Use LEDs to Improve Ornamental Crop Production

Youbin Zheng (PI), Yun Kong, David Llewellyn, Devdutt Kamath, Qingming Li, Chevonne Dayboll and Theo Blom

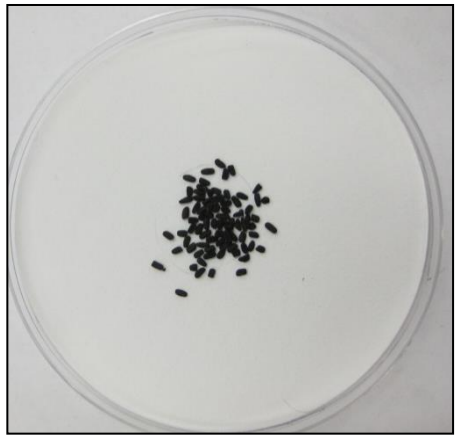
UNIVERSITY of GUELPH

Light Quality and Seeds Germination

Objective: Investigate how different light spectral qualities affect seed germination of ornamental crops in propagation systems using LED as sole light source

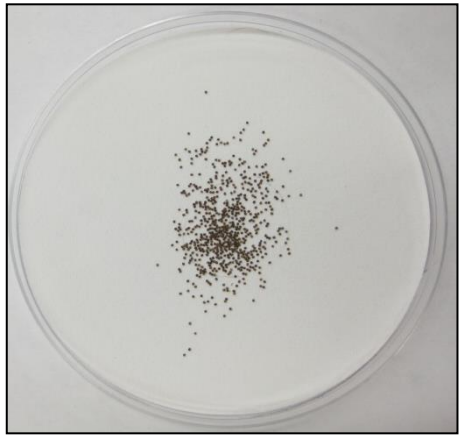
Plant materials

Vinca
Catharanthus roseus



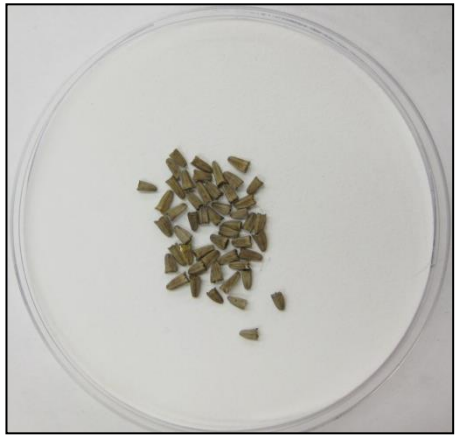
- ‘Mediterranean XP Red Dark’
- ‘Pacifica XP Burgundy’
- ‘Pacifica XP Magenta Halo’

Petunia
Petunia ×hybrida



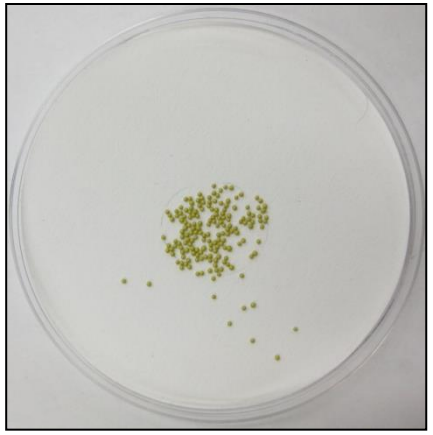
- ‘Easy Wave Coral Reef’
- ’Easy Wave Red Velour’
- ’Easy Wave White’

Echinacea
Echinacea ×hybrida



- Lakota Santa Fe
- PowWow Wild Berry

Begonia
Begonia ×tuberosa



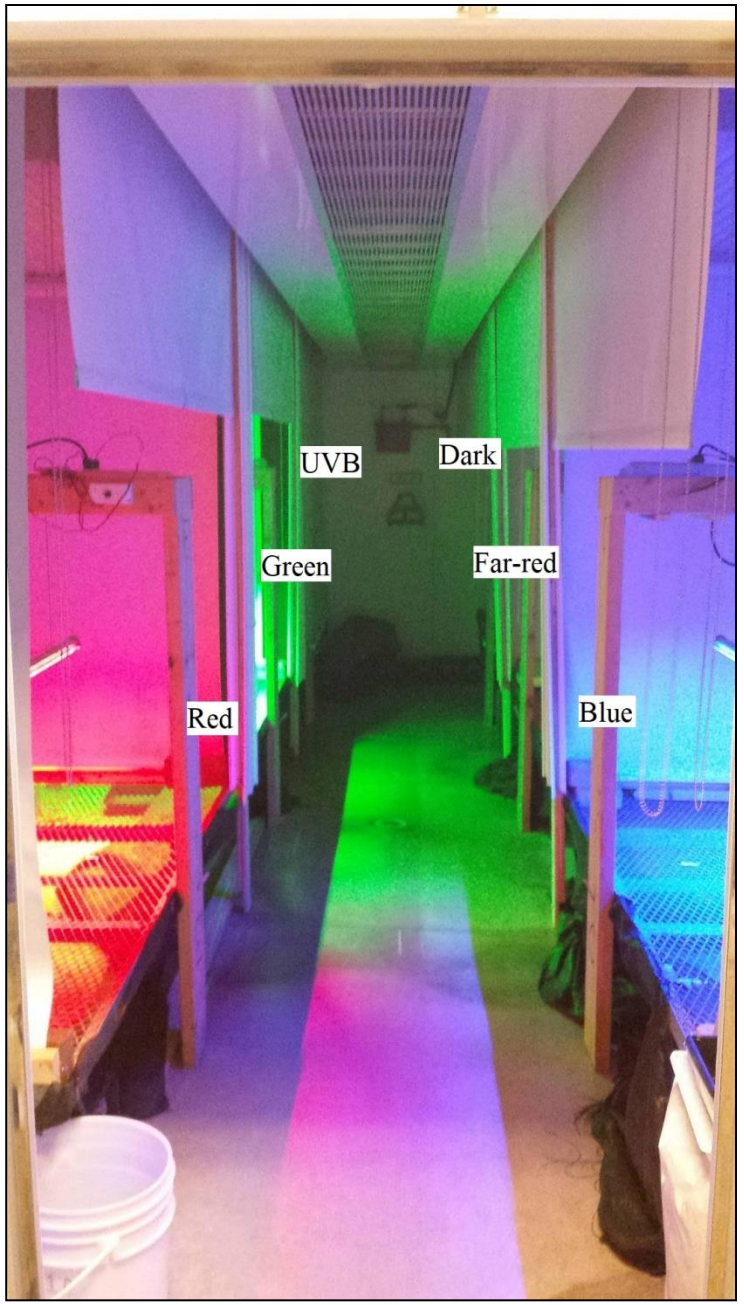
- ‘Tuberous Illumination Apricot Shade’
- ’Nonstop Red’

Gerbera
Gerbera jamesonii

- ‘Majorette Red Dark Eye’ (coated and uncoated)
- ’Maxi Pink’
- ‘Maxi White’
- ‘Midi Dark Purple’

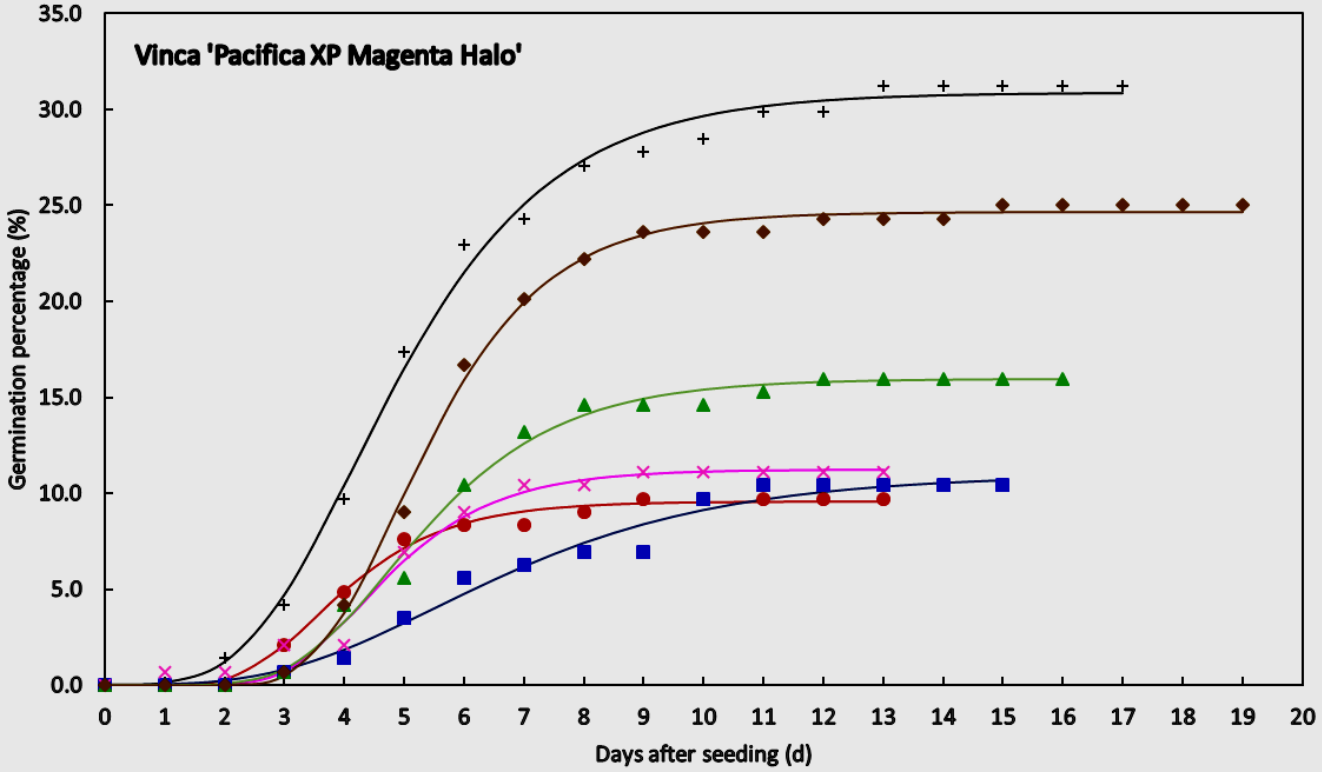
Experimental setup

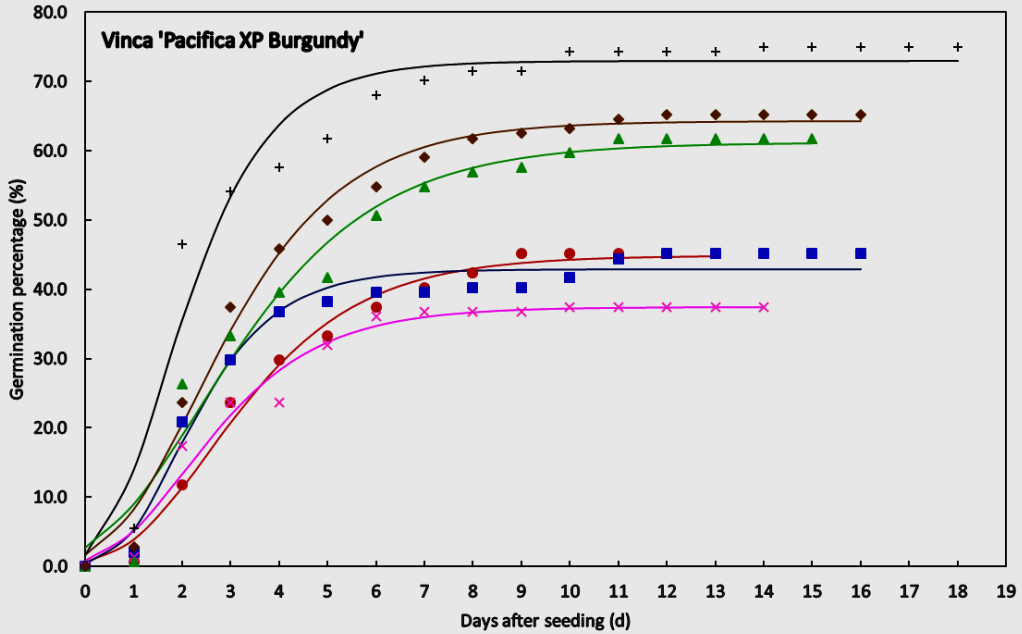
- Treatments
  - Dark (control)
  - 20 μmol·m^{-2}·s^{-1} Red
  - 20 μmol·m^{-2}·s^{-1} Blue
  - 20 μmol·m^{-2}·s^{-1} Far-red
  - 20 μmol·m^{-2}·s^{-1} Green
  - 0.5 μmol·m^{-2}·s^{-1} UVB
- Chamber conditions
  - 24 h lighting
  - 23˚C and 75%RH

