

Comparing Photoperiodic Lighting Strategies In Controlled Greenhouse Environments

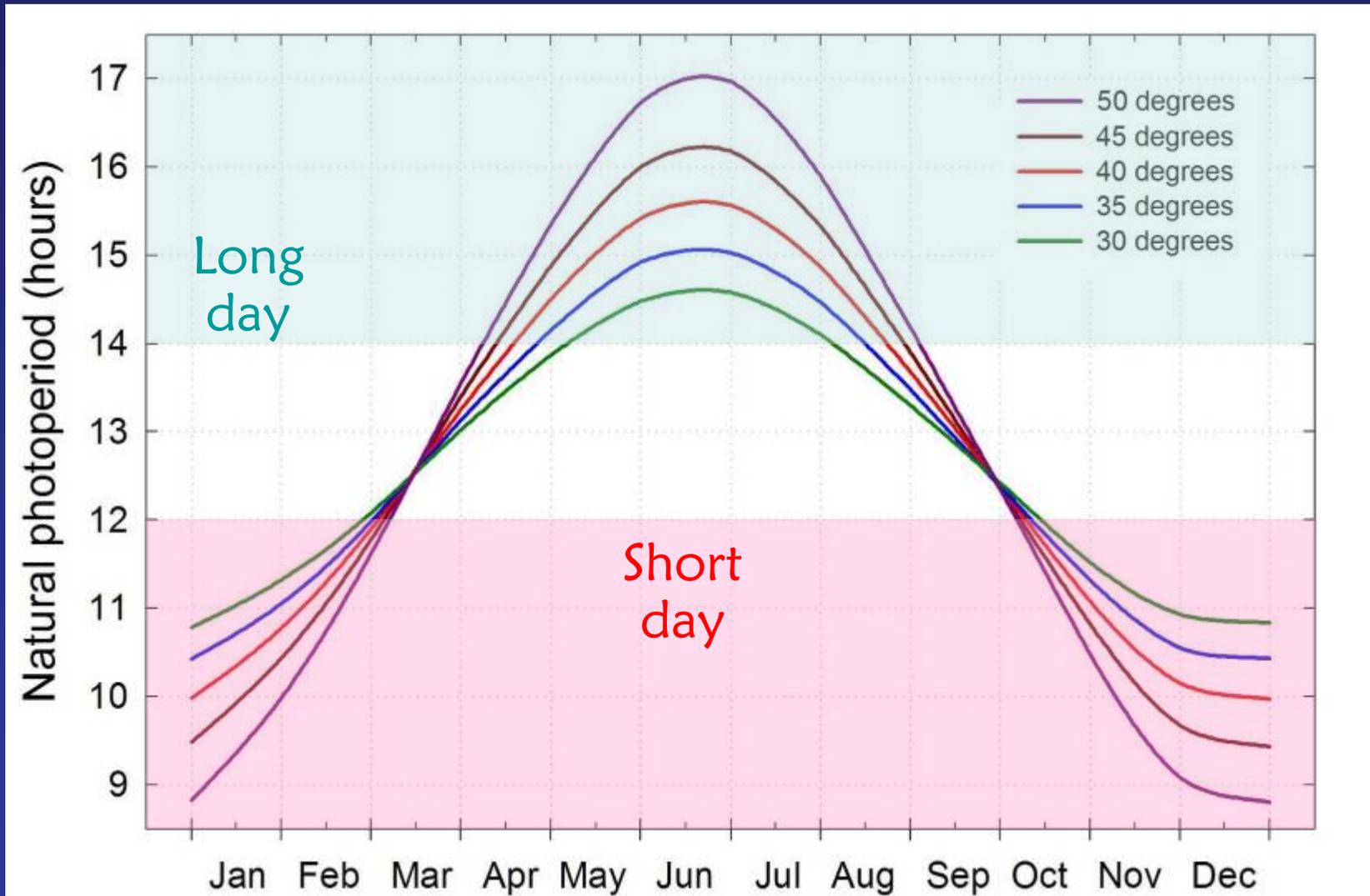
A Preliminary Report to the NCERA-101 Working Group



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Natural Photoperiod in the Northern Hemisphere



Long-day Plant

Coreopsis 'Limerock Dream'

10 weeks at 20 °C



9-h

16-h INC

16-h HPS

Providing Long Days to Floriculture Crops

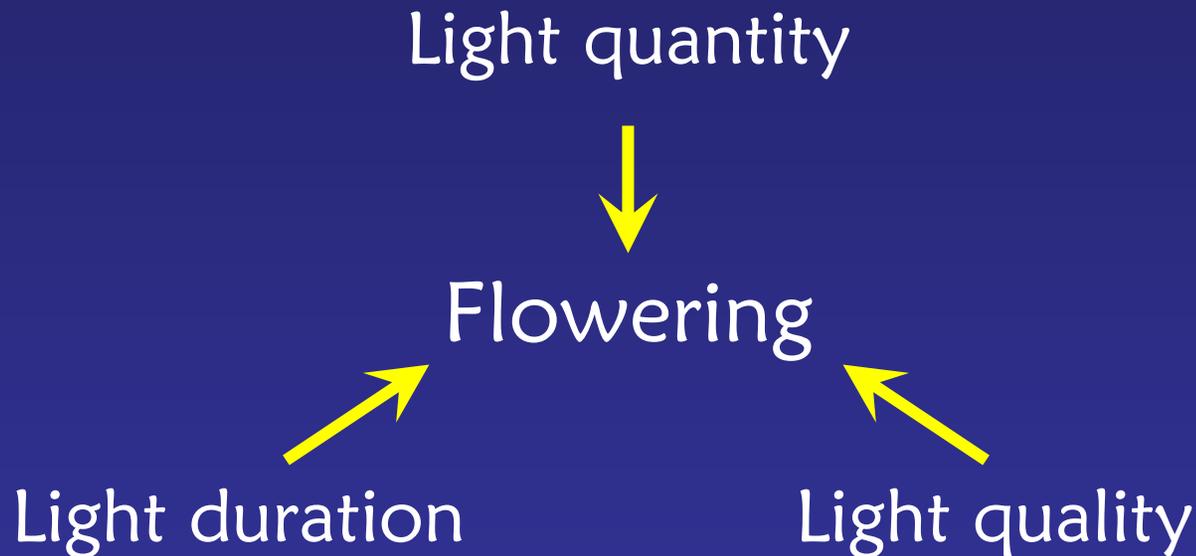
- Day Extension (DE) Lighting
- Night Interruption (NI) Lighting
 - Continuous lighting
 - Cyclic Lighting

