



**5TH INTERNATIONAL
STRAWBERRY CONGRESS**

Thursday

Welcome



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Parallel Session 3: Innovative Technology & Vertical Farming

The colourful life of plants in vertical farms

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History: 100 years ago

First forms of controlled environment agriculture.



Ever increasing control of production



Ever increasing control of production



Ever increasing control of production



Vertical agriculture

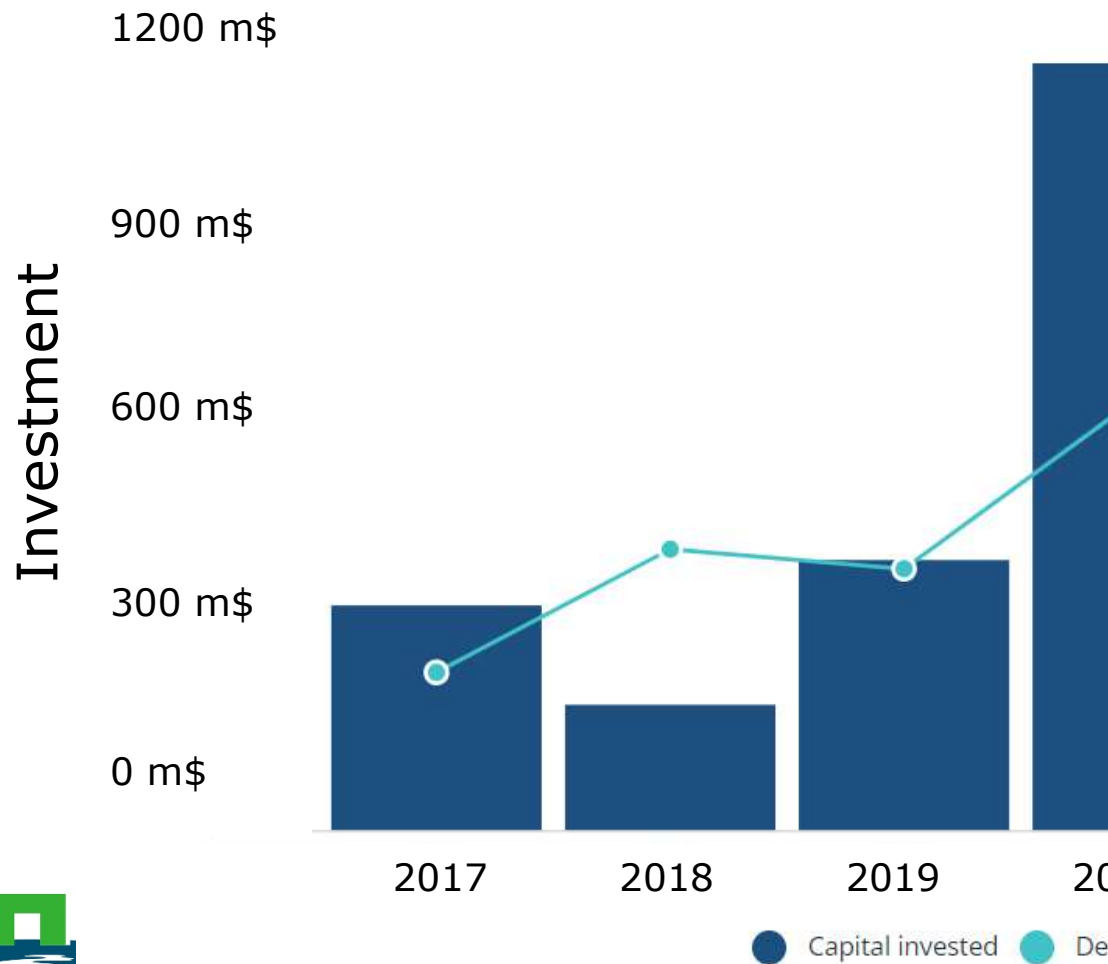
Crops in buildings; multi layers or vertical walls

- Full control of production process
- Extremely little
 - Land use
 - Water use
 - Fertiliser use
- No pesticides
- Anywhere
- Independent of climate or soil
- Guarantees on quantity and quality



Vertical farming

Worldwide investment: 1.2 billion



Examples of some investments

Plenty

500 m\$ (SoftBank, Amazon)

Aerofarms

240 m\$ (Ikea, Sjeik/Dubai)

Bowery farming

170 m\$ (Google Venture)

80 Acres farm

200m\$

Infarm

400 m€

Plantlab (NL)