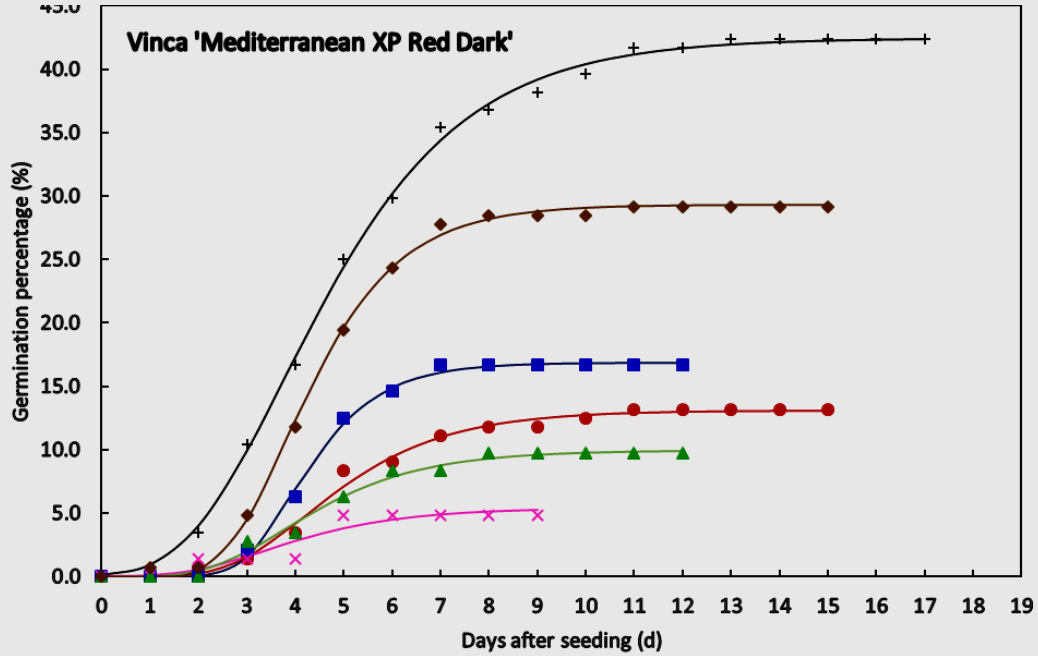


Germination dynamic

Vinca

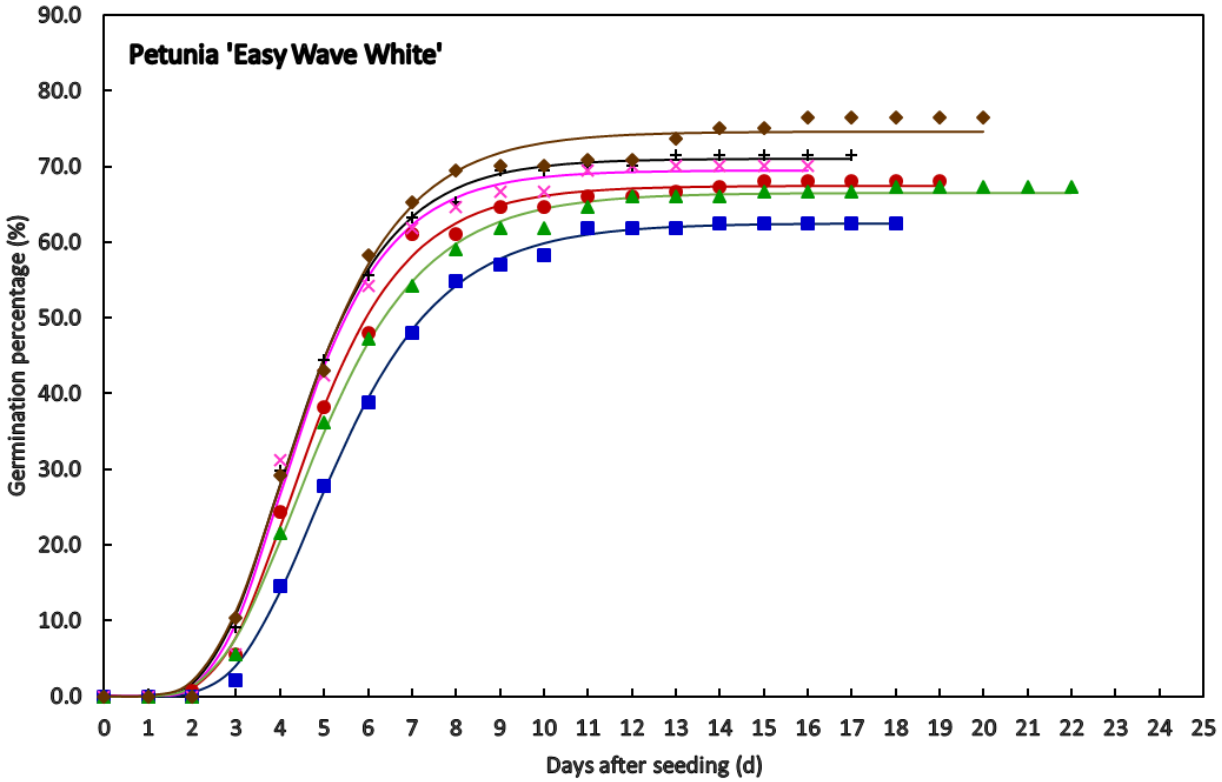


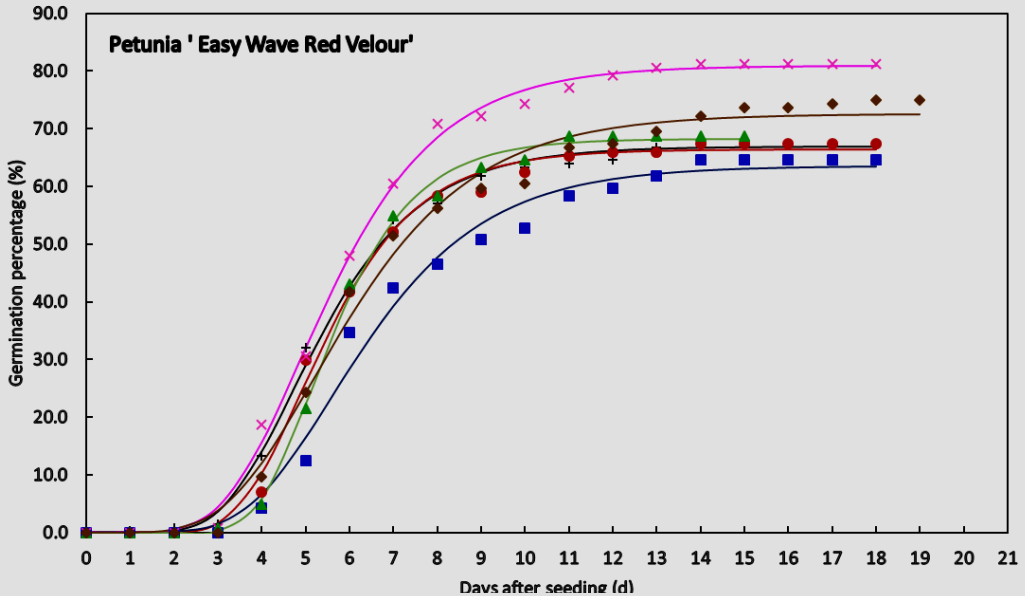


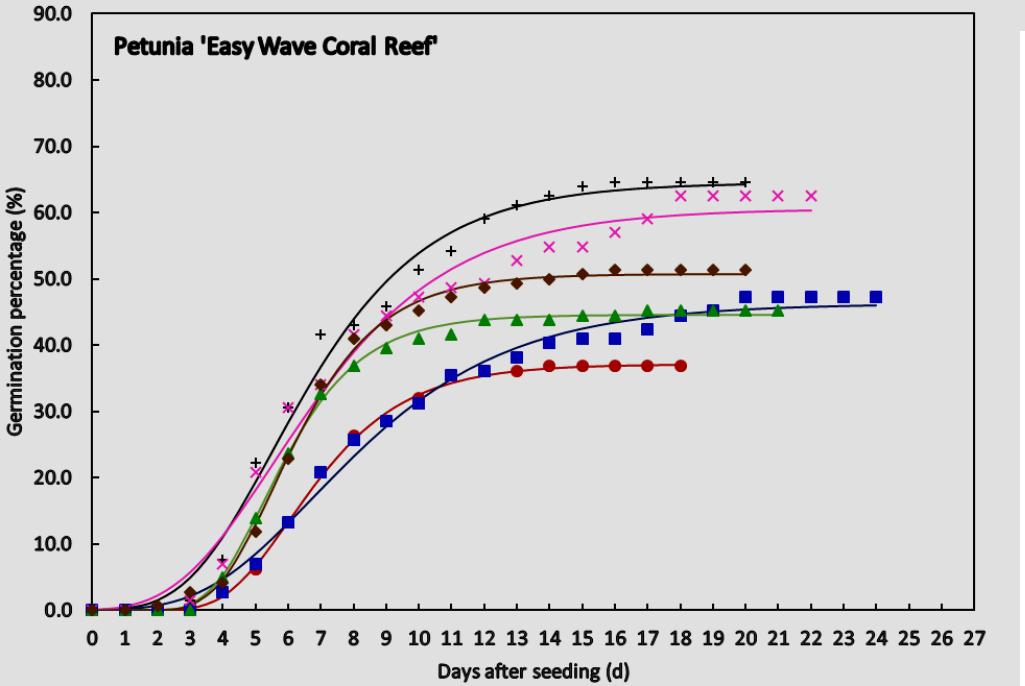


Germination dynamic

Petunia

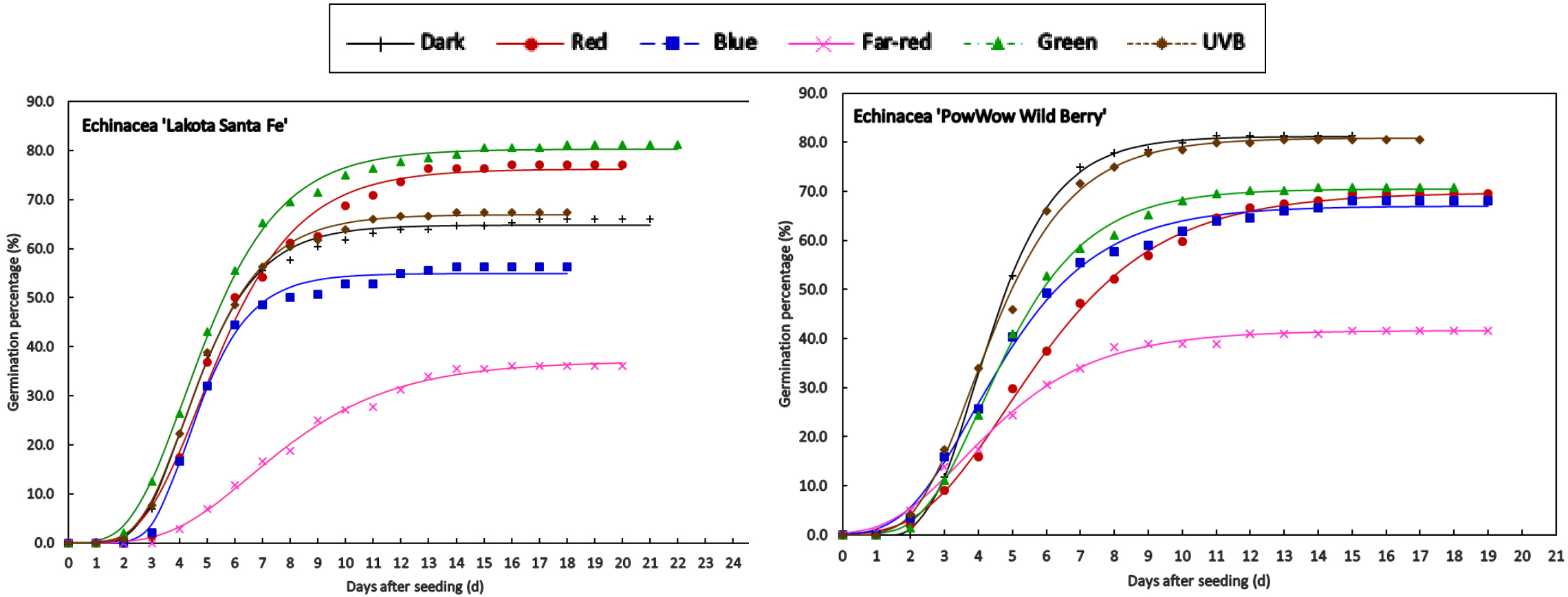






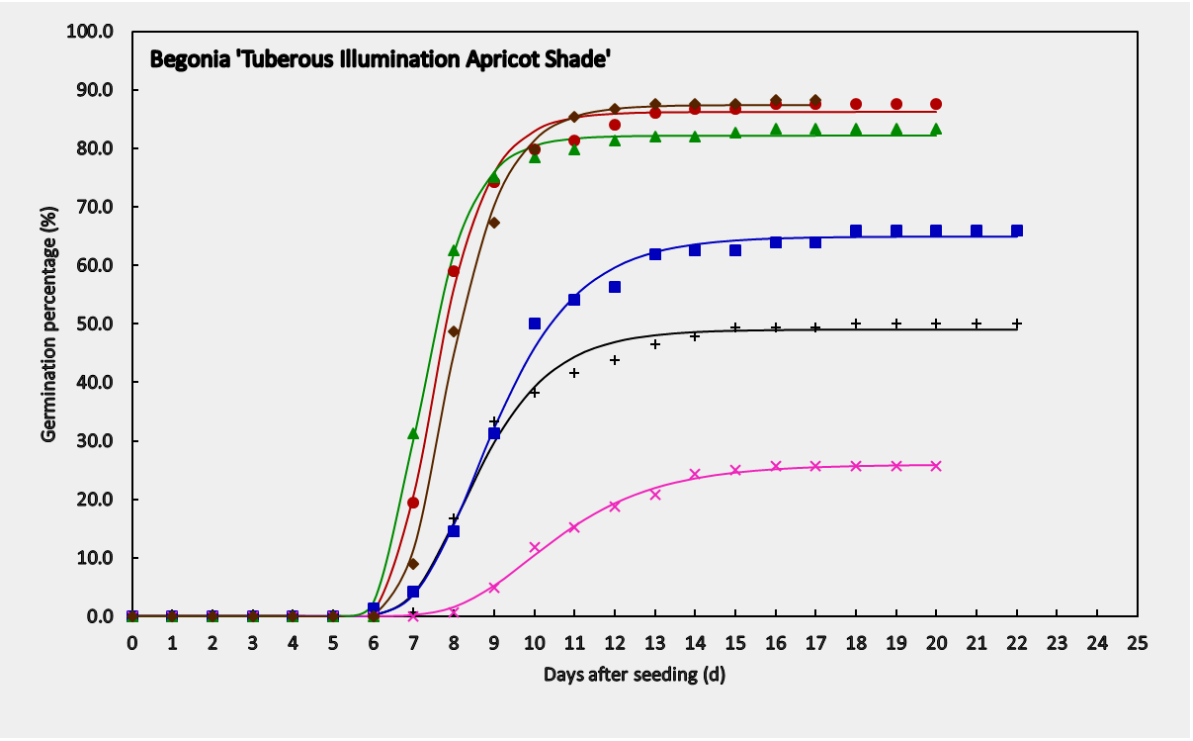
Germination dynamic

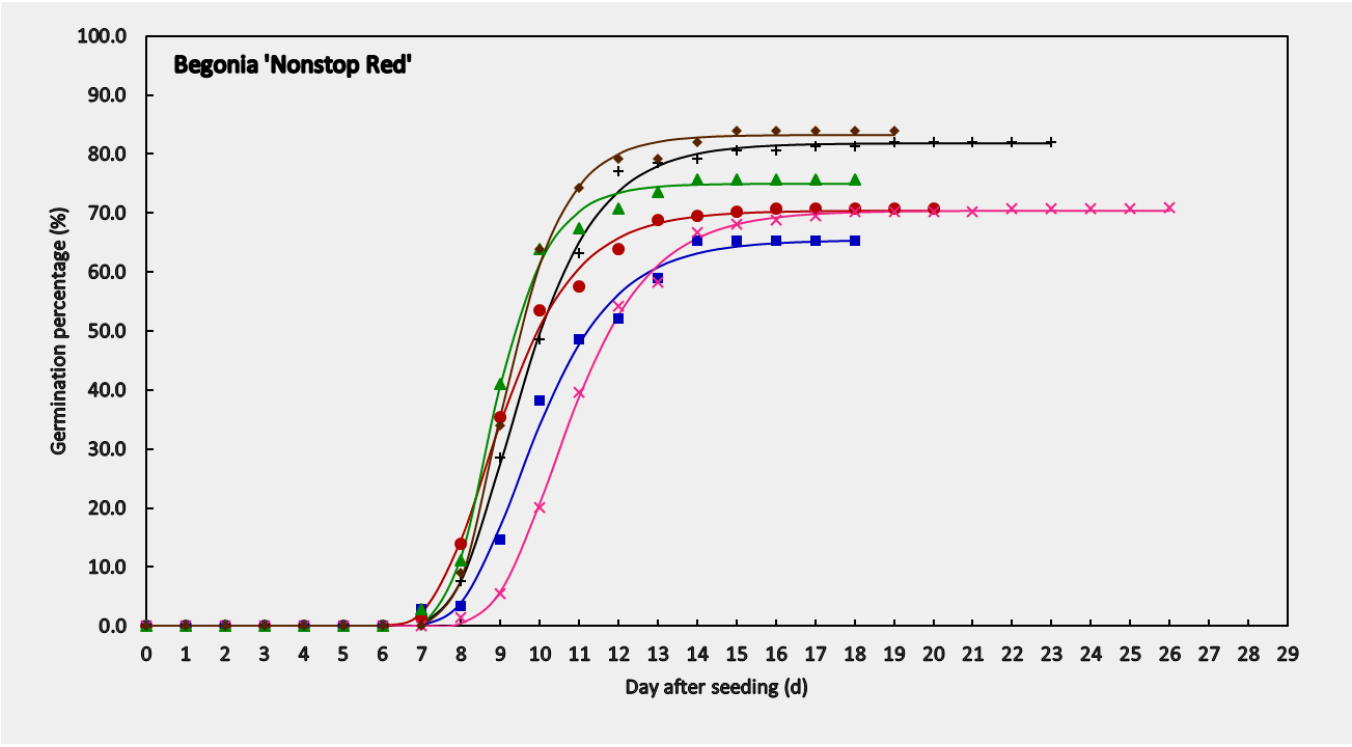
Echinacea

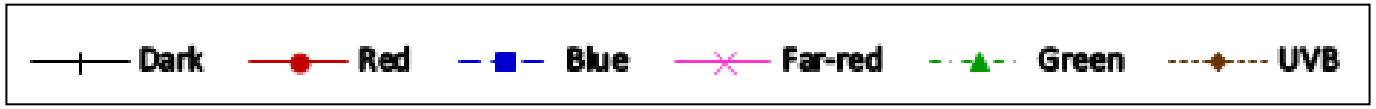


Germination dynamic

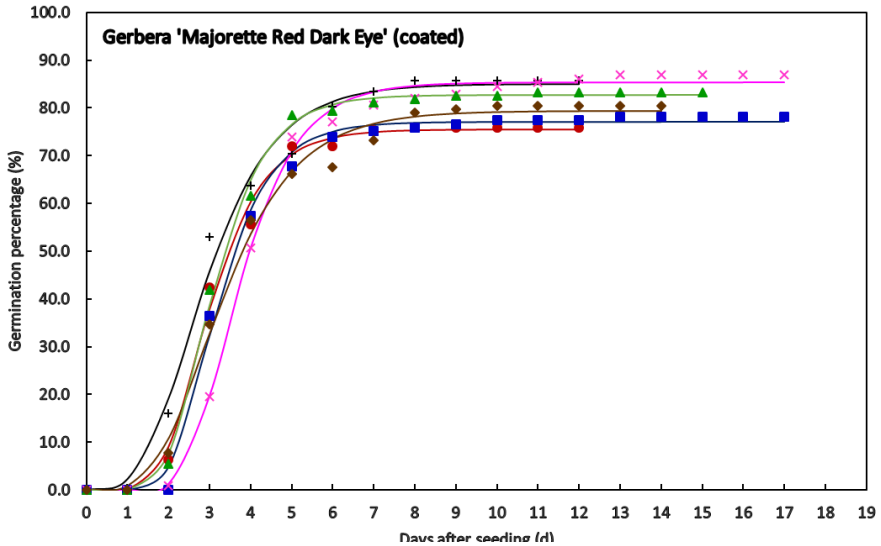
Begonia

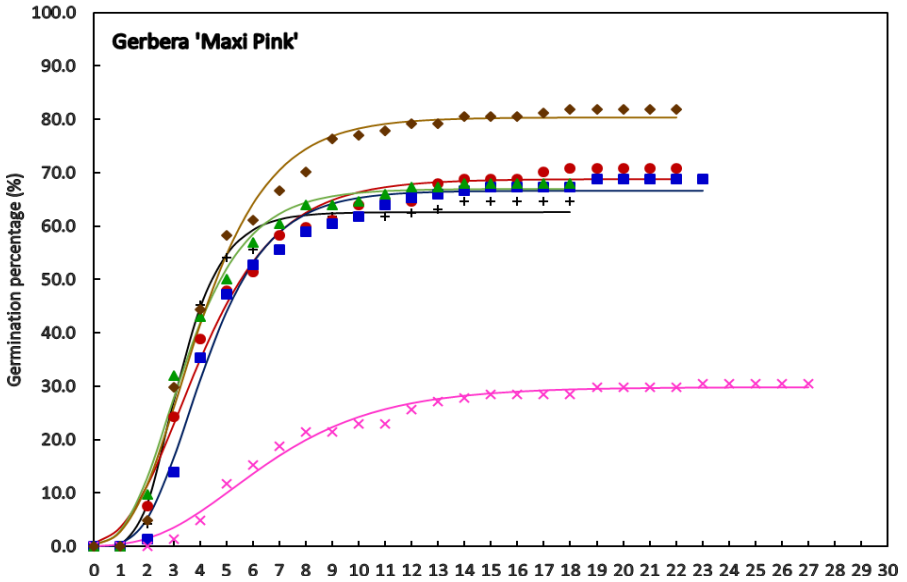




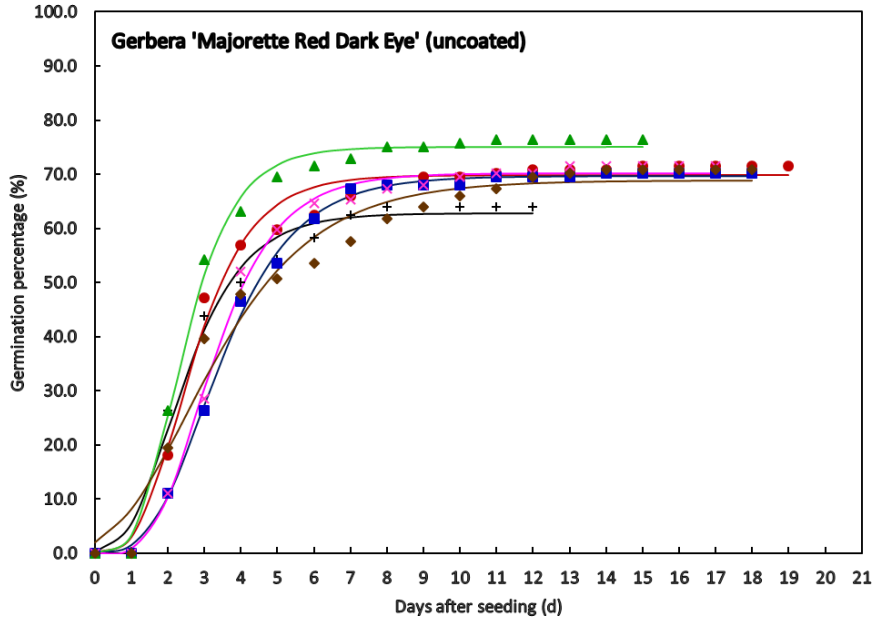


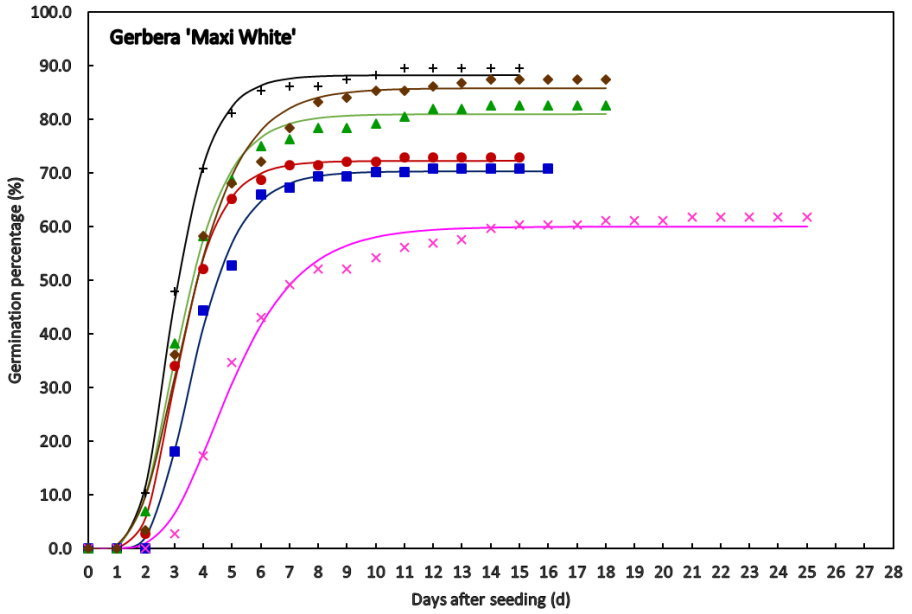
Germination dynamic





Gerbera





Light Quality and Seedling Propogation