Effect of Night Interruption Duration

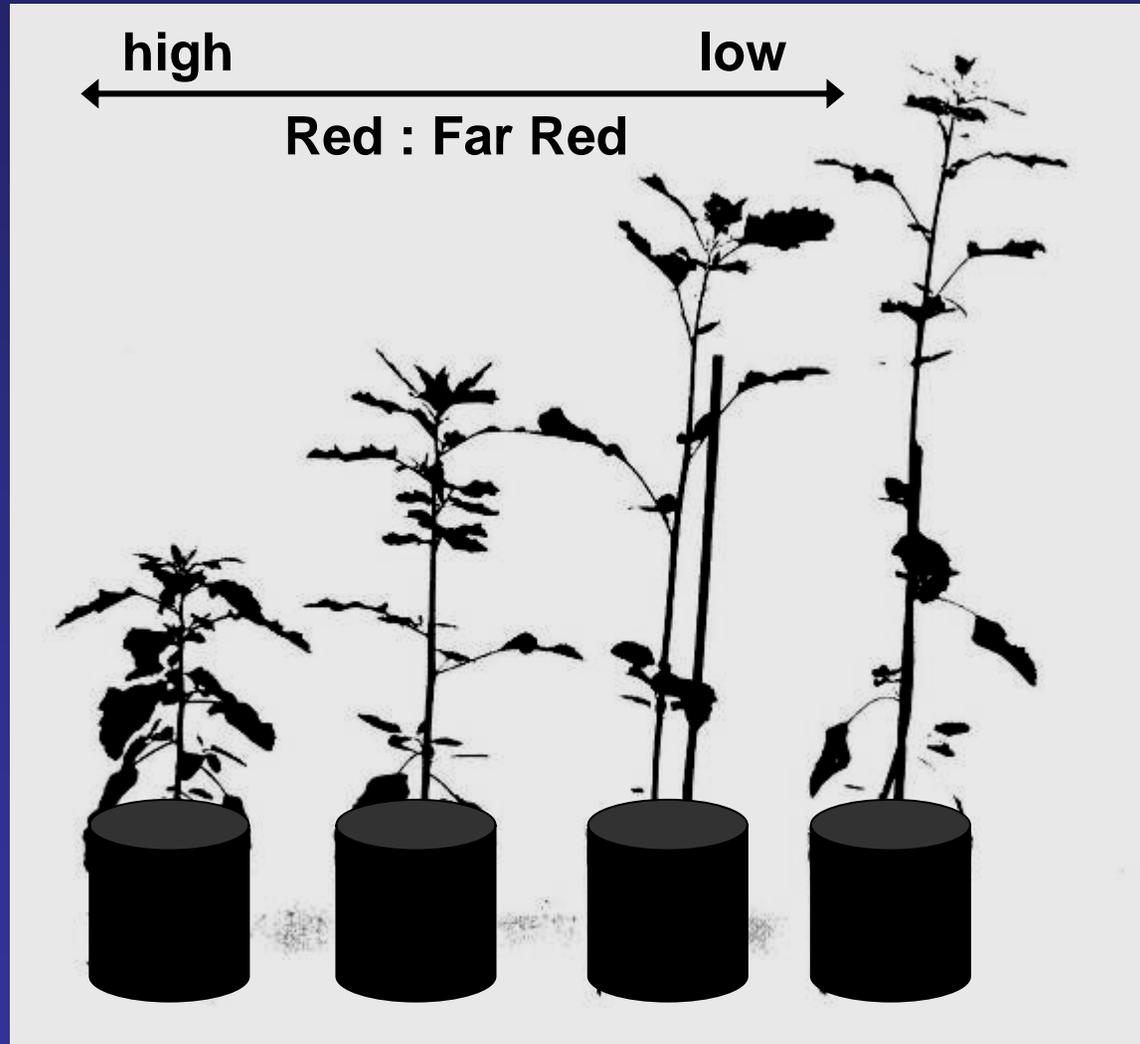


With low intensity lighting, a continuous 4-hour night interruption generally elicits the most rapid flowering

Light Consists of Three Dimensions



Effects of Red to Far-Red Ratio



From Photomorphogenesis in Plants (2nd ed.) by Kendrick and Kronenberg, 1994.