20 m€

Nordic Harvest (Dk)

10 m€



2022: The hype is over Shake-up – shake out

AeroFarms successfully exits Chapter 11

ADDED ON 19 SEPTEMBER 2023



News September 26, 2023

Dutch arm of vertical farming startup Infarm declared bankrupt

The news comes after the company shut down operations across its key markets of the UK, France, Germany, the Netherlands and Denmark over the past year

Kalera Stock Jumps on Plans to Divest Units

Published: Oct. 18, 2022 at 7:48 a.m. ET

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NL: Glowfarms ceases all activities, unable to find sufficient funds

November 2022

Beyond the hype → now getting to the realism

New farms are still starting: A few examples



NL: Growy to construct new vertical farm in Amsterdam



Veticalfarm daily (Aug 2024): In 2023, 280 million EURO venture capital investments in Europe



80 Acres Farms on its newest 18,500 m2 Florence farm
"This farm was sold out as soon as it opened"

What led to the fall?

- Increase in energy price
- Money got more expensive

→ These factors determined the moment of falling down

these are not the full story



What led to the fall?

What works well

- High yield
- High quality
- Little use of
 - Land
 - Water
 - Nutrients
 - Pesticides

What works less well

- Costs
- Product price?
- Energy (sustainability & costs)
- Labour
- Knowledge and knowledge sharing

From Fairy tale, to Fair story

labour

- Farm scale is often small → difficult automation
- A lot of manual work
- Many people in the office

What people are needed?

- **Grower!**
- Technician
- Marketeer
- Entrepreneur
- Financial expert
- Human Resource management



Which crops?

- High added value
- Fresh
- Pharmaceutical, nutraceutical crops
- Young-plant raising



Main issues:

- High use of energy
- High costs

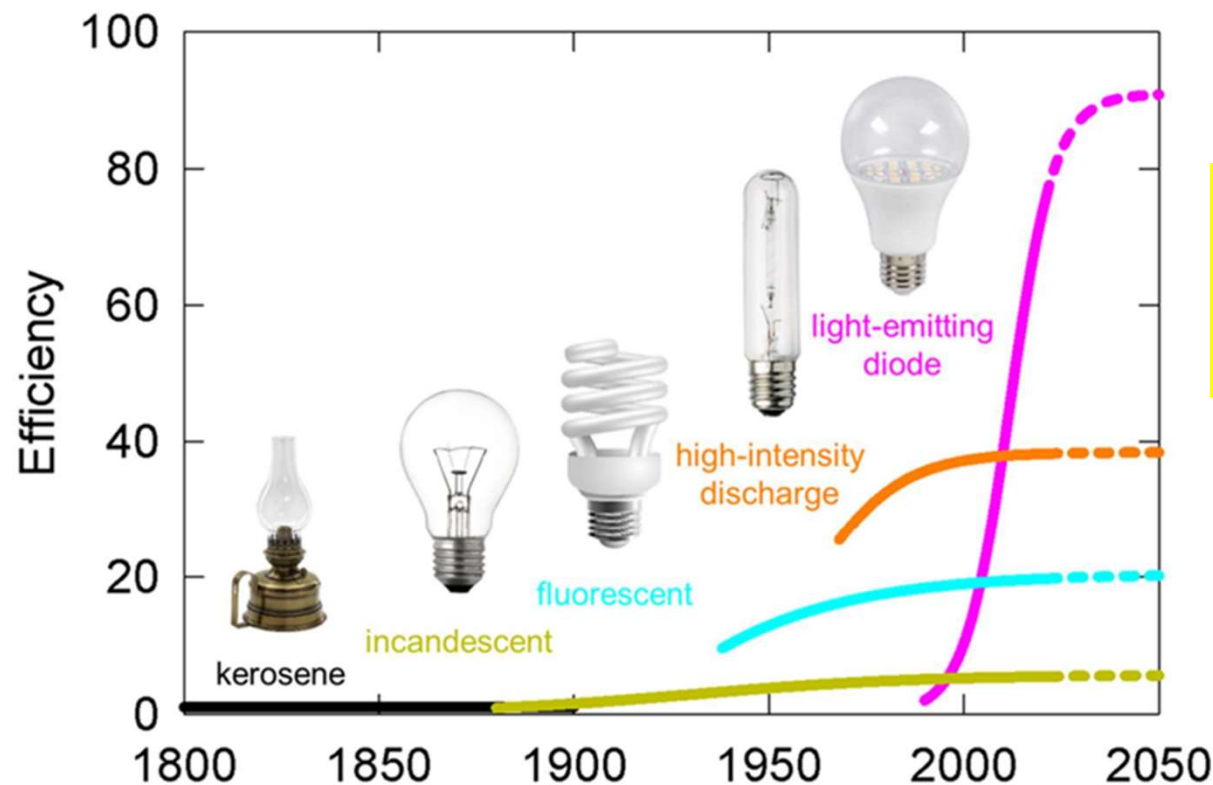
- Most energy for the lighting

- Three steps

1. Reduce energy use drastically
2. Used energy should be renewable
3. use less when expensive

- It is key to reduce energy use per kg product

Past years: enormous increases efficacy of lamps;
still some increase possible but not that monumental



**Light use efficiency of plants:
Still a lot to increase**

1. Drastic reduction energy use

- Many unexplored possibilities
- And it is not just about optimizing light recipe



Light influences plant growth in multiple ways

- Light Intensity
(Photosynthesis)



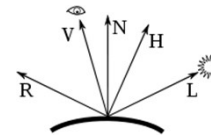
- PhotoPeriodism, daylength
(Plant Development, e.g. flowering)



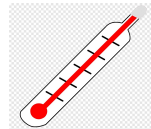
- Light Quality, Spectral Composition
(Photosynthesis & Development)