Objective: To investigate how different light spectral qualities affect seedling performance of ornamental crops in propagation systems using LED as sole light source

Experiment materials

- Four gerbera cultivars
- http://bayviewflowers.com

Midi Dark Purple

Maxi White

Maxi Pink

Majorette Red

Light treatments

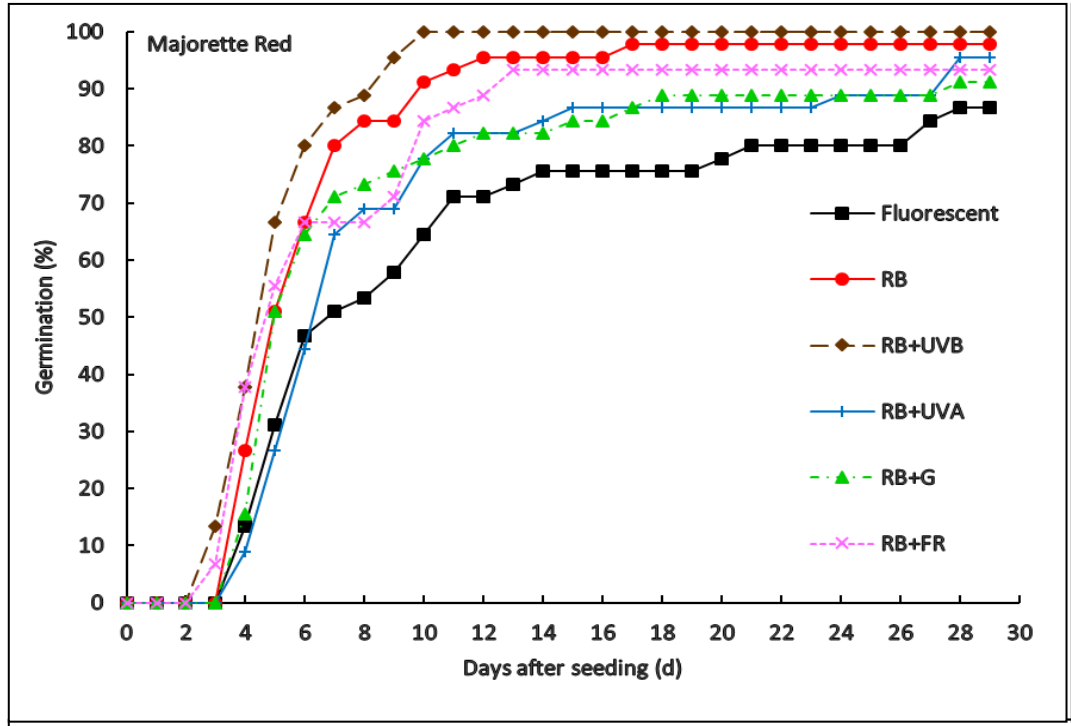
Treatment	Intensity µmol·m^{-2}·s^{-1}						
	PPFD at center	Blue (400-500 nm)	Red (600-700 nm)	UVB (280-320 nm)	UVA (320-400 nm)	G (500-600 nm)	FR (700-800 nm)
Fluorescent	167	na	na	na			
R85B15	181	27	153				
RB+UVB	181	27	153	0.53			
RB+UVA	180	27	153		11.05		
RB+G	180	27	108			45.5	
RB+FR	181	27	153				18

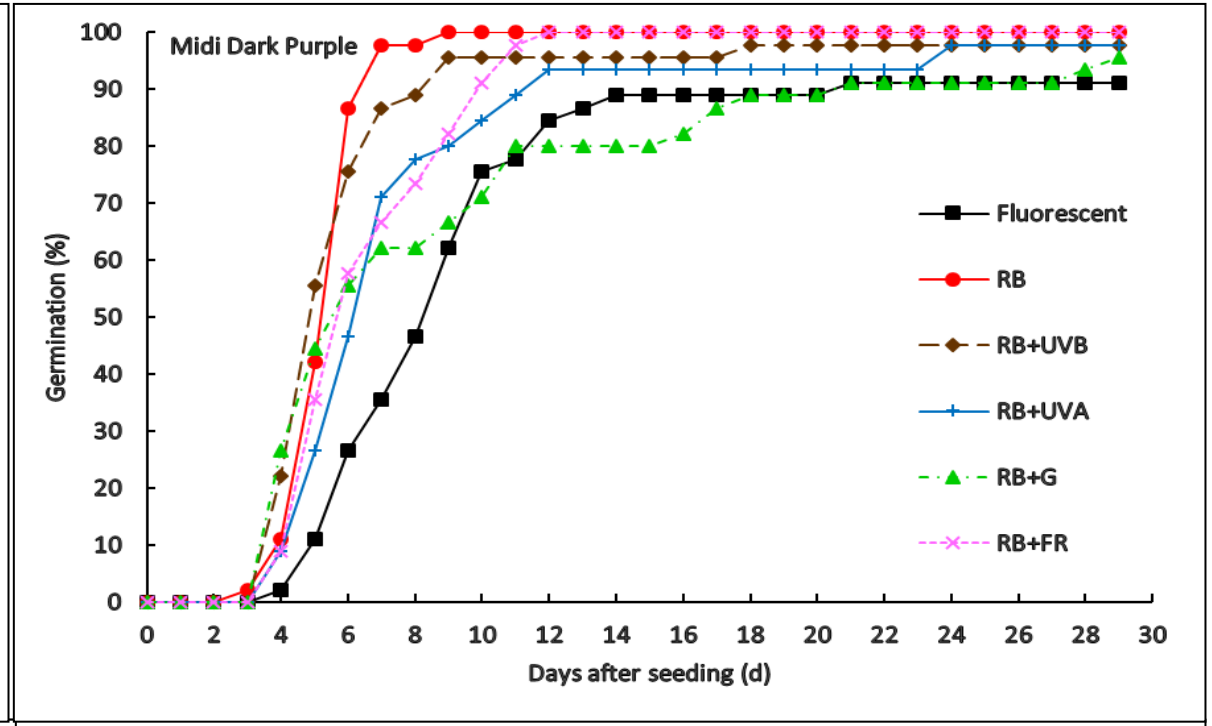
Treatments arrangement, environment & plant maintenance