Light Quality and Flowering

VIOLA xWITTROCKIANA 'CRYSTAL BOWL YELLOW'
30 DAYS UNDER FILTERS AT 22 °C
16-H PHOTOPERIOD WITH HPS

C	-B			-R			-FR		
	UVB	C	AVB	UVB	C	AVB	UVB	C	AVB
90	100	100	80	100	90	60	10	0	20



Objective

- To quantify the efficacy of NI lighting on floral evocation of LD and SD plants using compact fluorescent (CF) lamps alone or in combination with incandescent (INC) lamps

Species Evaluated

- LD plants:
 - *Petunia* ‘Purple Wave’
 - *Rudbeckia hirta* ‘Orange Becky’
 - *Coreopsis grandiflora* ‘Early Sunrise’
 - *Campanula carpatica* ‘Deep Blue Clips’
- SD plants:
 - *Chrysanthemum* ‘Auburn’
 - *Chrysanthemum* ‘Bianca’

Protocol Prior to Treatments

- Plants received from a commercial grower at germination
- LD plants grown under SD (9 h) at 20 °C in a growth chamber
- SD plants grown under LD (16 h) at 20 °C in a greenhouse
- Ten plants of each species were randomly assigned to each treatment

Experimental Conditions

- Plants were grown at 20 °C under a 9-h base photoperiod provided by a blackout system with LD lighting treatments
- Supplemental lighting with HPS lamps was provided during the 9-h base photoperiod
- Light intensity at plant height was measured at 3 locations using line quantum sensors each containing 10 photodiodes

Lighting Treatments

#	Lamp Type	Photoperiod Treatment
1	INC	6-h DE (15-h photoperiod)
2	INC	4-h NI
3	INC	2-h NI
4	FL	6-h DE (15-h photoperiod)
5	FL	4-h NI
6	FL	2-h NI
7	50% INC + 50% FL	6-h DE (15-h photoperiod)
8	50% INC + 50% FL	4-h NI
9	50% INC + 50% FL	2-h NI
10		SD (9-h)

Experimental Conditions

- Air temperature was measured by aspirated thermocouples on every bench every 10 s
- Heaters operated underneath benches during the scotoperiod to maintain air temperature during the night

INC Treatment



$R = 1.46$
 $FR = 2.45$
 $R:FR = 0.6$

$R = 600 \text{ to } 700 \text{ nm}$
 $FR = 700 \text{ to } 800 \text{ nm}$

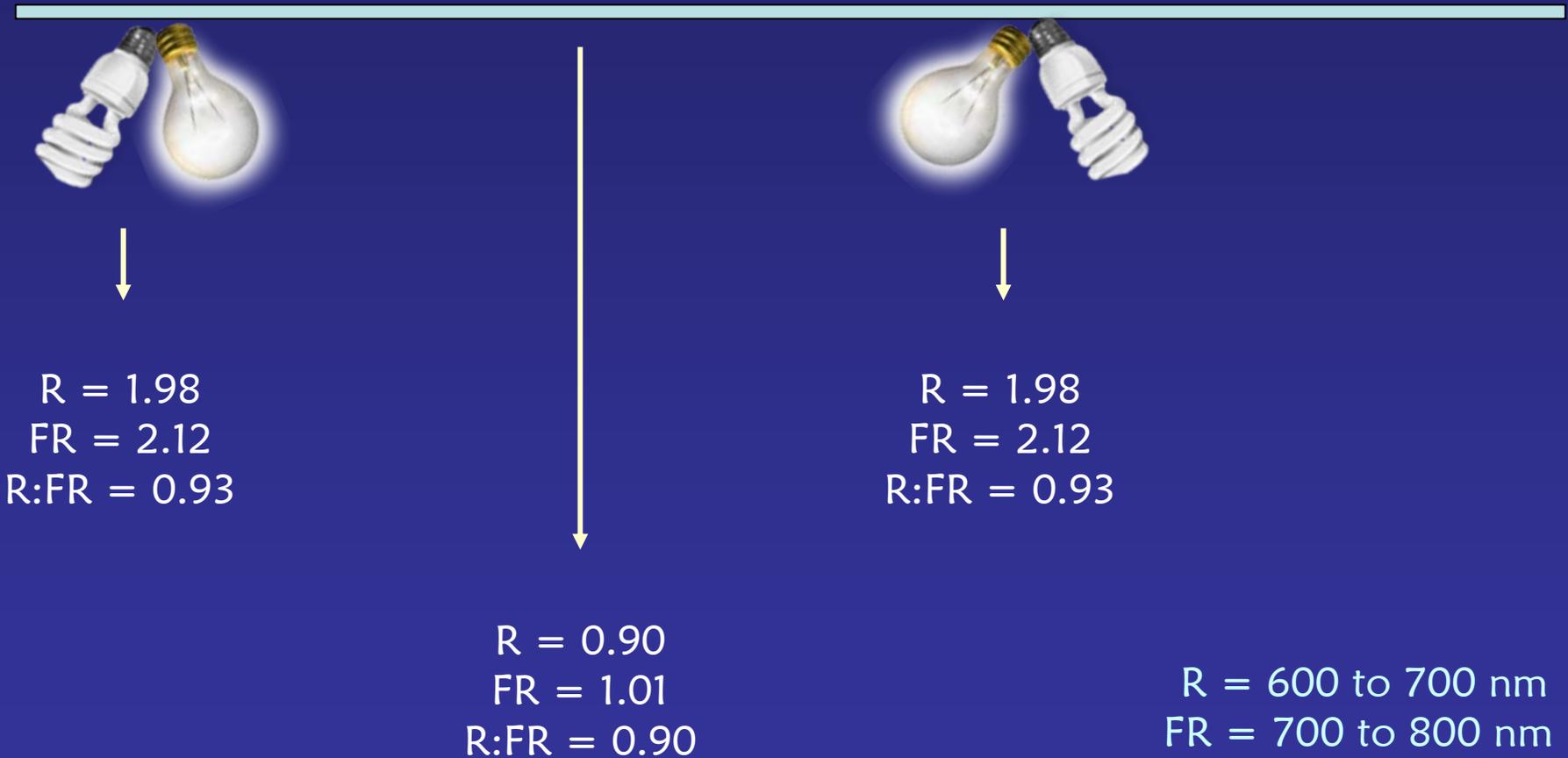
FL Treatment



$R = 1.05$
 $FR = 0.12$
 $R:FR = 8.44$

$R = 600 \text{ to } 700 \text{ nm}$
 $FR = 700 \text{ to } 800 \text{ nm}$

50% INC + 50% FL Treatment



50% INC + 50% FL Lamps



Photon Emission ($\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$) and R:FR of Each Lamp Type

