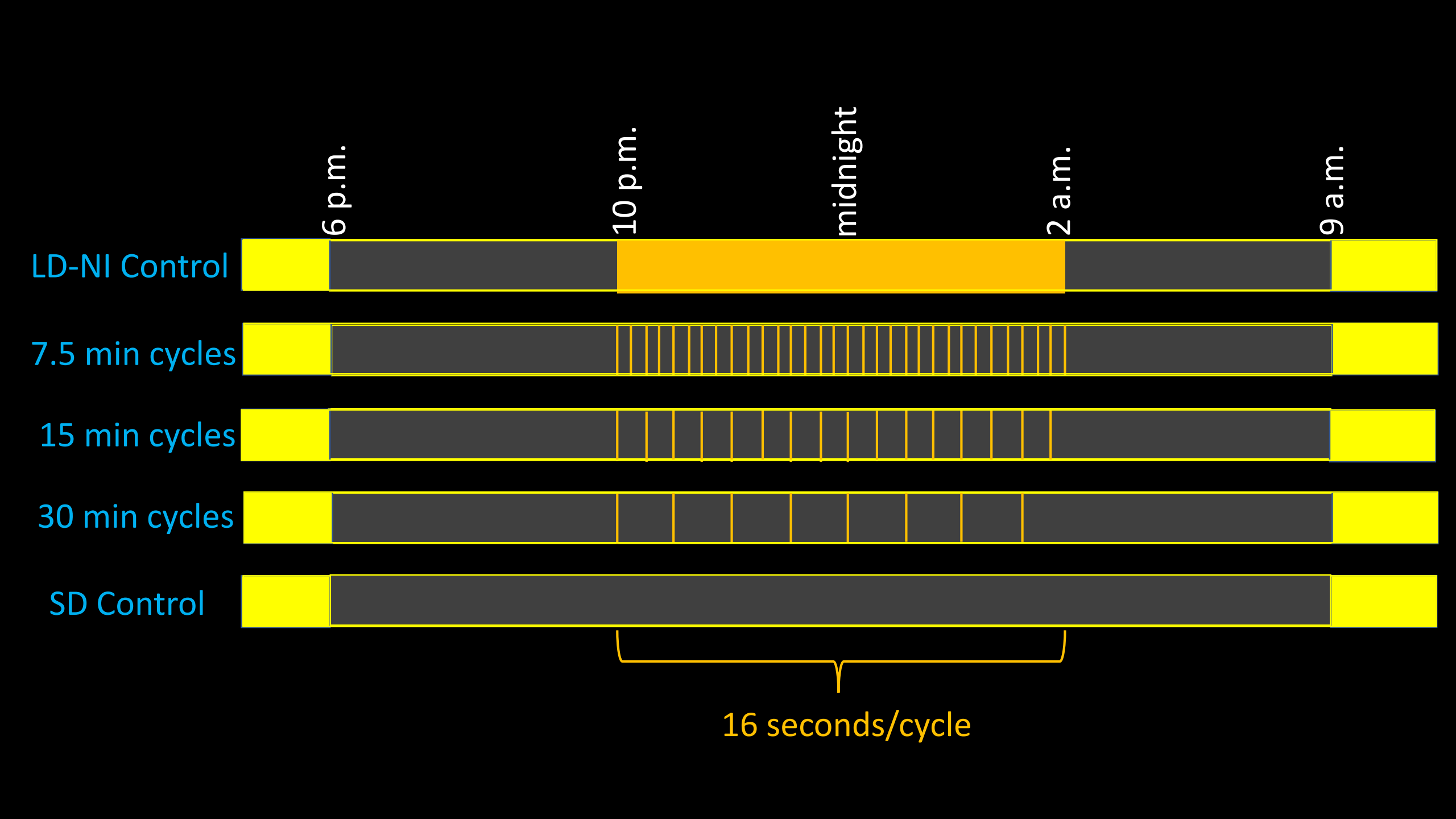

# Night Light Integral (NLI) or Night Interruption Light Integral ($NIL_{int}$)



# Five Photoperiod Treatments

- Short days (10h day)
- Long days (10h day + 4h continuous NI)
- Cyclic lighting (10h day + cyclic lighting for 4h)
  - 16 s every 30 min (8 cycles per 4h night or 2/h)
  - 16 s every 15 min (16 cycles per 4h night or 4/h)
  - 16 s every 7.5 min (32 cycles per 4h night or 8/h)
- PPFD (light intensity)
  - Range from ~8 to 30 µmol $m^{-2}$ $s^{-1}$ (~50 to 120 ftc)