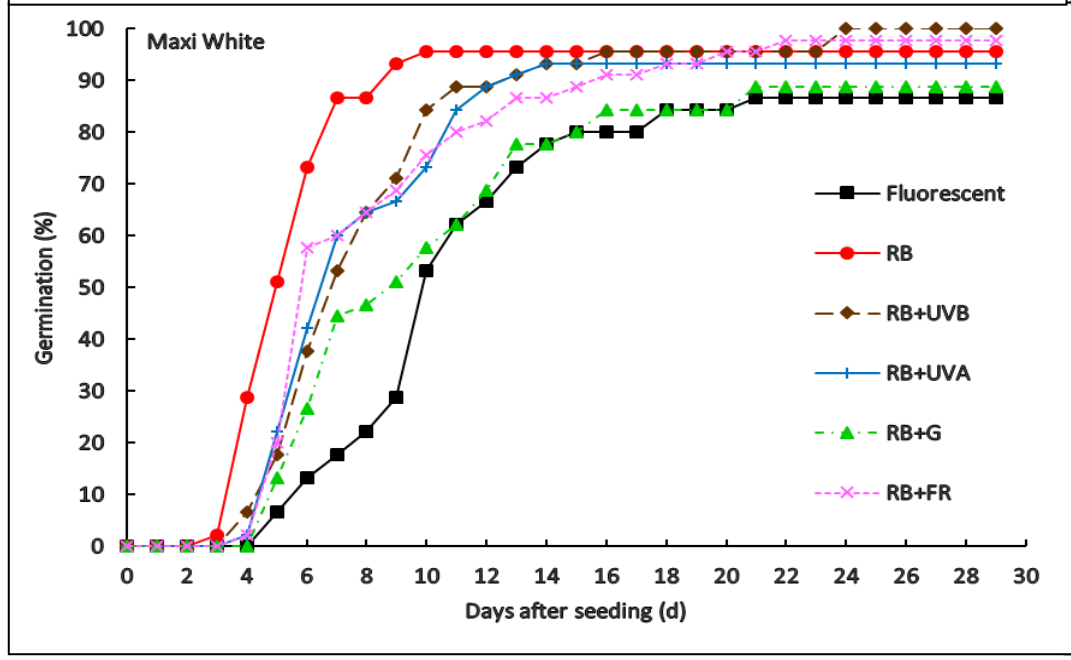
- Random complete block design

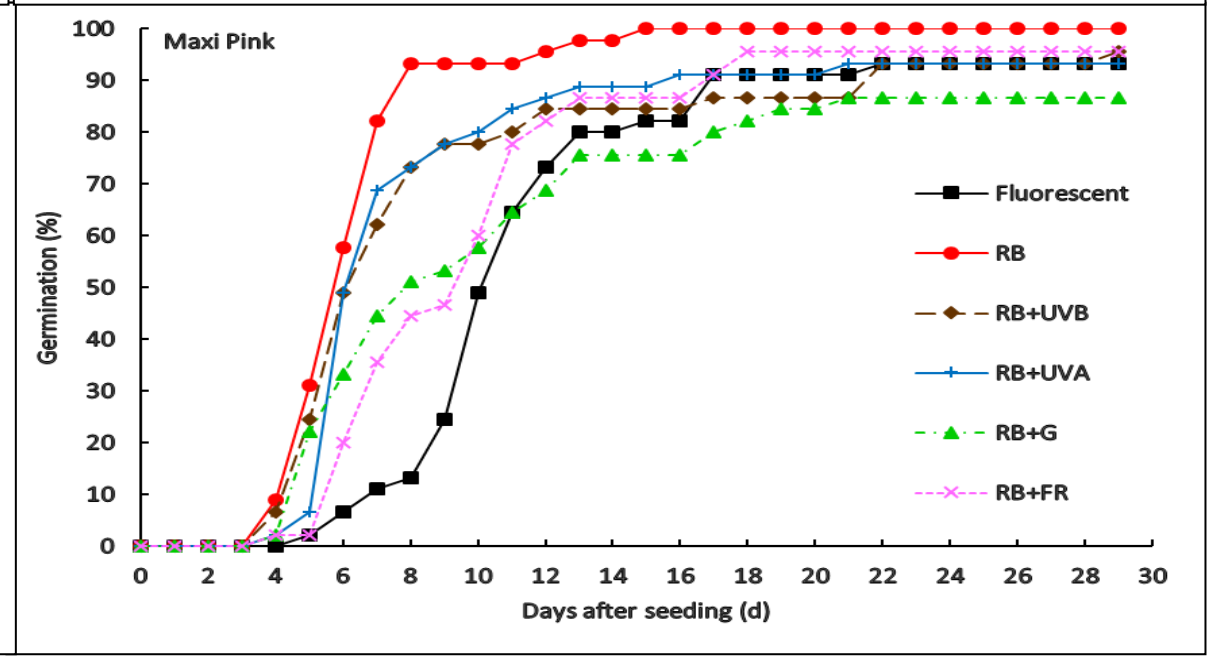
- 16 h photoperiod
- Temperature and RH (23˚C and 65%)

- Seeds sown in a 7×15 plug tray (each cell was ~1.3″×1.7″)
- Grew for 4 weeks (~3-4 true leaves when harvested and transplanted)


Majorette Red
Germination (%)
Days after seeding (d)
Fluorescent
RB
RB+UVB
RB+UVA
RB+G
RB+FR


Midi Dark Purple
Germination (%)
Days after seeding (d)
Fluorescent
RB
RB+UVB
RB+UVA
RB+G
RB+FR


Maxi White
Germination (%)
Days after seeding (d)
Fluorescent
RB
RB+UVB
RB+UVA
RB+G
RB+FR

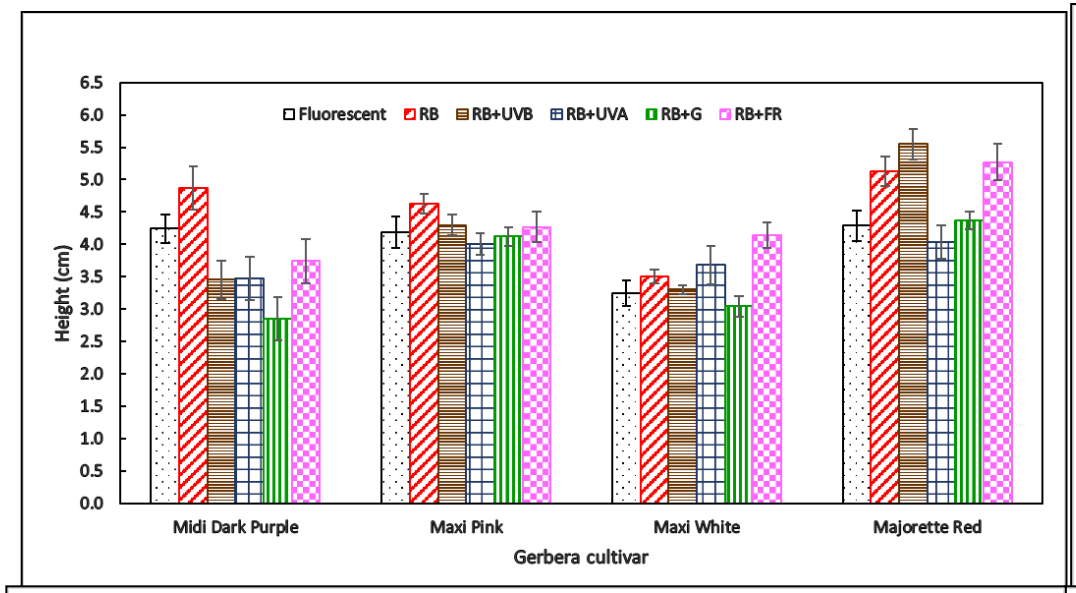

Maxi Pink
Germination (%)
Days after seeding (d)
Fluorescent
RB
RB+UVB
RB+UVA
RB+G
RB+FR