	INC	FL	INC+FL
R (600-700 nm)	1.46	1.05	1.98
FR (700-800 nm)	2.45	0.12	2.12
R:FR	0.60	8.44	0.93

Experimental Conditions



Petunia 'Purple Wave'



Petunia 'Purple Wave'



Photographs taken 59 d after transplant at 20 °C



SD

6-h
DE

4-h
NI

2-h
NI

INC

6-h
DE

4-h
NI

2-h
NI

FL

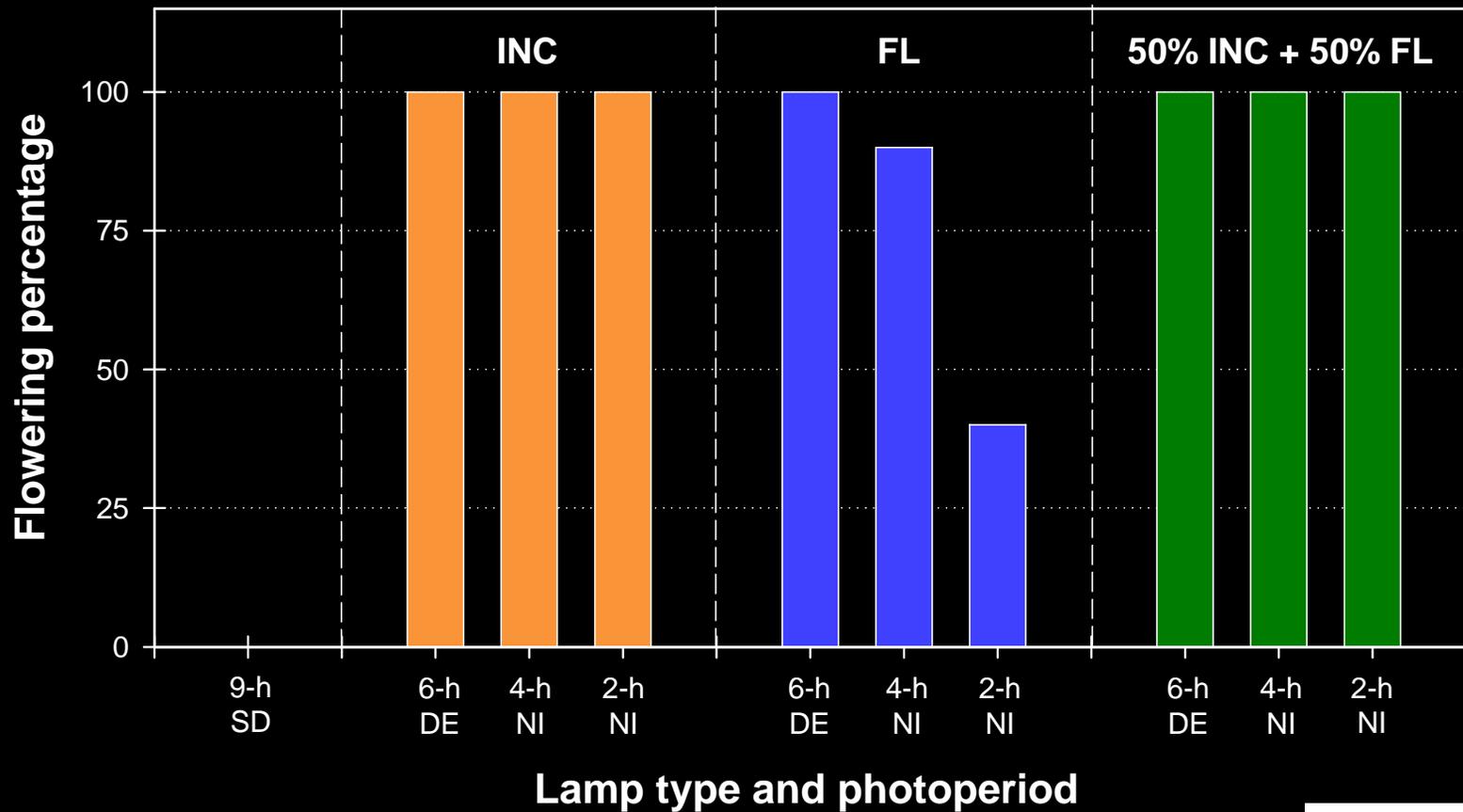
6-h
DE

4-h
NI

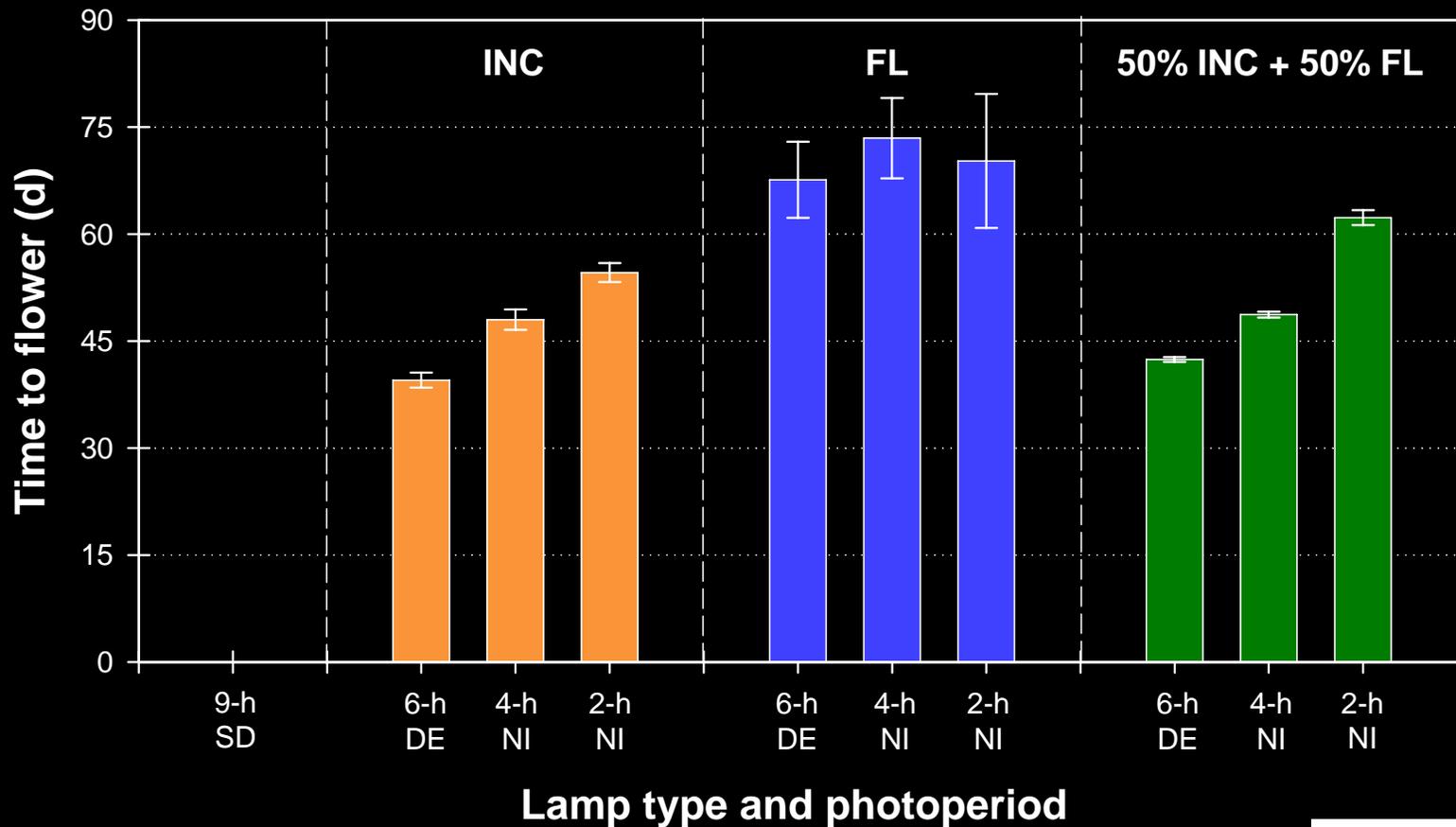
2-h
NI

50% INC + 50% FL

Petunia 'Purple Wave'

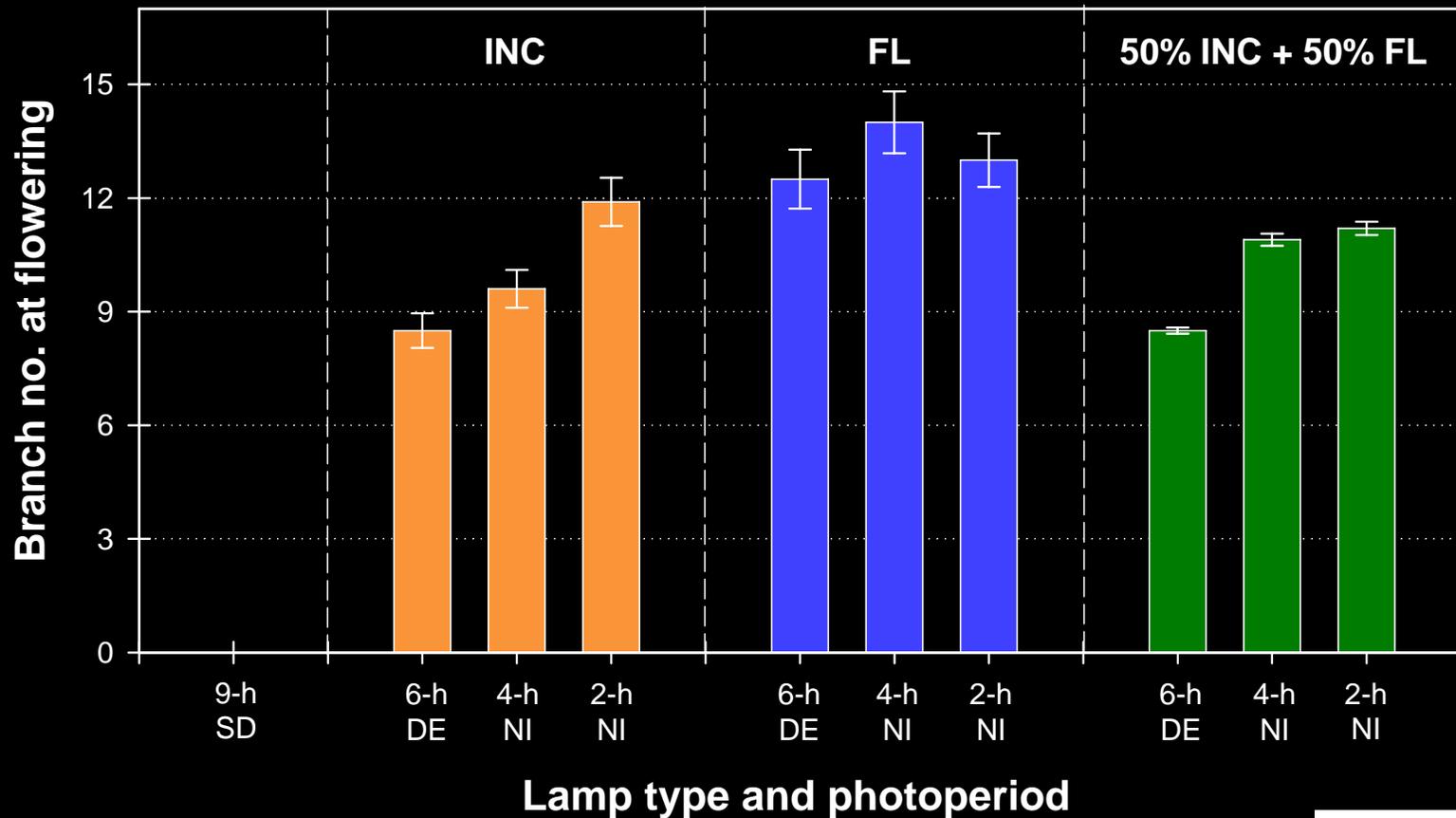


Petunia 'Purple Wave'