6 p.m.
10 p.m.
midnight
2 a.m.
9 a.m.
LD-NI Control
7.5 min cycles
15 min cycles
30 min cycles
SD Control
16 seconds/cycle

# ~NLI (μmol/4-h night)

| PPFD ($\mu mol\ m^{-2}\ s^{-1}$) | Cycles/Night | | |
|---|---|---|---|
| | 8 | 16 | 32 |
| 12 | 1500 | 3000 | 6000 |
| 20 | 2500 | 5000 | 10000 |
| 30 | 4000 | 8000 | 15000 |

Poinsettia ‘Orion’

# Frequency
(cycles/4h NI)

8 16 32

PPFD
(µmol $m^{-2}$ $s^{-1}$)

SD Control

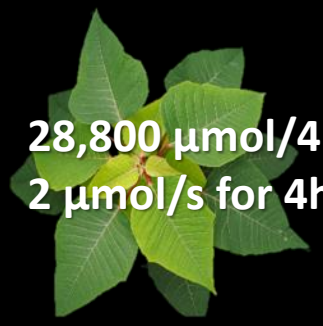
12

20

30

1536 µmol/4h
~0.1 µmol/s for 4h

LD Control



28,800 µmol/4h
2 µmol/s for 4h

Campanula
Fluence Custom

SD
Control

0

PPFD
(µmol $m^{-2}$ $s^{-1}$)

Frequency
(cycles/4-h NI)

| PPFD | 8 | 16 | 32 |
|---|---|---|---|
| 12 | 1 | 10 | 9 |
| 20 | 3 | 5 | 19 |
| 30 | 2 | 20 | 18 |

Flowers per plant

LD
Control

21

Petunia
Fluence Custom

SD Control

0

| PPFD ($\mu mol\ m^{-2}\ s^{-1}$) | Frequency (cycles/4-h NI) 8 | 16 | 32 |
|---|---|---|---|
| | Flowers per plant | | |
| 12 | 0 | 3 | 43 |
| 20 | 0 | 14 | 41 |
| 25 | 1 | 24 | 52 |
| 30 | 0 | 27 | 52 |

LD Control

55

Petunia
Hubbell B-R

SD Control

0

| PPFD ($\mu mol\ m^{-2}\ s^{-1}$) | Frequency (cycles/4-h NI) 8 | 16 | 32 |
|---|---|---|---|
| | Flowers per plant | | |
| 12 | 1 | 0 | 11 |
| 20 | 1 | 4 | 9 |
| 25 | 1 | 8 | 23 |
| 30 | 3 | 6 | 9 |

LD Control

55

# Preliminary Summary

| | Spectrum | PPFD (µmol/m2 s) | Frequency (min./cycle) | NLI (µmol/4h n) |
|---|---|---|---|---|
| Poinsettia (SD) | - | ≥12 | ≤30 | ≥1500 |
| Campanula (LD) | - | ≥20 | ≤7.5-15 | ≥8000 |
| Petunia (LD) | +FR | ≥20 | ≤7.5 | ≥8000 |

# Acknowledgements


Floriculture Research Alliance

- Ball Horticulture
- Battlefield Farms
- Dummen-Orange
- Fluence Bioengineering/Osram
- Metrolina Greenhouses
- Smithers-Oasis/Floralife
- Syngenta Flowers

American Floral Endowment

Funding Generations of Progress
Through Research and Scholarships

Floriculture & Nursery Research Initiative

SAF USDA ARS ANLA

Longwood Gardens