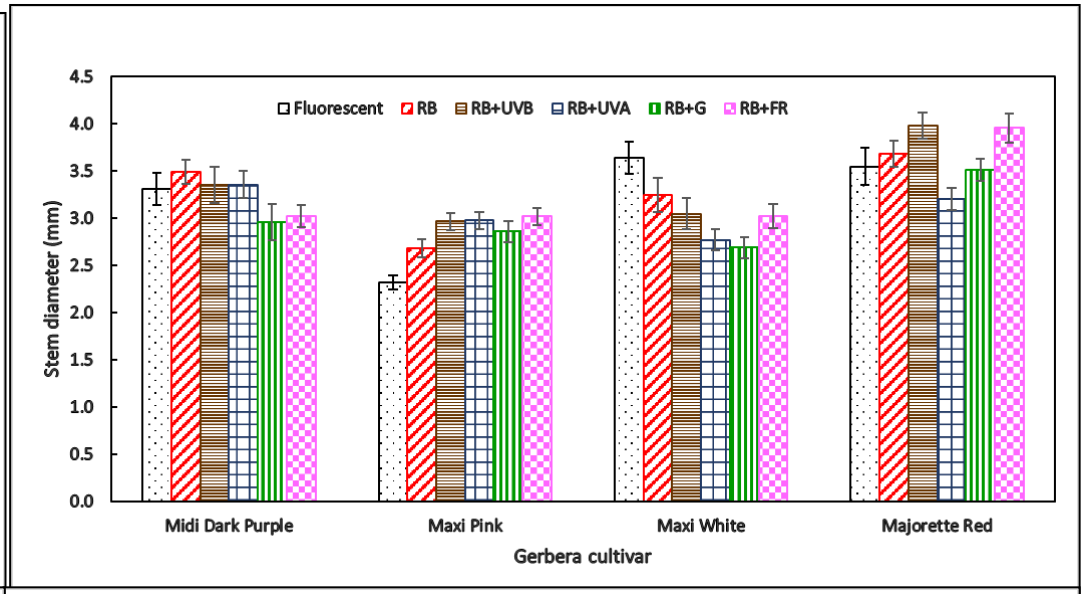
Transplants appearance

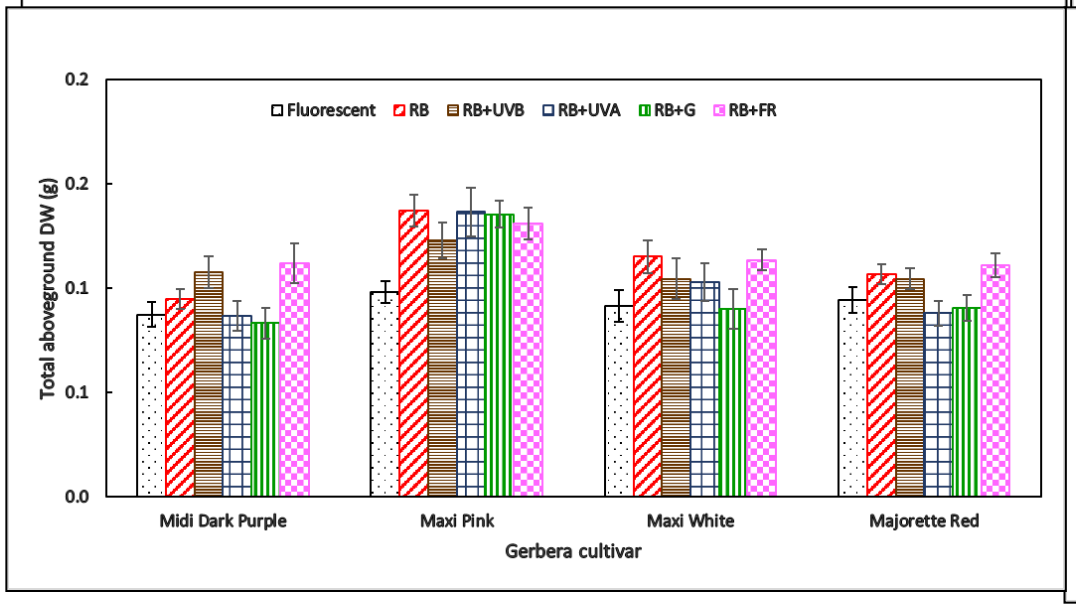
Light treatment

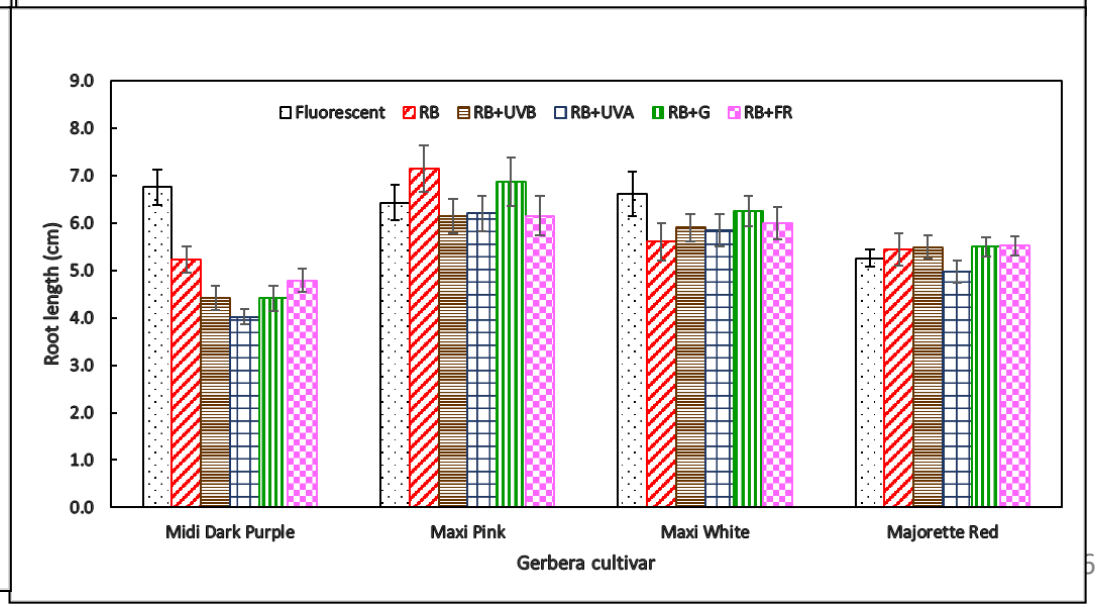
Cultivar

Plant growth

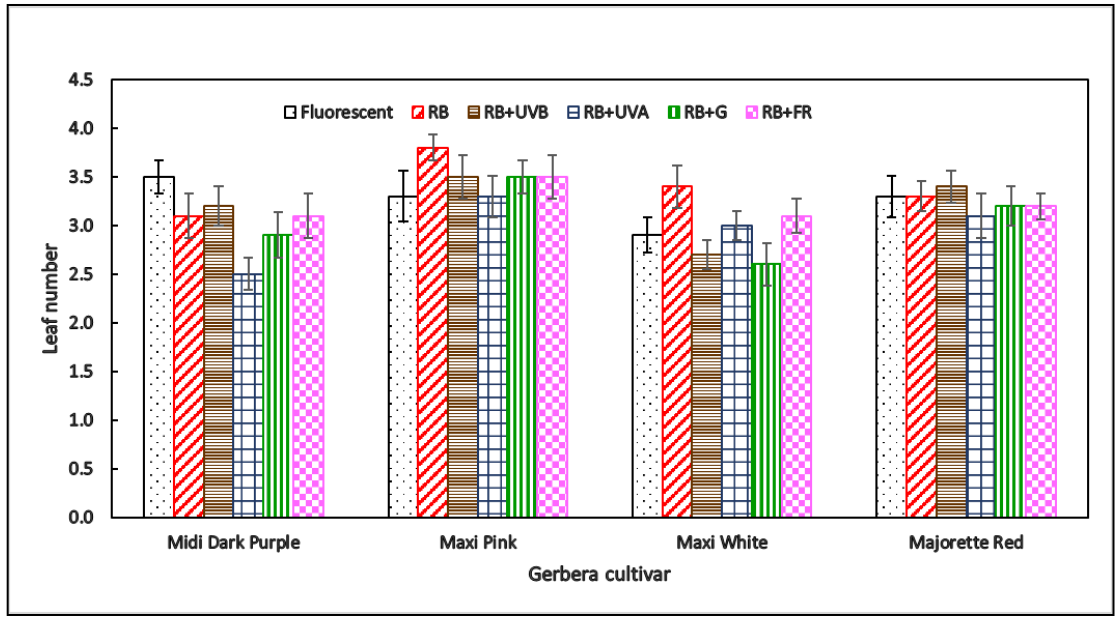


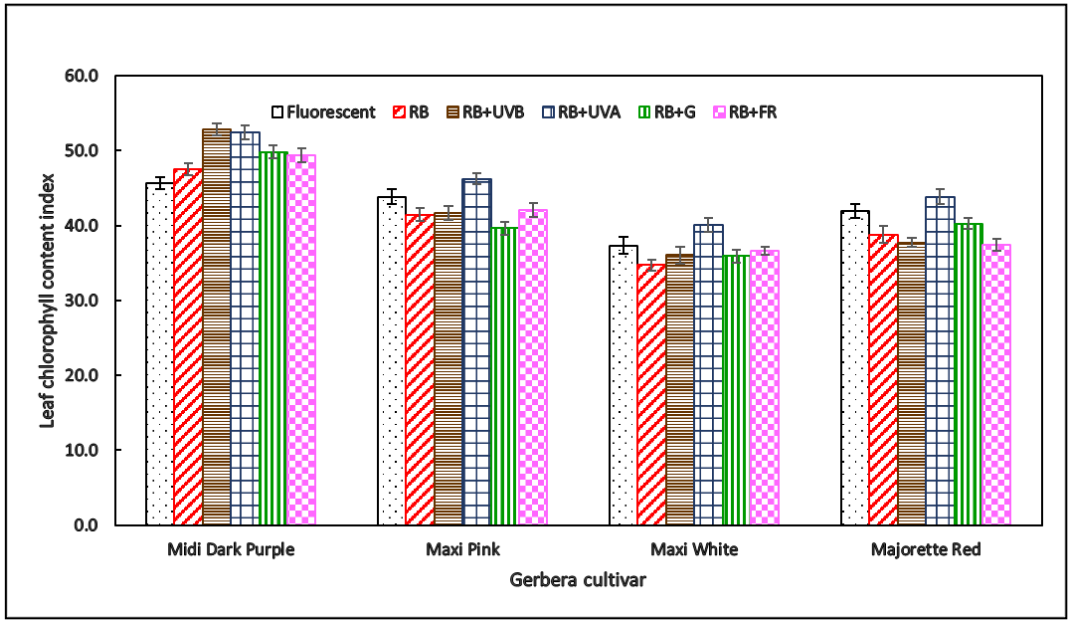




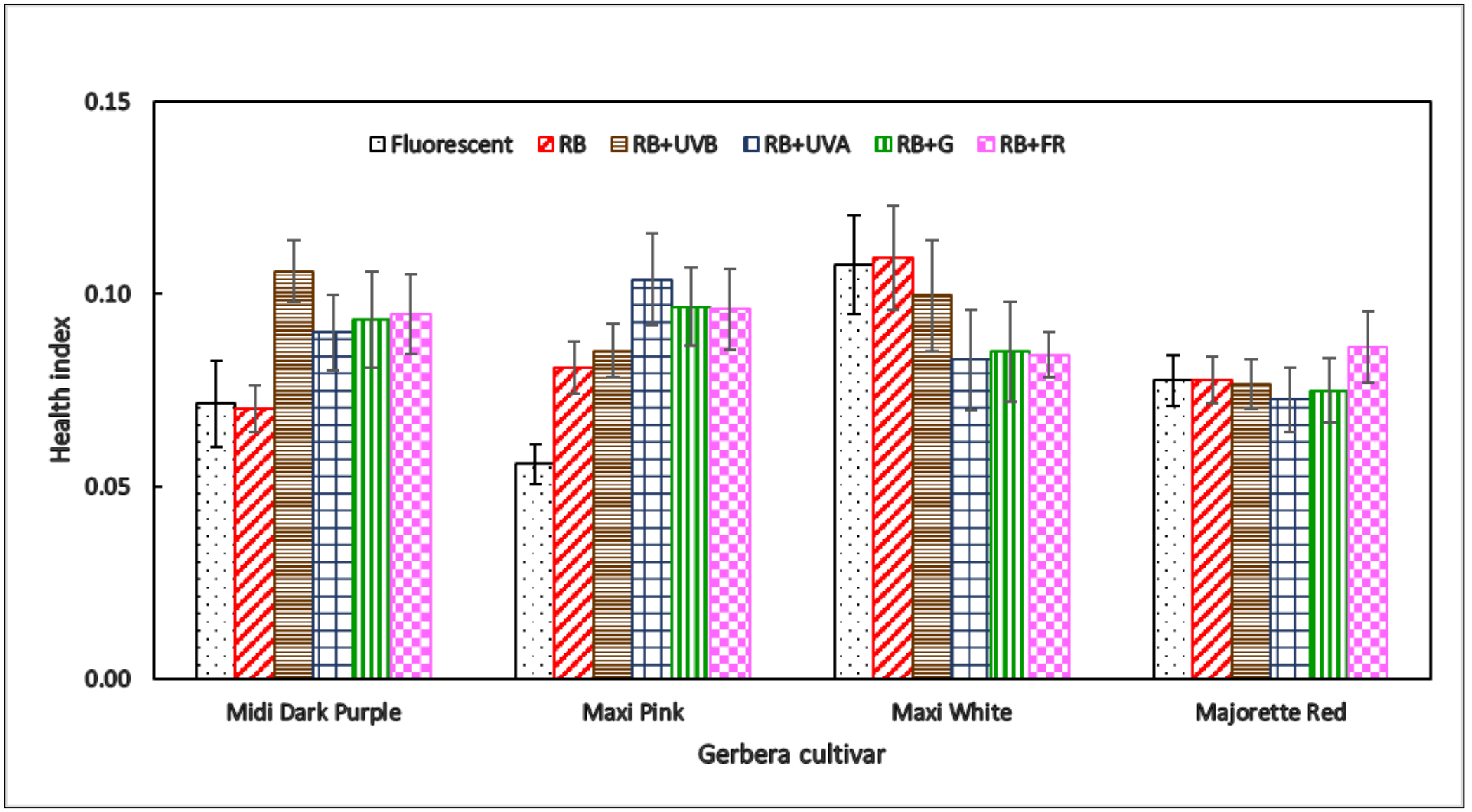


Leaf morphology

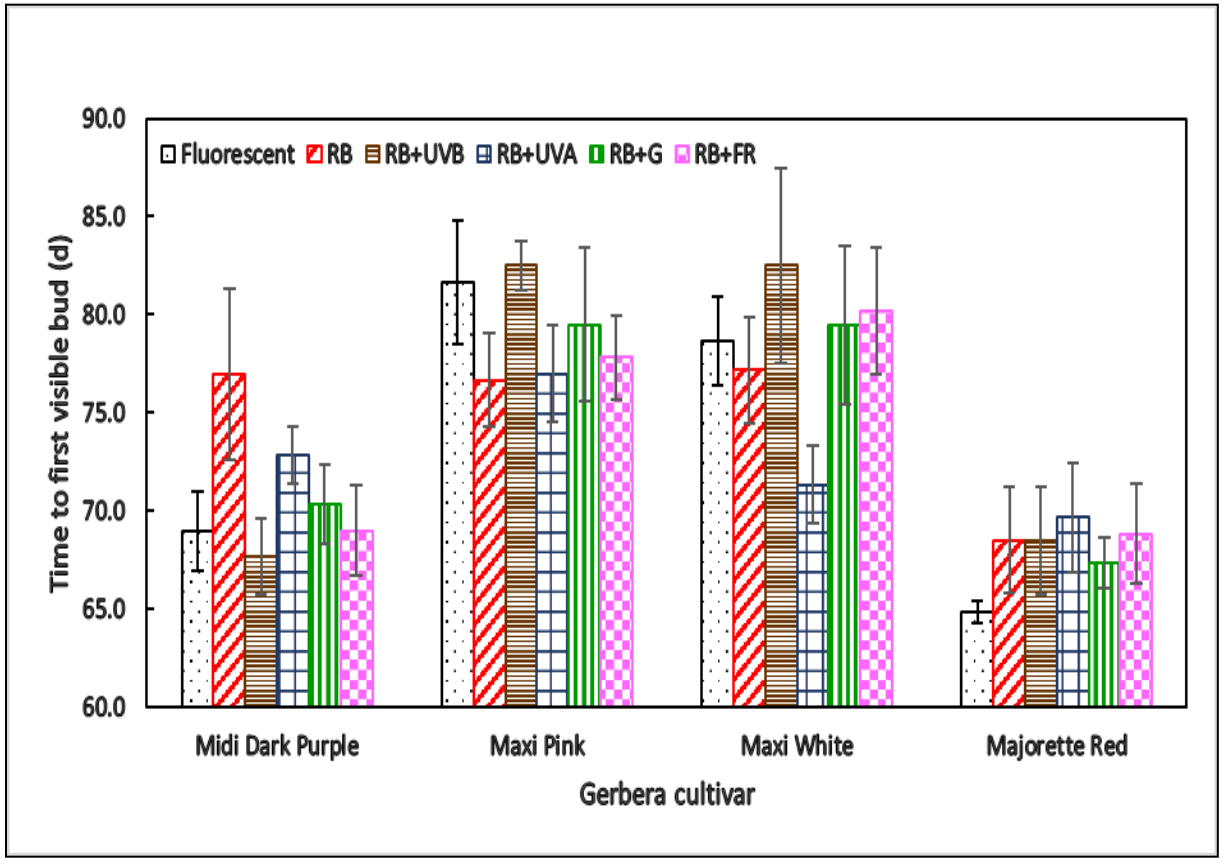


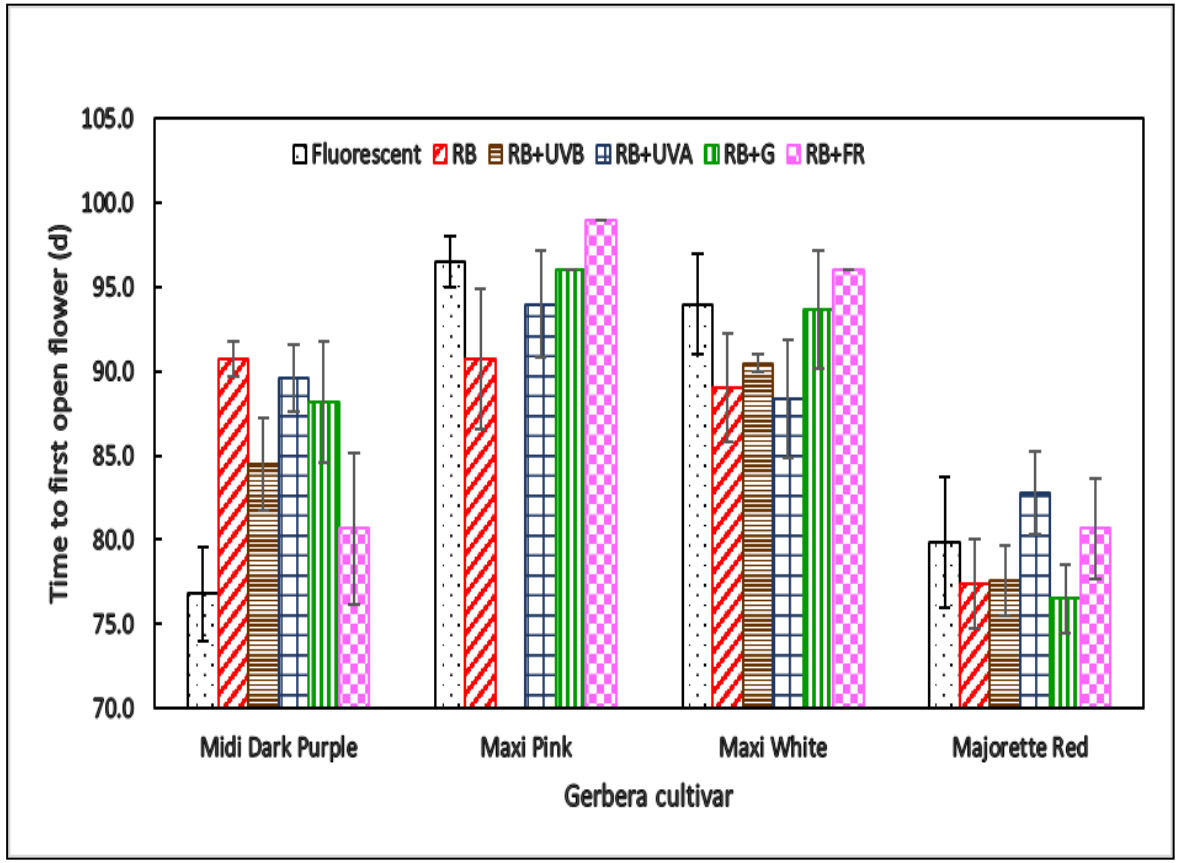


Health index
=(Stem diameter/Height)(Aboveground DW)



Flowering after transplanting





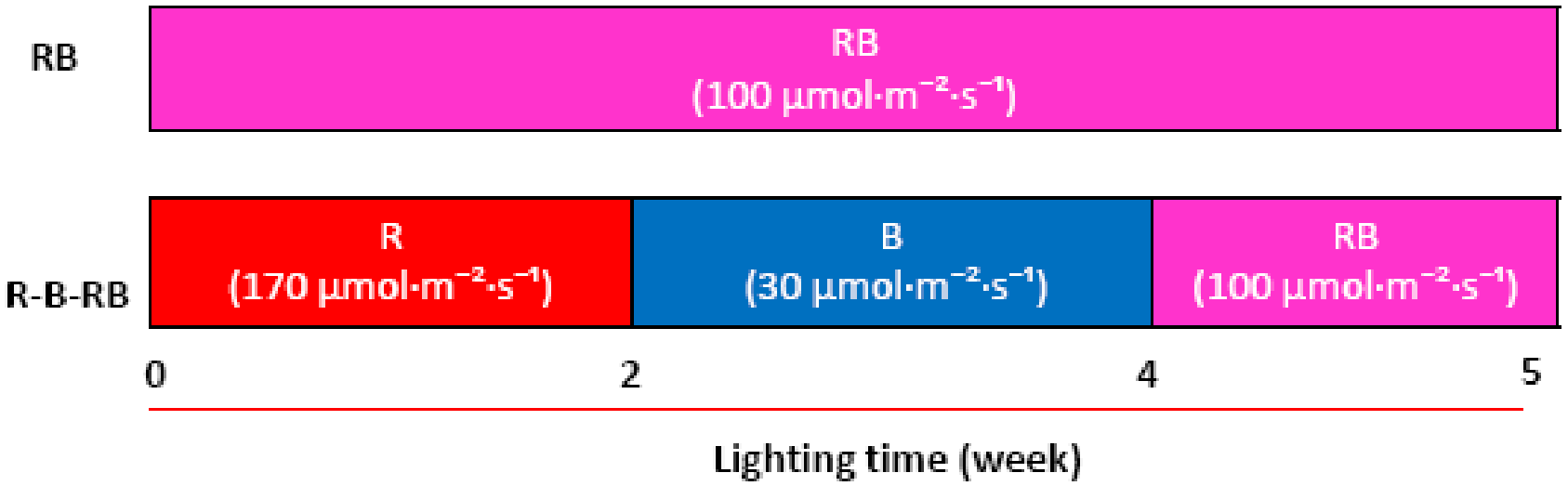
Light Quality and Stock Plants

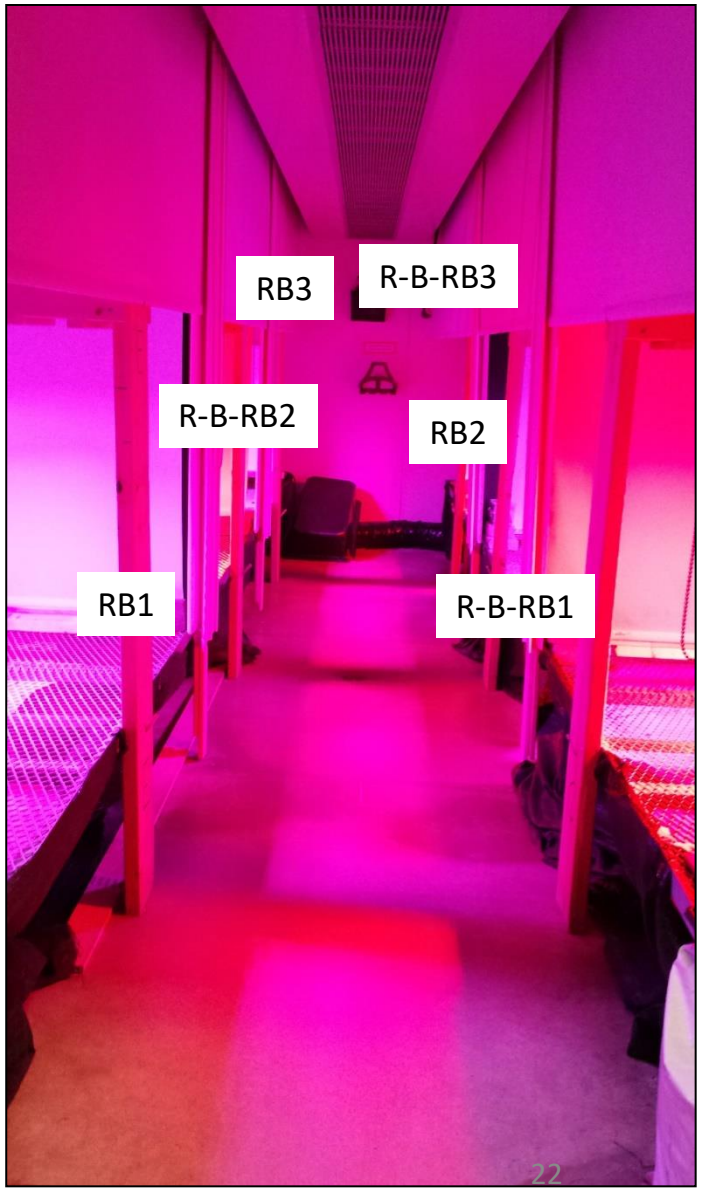
Objective: Investigate different lighting strategies on stock plant characteristics, for the purposes of improving the quality of cuttings and ease of harvesting.