*Vertical bars represent standard errors of means of flowering plants

Petunia 'Purple Wave'



*Vertical bars represent standard errors of means of flowering plants



Rudbeckia hirta 'Orange Becky'





Rudbeckia hirta 'Orange Becky'

Photographs taken 75 d after transplant at 20 °C



SD



6-h
DE



4-h
NI



2-h
NI

INC



6-h
DE



4-h
NI



2-h
NI

FL



6-h
DE



4-h
NI

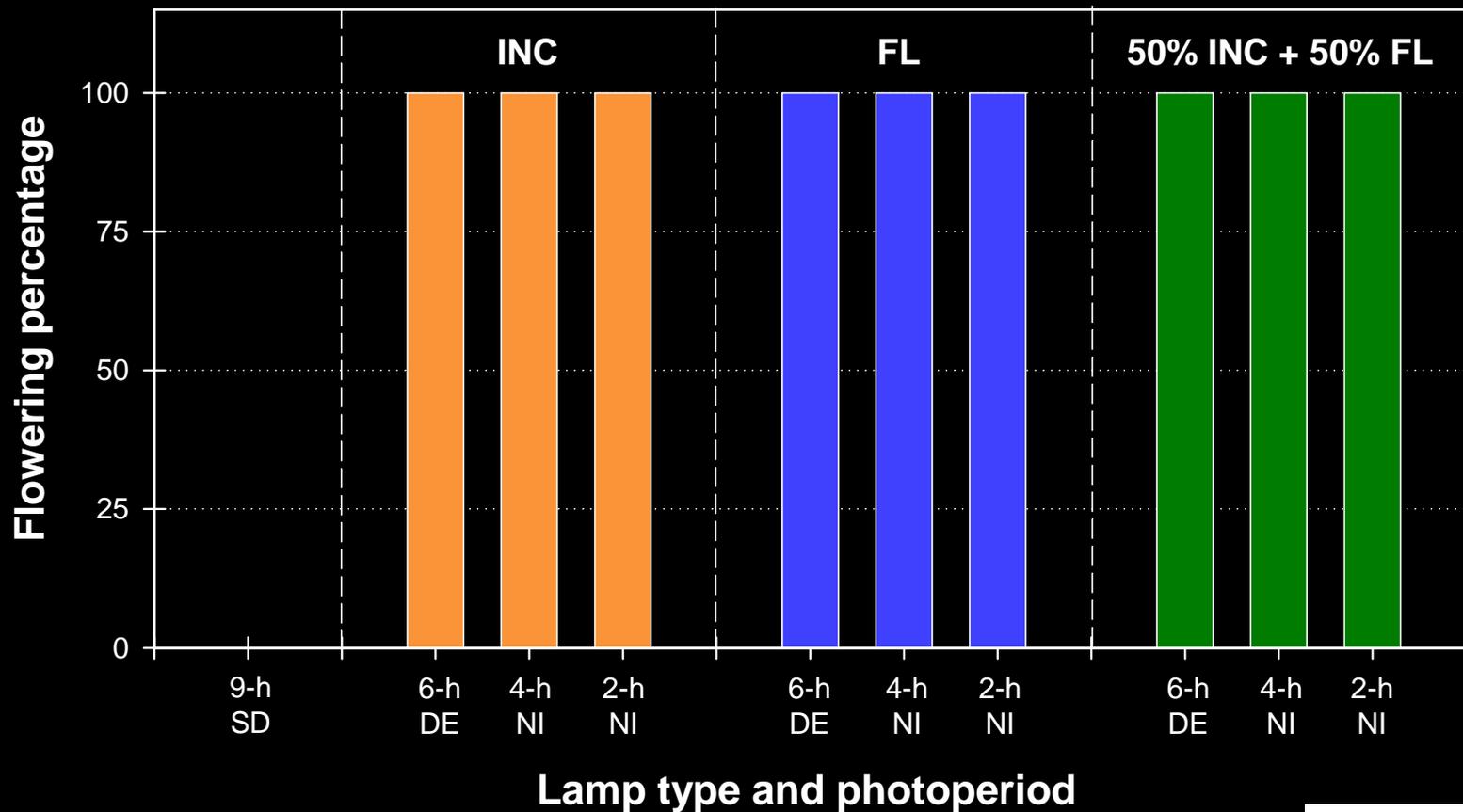


2-h
NI

50% INC + 50% FL



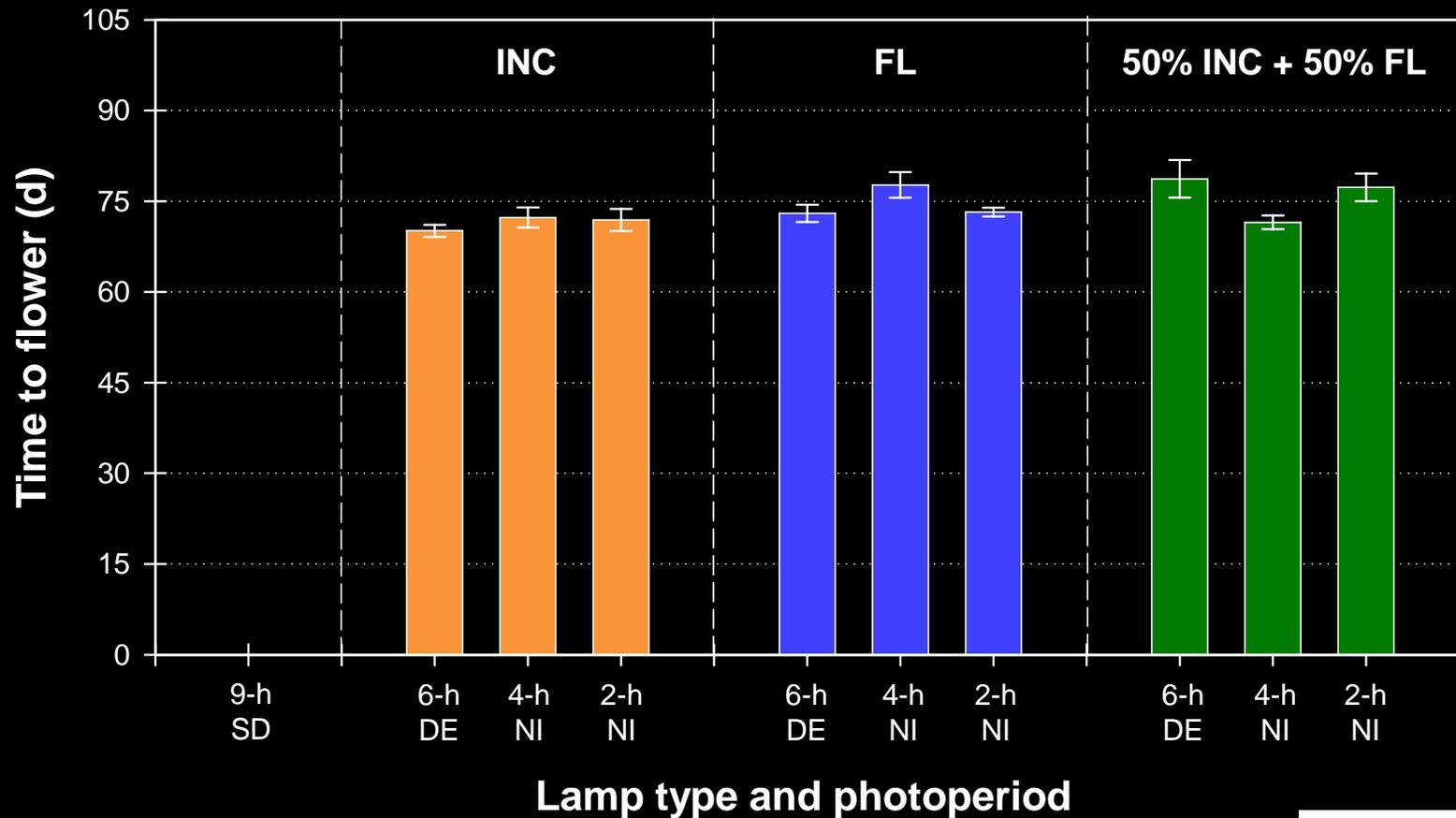
Rudbeckia hirta 'Orange Becky'



*Vertical bars represent standard errors of means of flowering plants



Rudbeckia hirta 'Orange Becky'



*Vertical bars represent standard errors of means of flowering plants

Chrysanthemum 'Auburn'



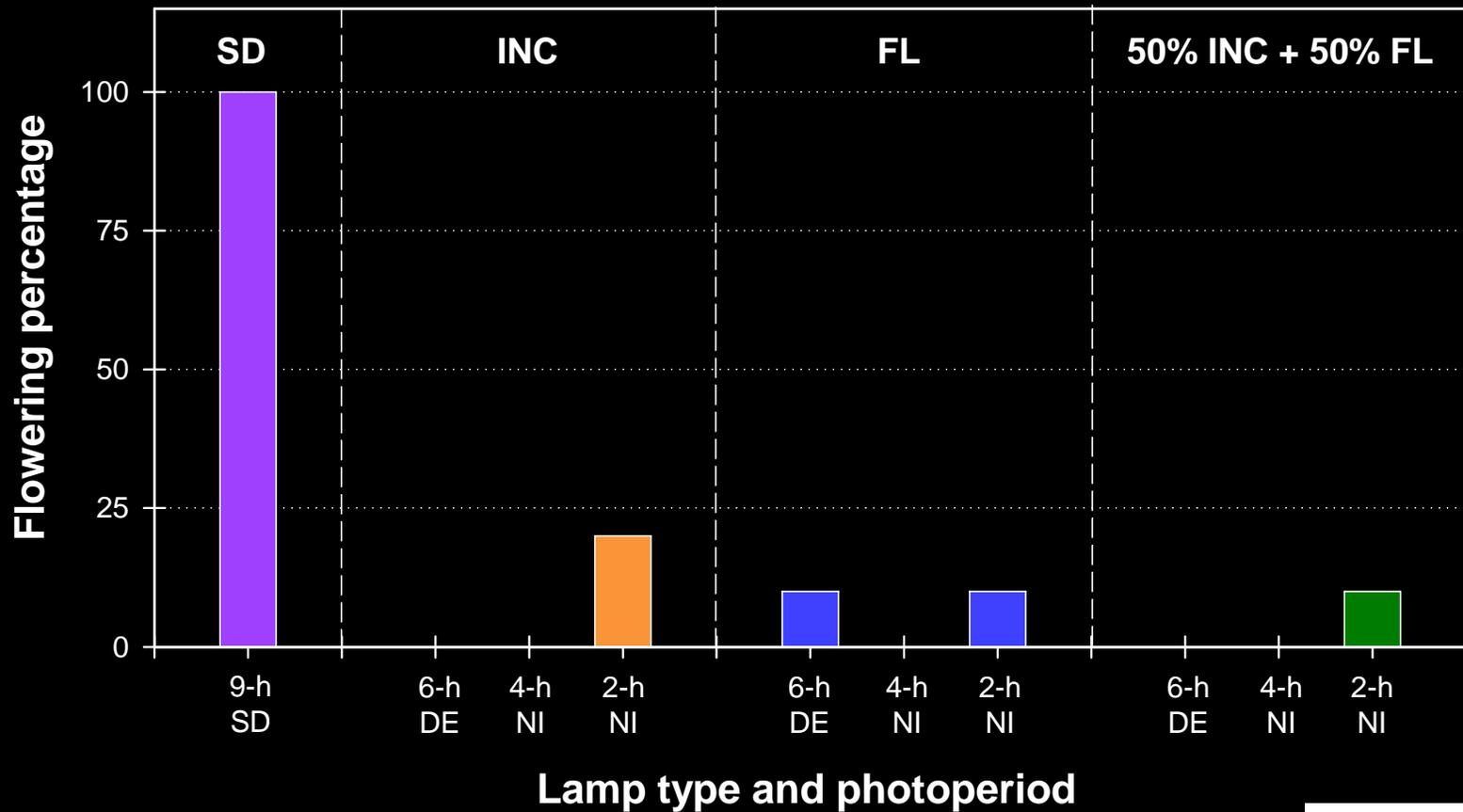
Chrysanthemum 'Auburn'