Plant materials

***Campanula* 'Get MEE'**

Light treatments

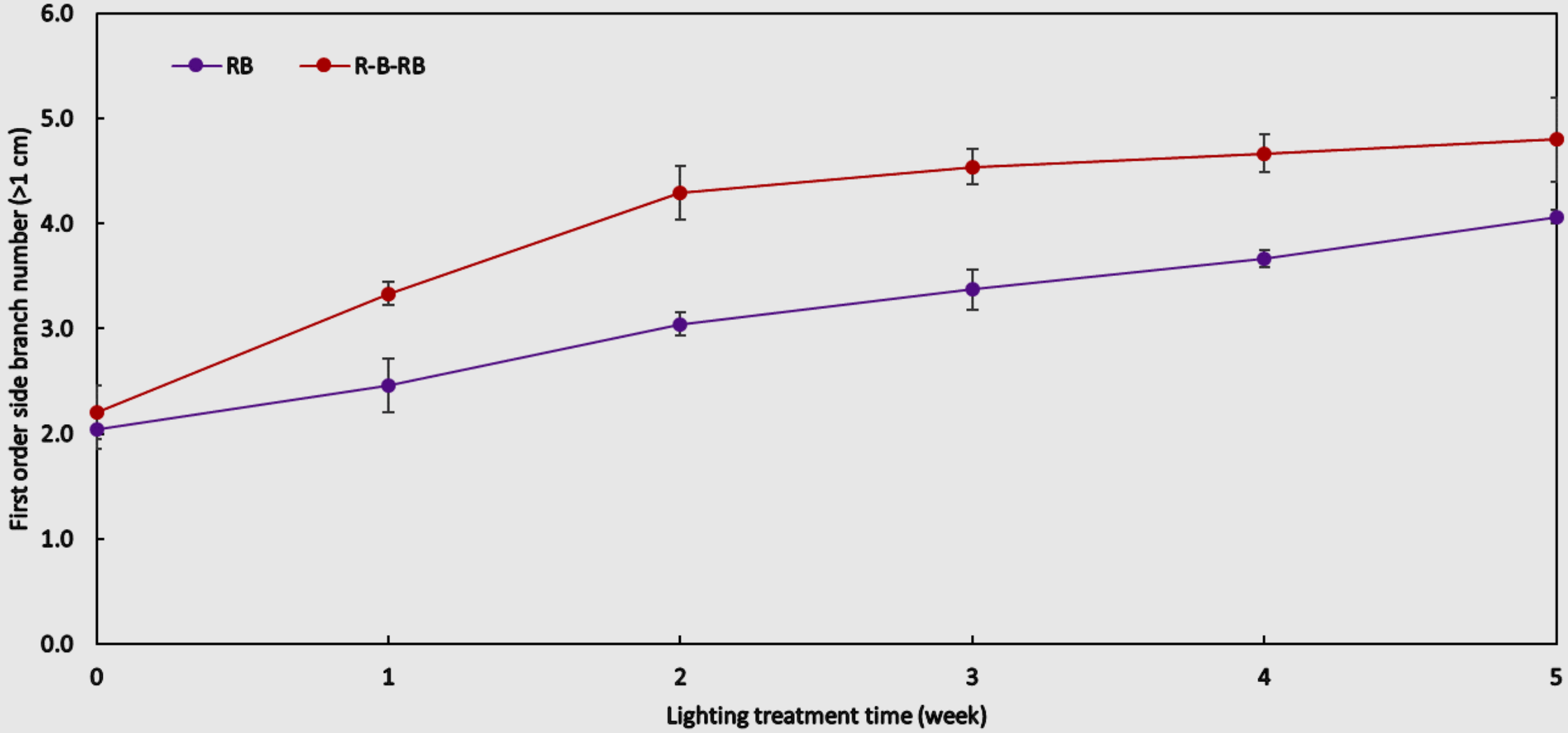




Chamber conditions:

- **24 h photoperiod,**
- **21˚C, and**
- **75% RH**

Side branch number

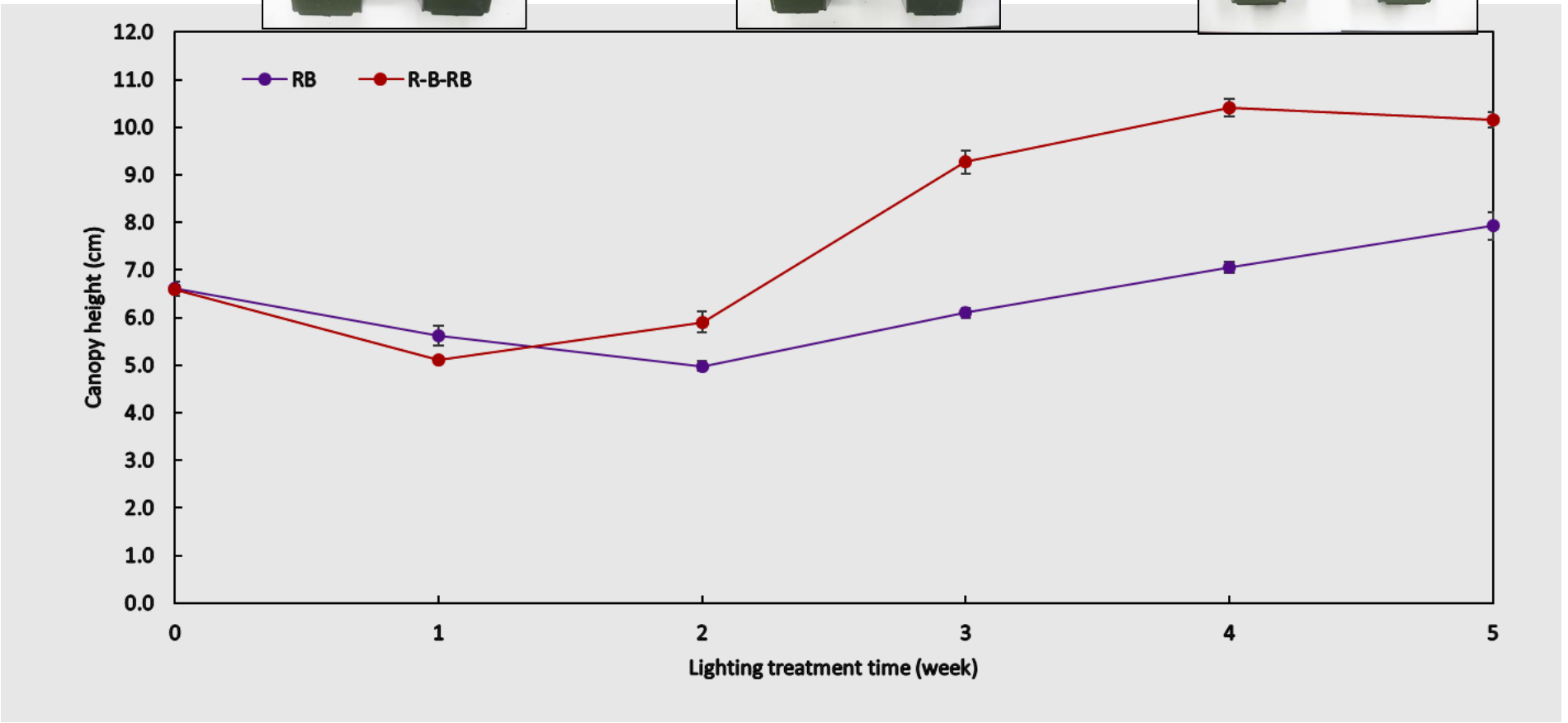


Canopy height

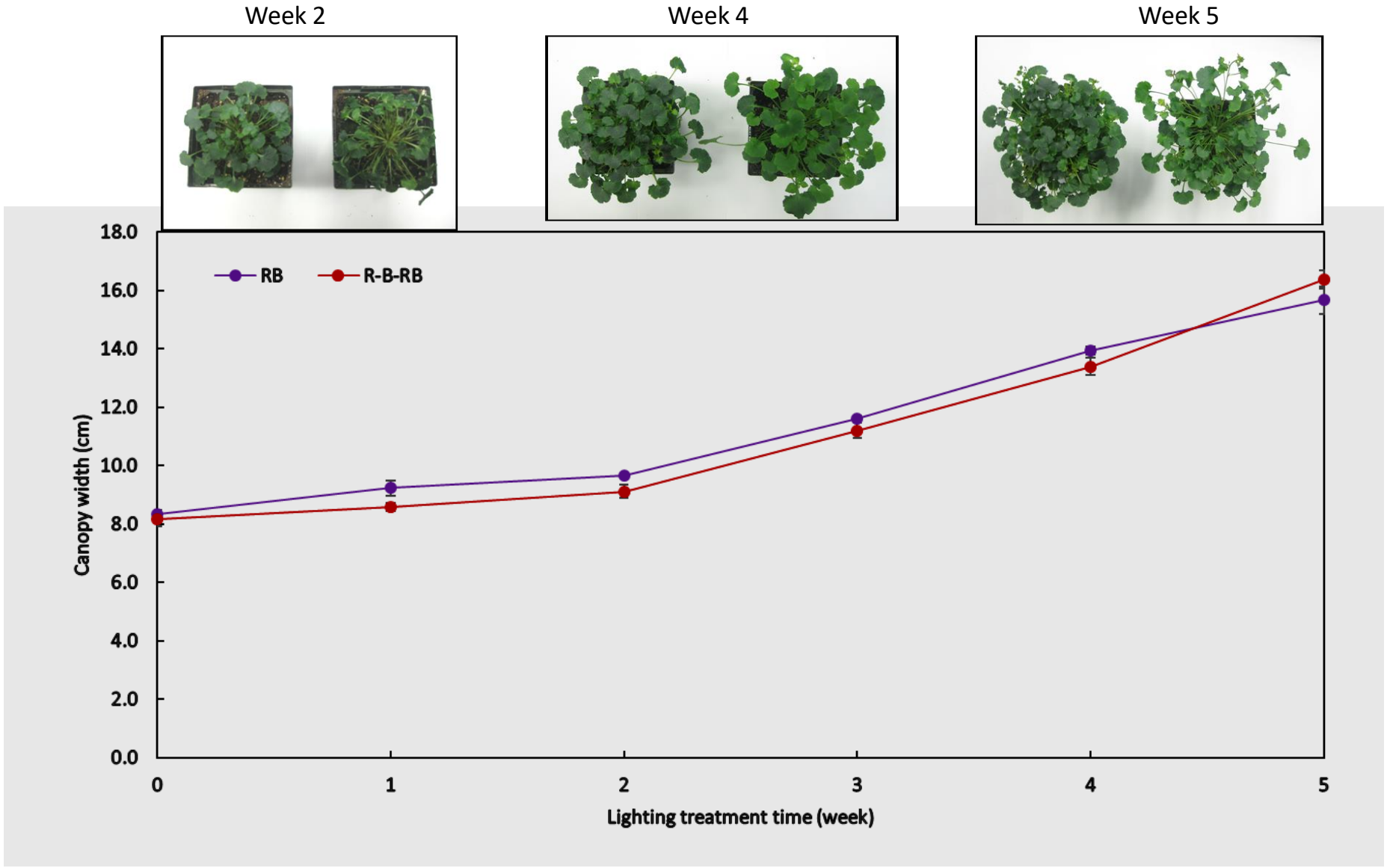
Week 2

Week 4

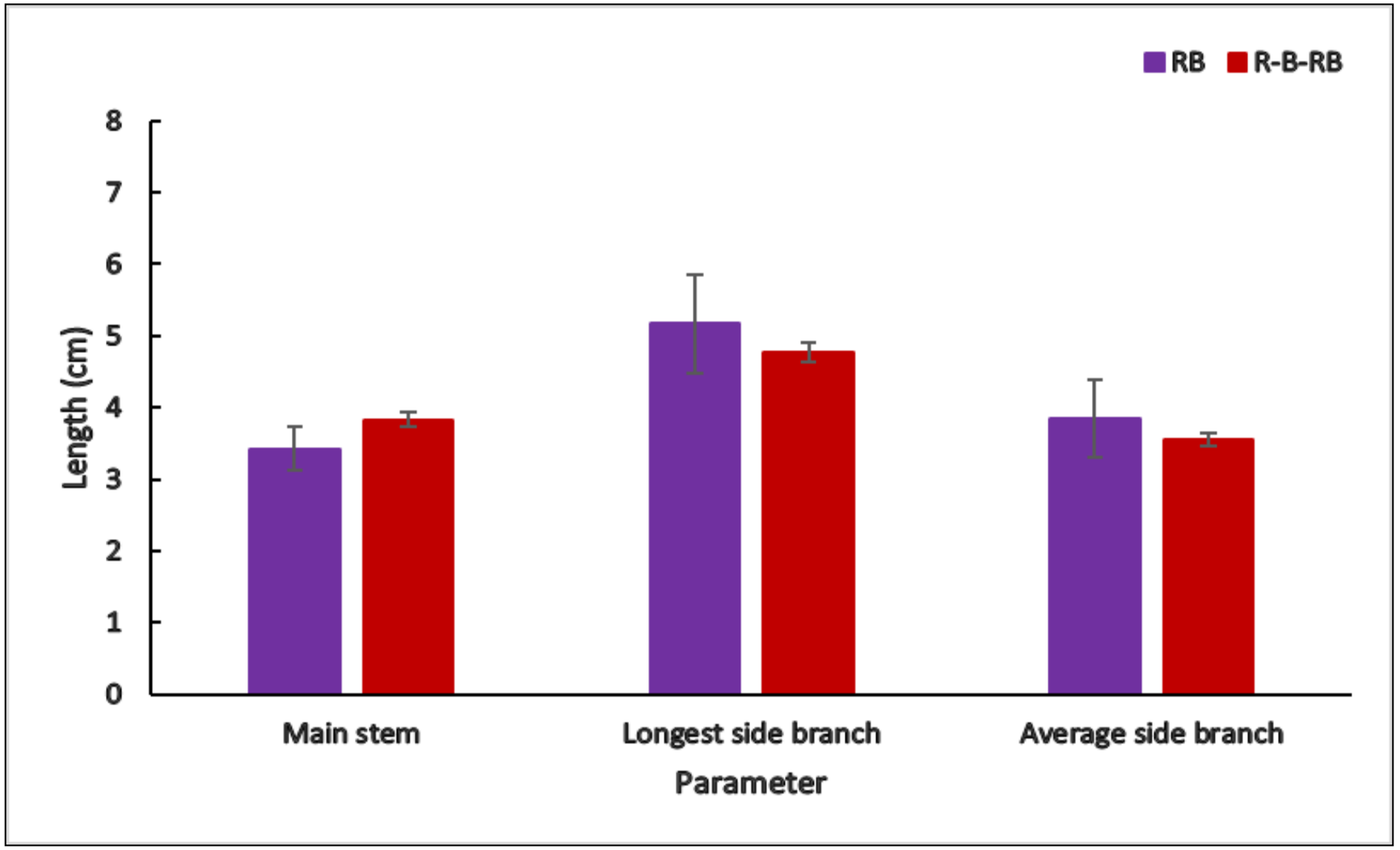
Week 5



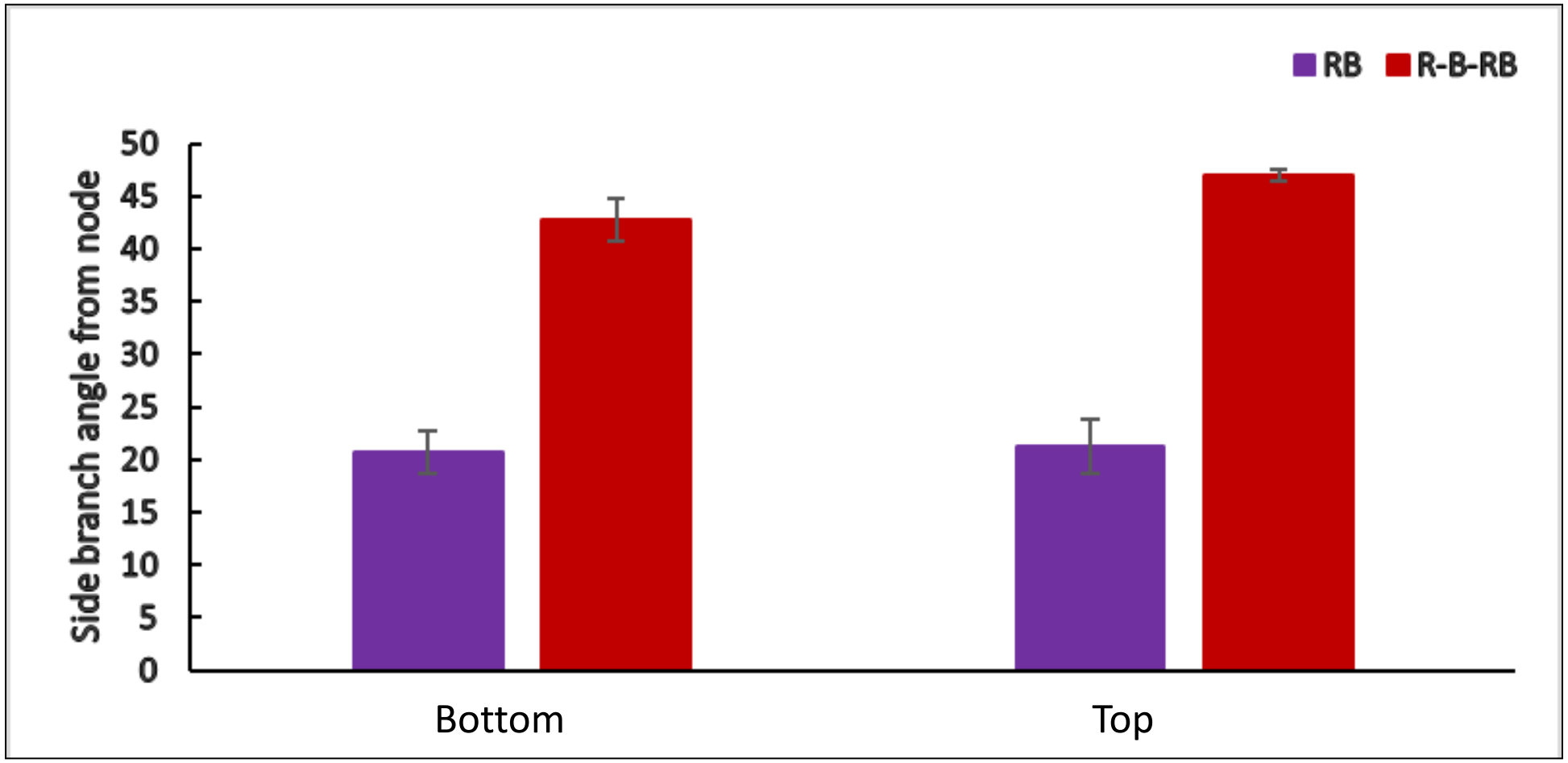
Canopy width



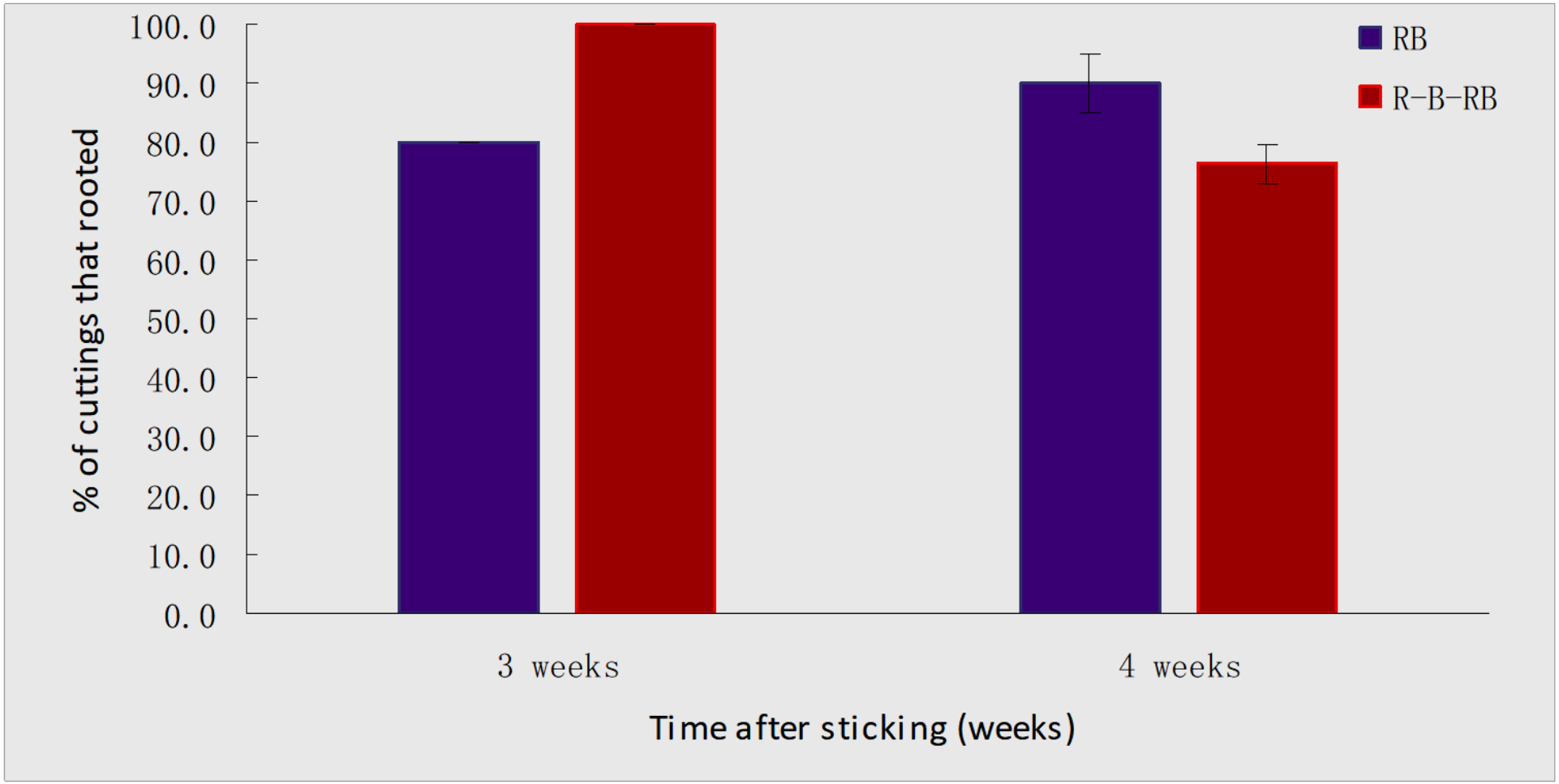
Stem and side branch length



Branching angle



Cuttings rooting

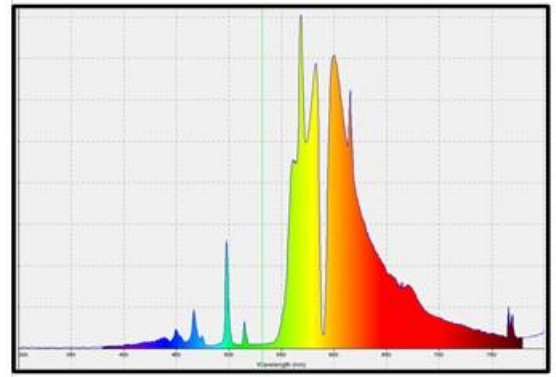
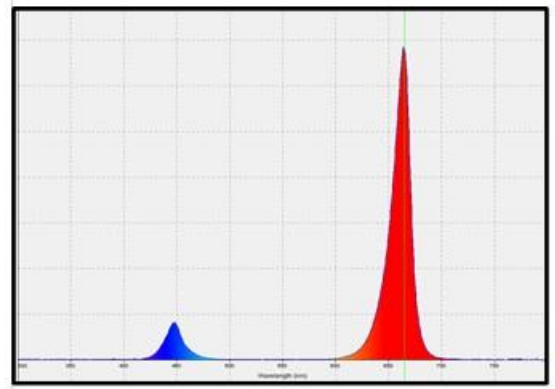
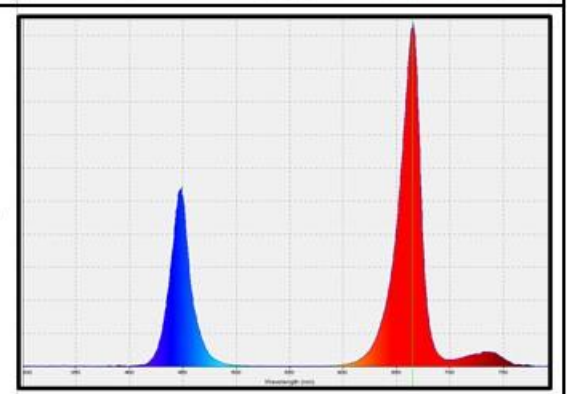


HPS VS LED Lighting for Propagation of Potted Floriculture Crops

Objective: Determine which supplemental lighting control protocol works the best with the best economic return

4 Lighting Treatments

- HPS (center)
- 2 LED treatments (left side)
  - Hortilux (foreground)
  - Yunustech (background)
- Unlit control treatment (far right)
- All supplemental treatments received 50 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of supplemental PAR, regardless of lighting type (LED or HPS)

Fixture Type	Manufacturer	Fixture Model	Spectrum	
HPS	PL Lights	NXT2	Broad spectrum	
LED	Hortilux	HortiLED Top	Blue 7 : Red 93 : Far-red 0	
LED	Yunustech	CERES V	Blue 23 : Red 71 : Far-red 6	

3 Supplemental lighting control algorithms

Natural light only

Natural + Supplemental light to pre-determined light threshold

~5.2 hours/day

Threshold = 325 W/m^2 outdoor global radiation level with proofing time of 10 minutes

Natural + Supplemental Light for a fixed time

14 hours/day

Results: Potted chrysanthemums

Chowchilla variety: 4 weeks in propagation, ready to move to finishing

14hr Treatments			Threshold Treatments			
Hortilux	Yunustech	HPS	Hortilux	Yunustech	HPS	Unlit Control

Three Commodities

2 Cultivars per crop

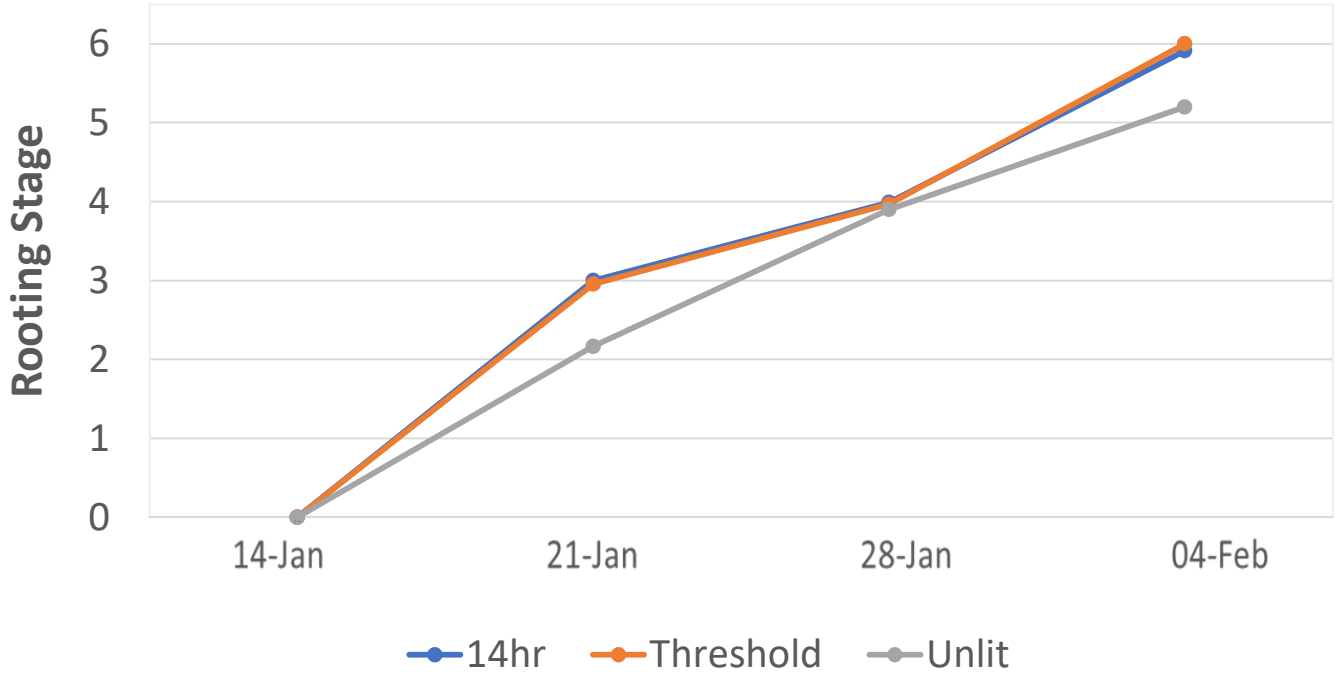
Chrysanthemum

Begonia

Kalanchoe

Results presented are for Chrysanthemum only

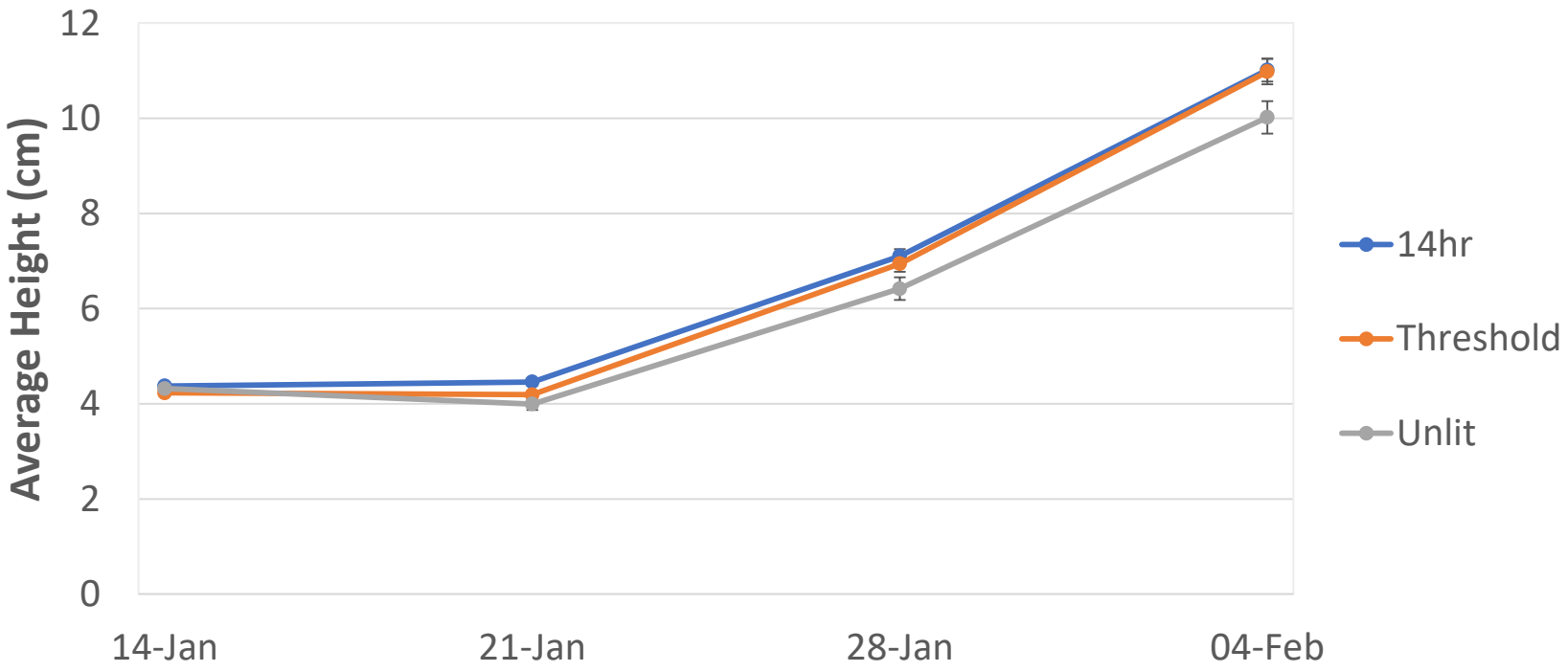
Root Development



Supplementary lighting decreases rooting time by a few days

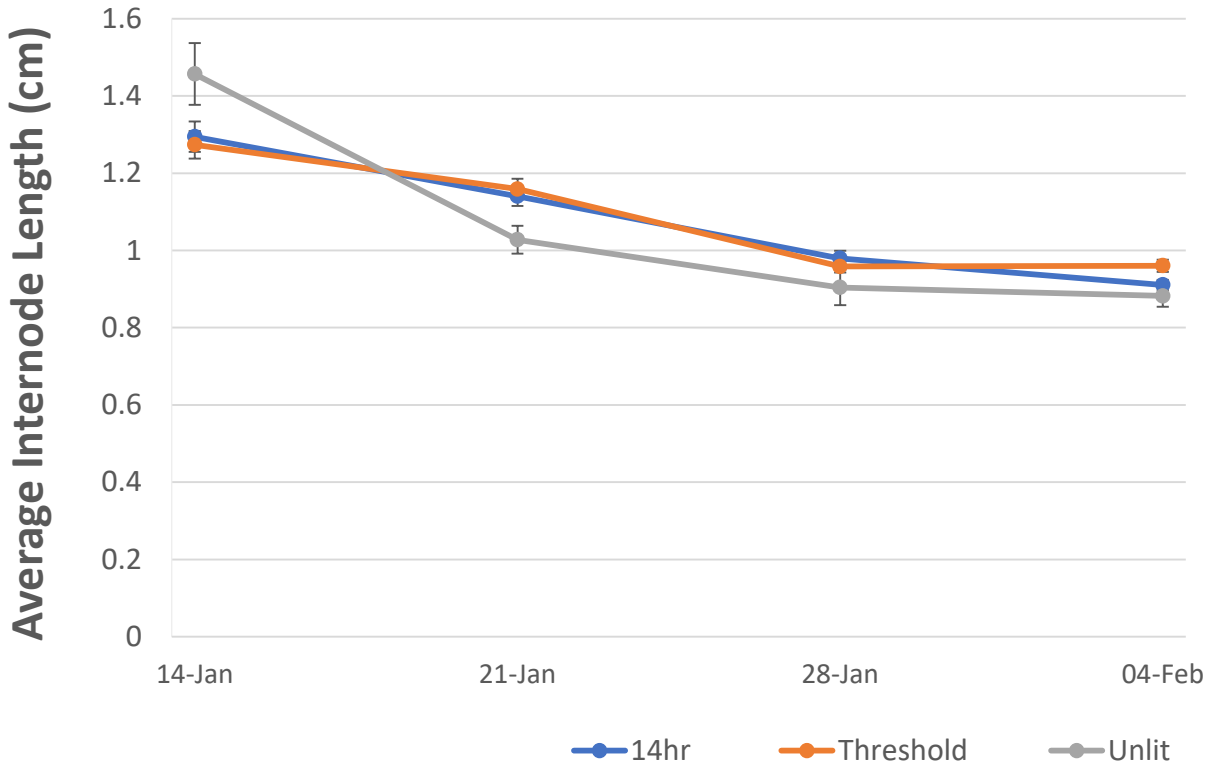
Rooting Stages	0	1	2	3	4	5	6
	No emergence, callus only	Root emergence, cutting still puts out of media easily	Rooted, can't be pulled from media easily	Roots visible on outer pot edge	Roots visible on top and bottom of pot and have started to wrap, may have secondary roots	Roots cover over 50% of soil area	Roots cover over 70% of soil area, almost no soil lost when pulled from pot.

Plant Height



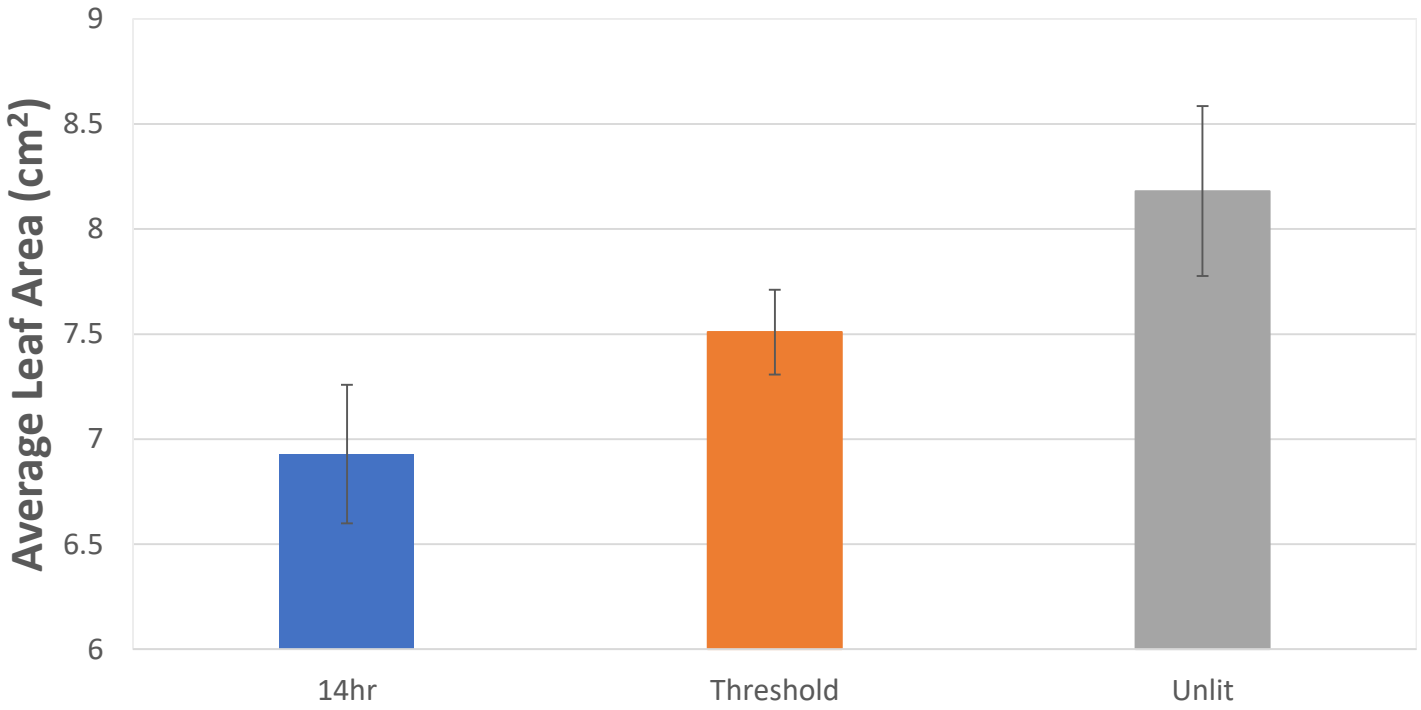
Supplementary lighting increases young plant height

Nodes and Internodes



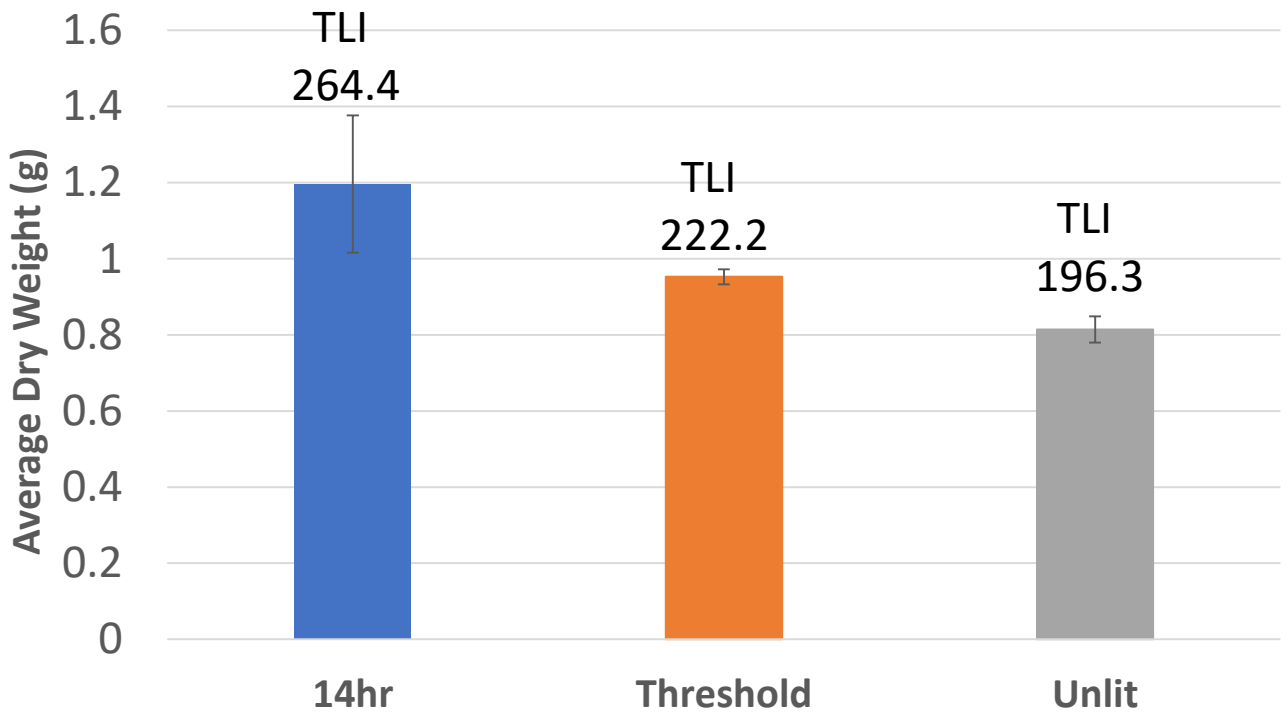
Internode length decreases over time in all treatments as the natural DLI increases

Leaf Area



Increasing supplemental light decreases leaf area

Aboveground Biomass



- **Increasing TLI by 13% increased dry weight by 17% (threshold treatment)**
- **Increasing TLI by 35% increased dry weight by 47% (14hr treatment)**

Energy use

- Threshold and 14-h supplemental lighting treatments were similar in height and rooting stage results
- Threshold control allows for less energy consumption – which translates into lower costs
- Threshold control allows plants to be productive for the entire photoperiod vs unlit, as it only provides supplementary light when ambient light is not sufficient for photosynthesis

Treatment	14 hour	Threshold	Unlit
TLI (mol/m^2)	264.4	222.2	196.3
% Supplemental Light	26%	12%	
Energy Use kWh·m^{-2}·d^{-1}	0.35	0.13	
Cost for 4 wks ($/m^2) (@$0.10/kWh)	$0.98	$0.35	

Other Deliverables

- Presentation at 2020 Canadian Greenhouse Conference: “Using Lighting Units to Optimize Production” (Chevonne Dayboll, OMAFRA)

- Engineering Design report: “Lighting Trial Technical Design and Implementation” (Mike Siemens, B.Sc Engineering candidate, Mohawk College)

Per-fixture energy usage measurements

Lighting Type	Kalanchoe (5 Weeks)	Chrysanthemum (4 Weeks)	Begonia (6 Weeks)
14 Hr Hortilux	152.5kW	122.0 kW	183.0 kW
14 Hr Yunustech	250.8 kW	200.6 kW	301.0 kW
14 Hr HPS	513.0 kW	410.4 kW	615.6 kW

Manipulating Flowering in Greenhouse-grown Potted Plants With LEDs

End-of-day (EOD) LED spectrum treatments:

1. Natural photoperiod (control)
2. EOD pure blue (B100)
3. EOD B96:R3:FR1

   (EOD treatments are 15 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 4 hr, starting 0.5 hr after dusk)

Four commodities from different photoperiod response groups

1. Gerbera (facultative short day)
2. Chrysanthemum (obligate short day)
3. Geranium (day neutral)
4. Calibrachoa (facultative long day)

THANKS


lumigrow


Plusrite
HORTSCIENCE


JEFFERY'S
GREENHOUSES


Ontario
Ministry of Agriculture, Food and Rural Affairs/Ministère de l'Agriculture, de l'Alimentation et des Affairs Rurales


Meyers
FARMS


Bayview
flowers


SAKATA
SEED AMERICA, INC.


GEORGE
SANT
& SONS
GREENHOUSES


SUNRISE
GREENHOUSES


BallSeed


CANADIAN
AGRICULTURAL
PARTNERSHIP


COHA
CANADIAN ORNAMENTAL HORTICULTURE ALLIANCE
ACHO
ALLIANCE CANADIENNE DE L'HORTICULTURE ORNEMENTALE


Canada