Photographs taken 71 d after transplant at 20 °C

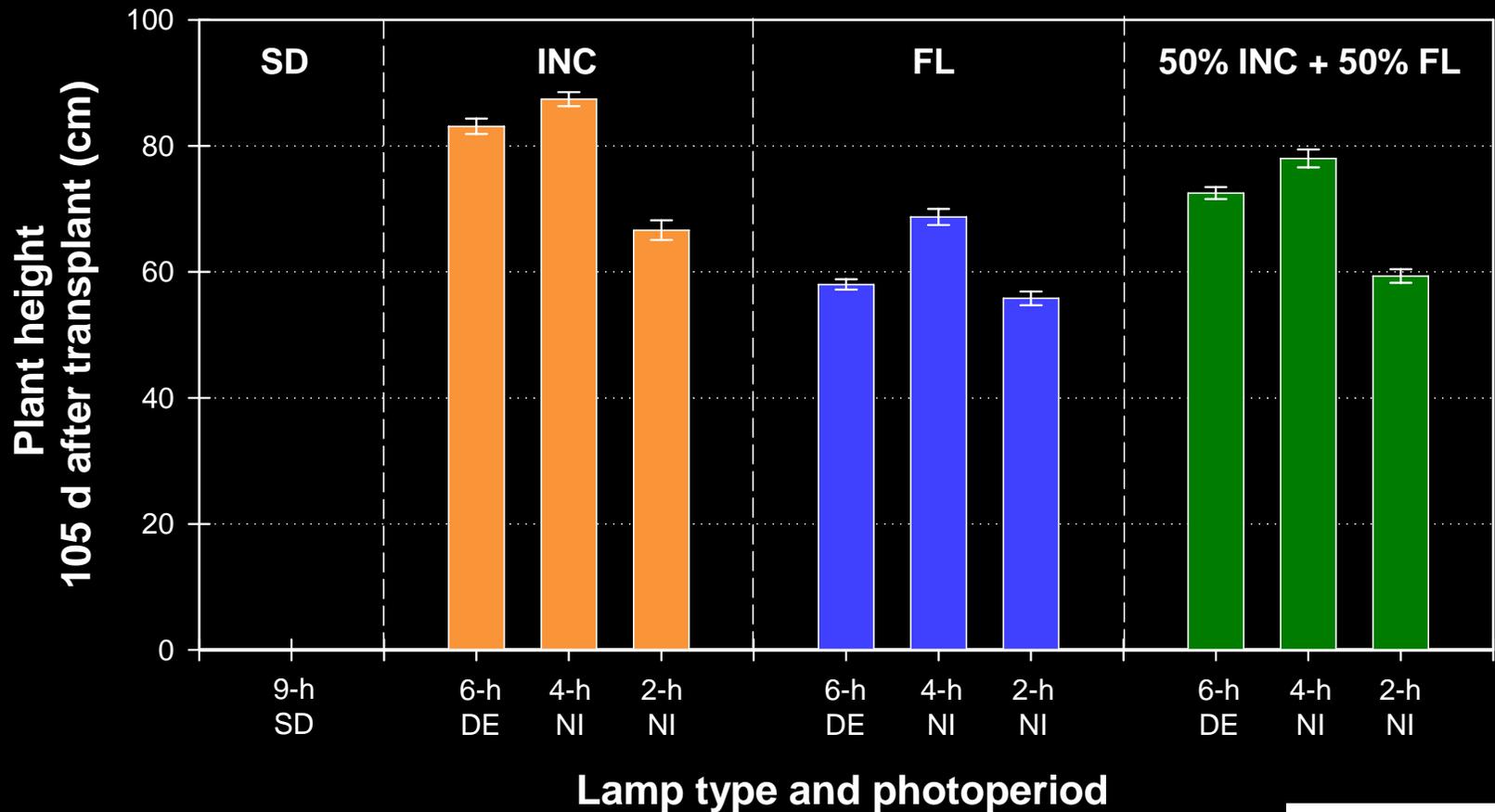


Chrysanthemum 'Auburn'



*Vertical bars represent standard errors of means of flowering plants

Chrysanthemum 'Auburn'



*Vertical bars represent standard errors of means of non-flowering plants

Conclusions

- LD lighting deficient in FR light, such as that provided by FL lamps, can delay flowering of some LD plants such as *Petunia* 'Purple Wave', but not others.
- Generally, plants grown under FL lamps had shorter internodes and greater axillary branching

Acknowledgements

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