- Direction of light

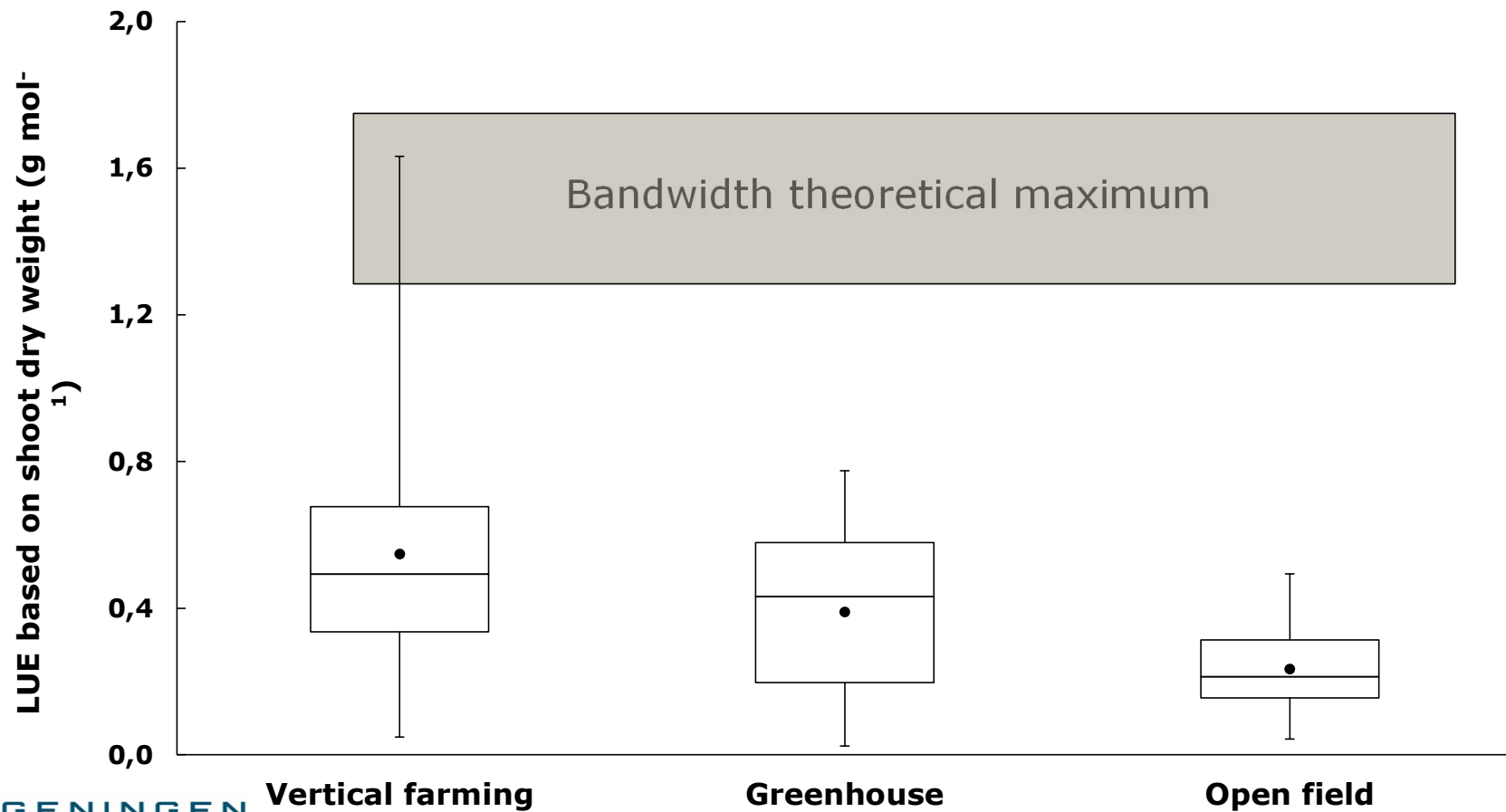


- Heat

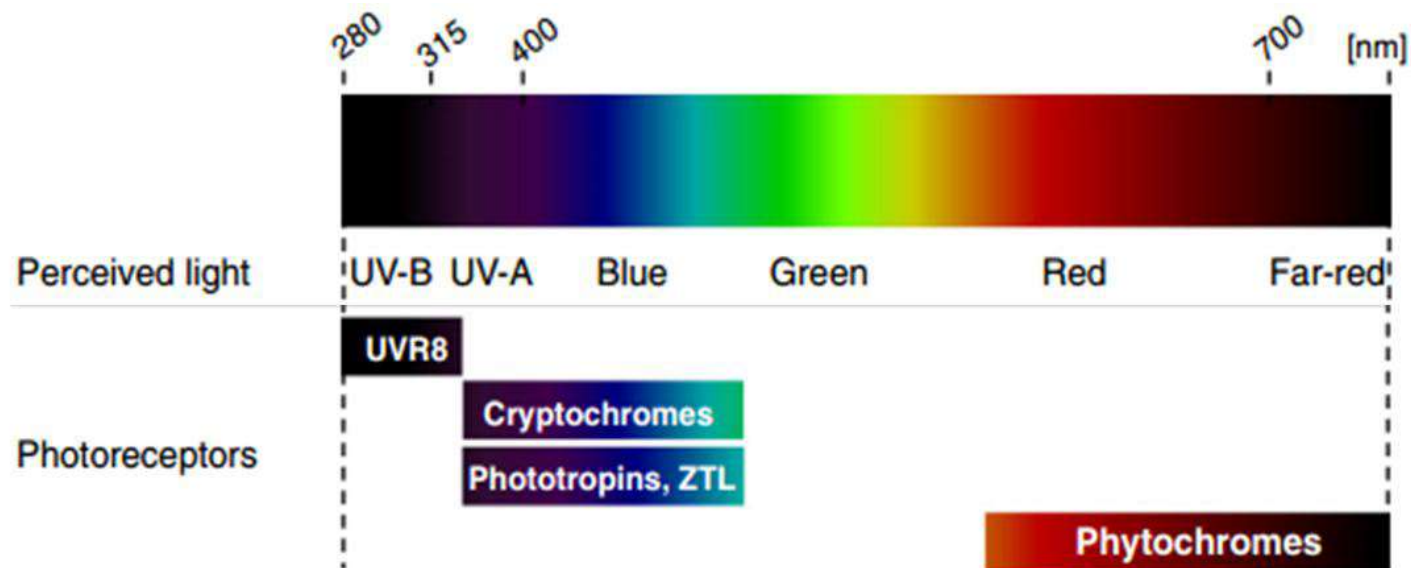


Comparing Light Use efficiency (LUE) among systems

$LUE = \text{Dry weight} / \text{light integral}$



Several photoreceptors in plants



What is the effect of far-red in strawberry?

- Fruit yield
- Fruit quality
- Energy use efficiency



Photosynthesis
effect

SWEET!! SUGAR!!

Fruit quality



Far-red light



Morphology
effect

Biomass
partitioning

Far-red on top of white light, or partly replacing white light

Treatment	White ($\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	Far-red ($\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	Total light ($\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
250White	250	0	250
250 White 40 Far-red	250	40	290
210 White 40 Far-red	210	40	250

Everbearing cv. Favori



210White+40Far-red



250White+40Far-red



250White



What did Far-red light do to Photosynthesis?

Growth Light

- 250 White
- 250 White
40 Far-red
- 210 White
40 Far-red

Measurement light for photosynthesis

White light
background

250

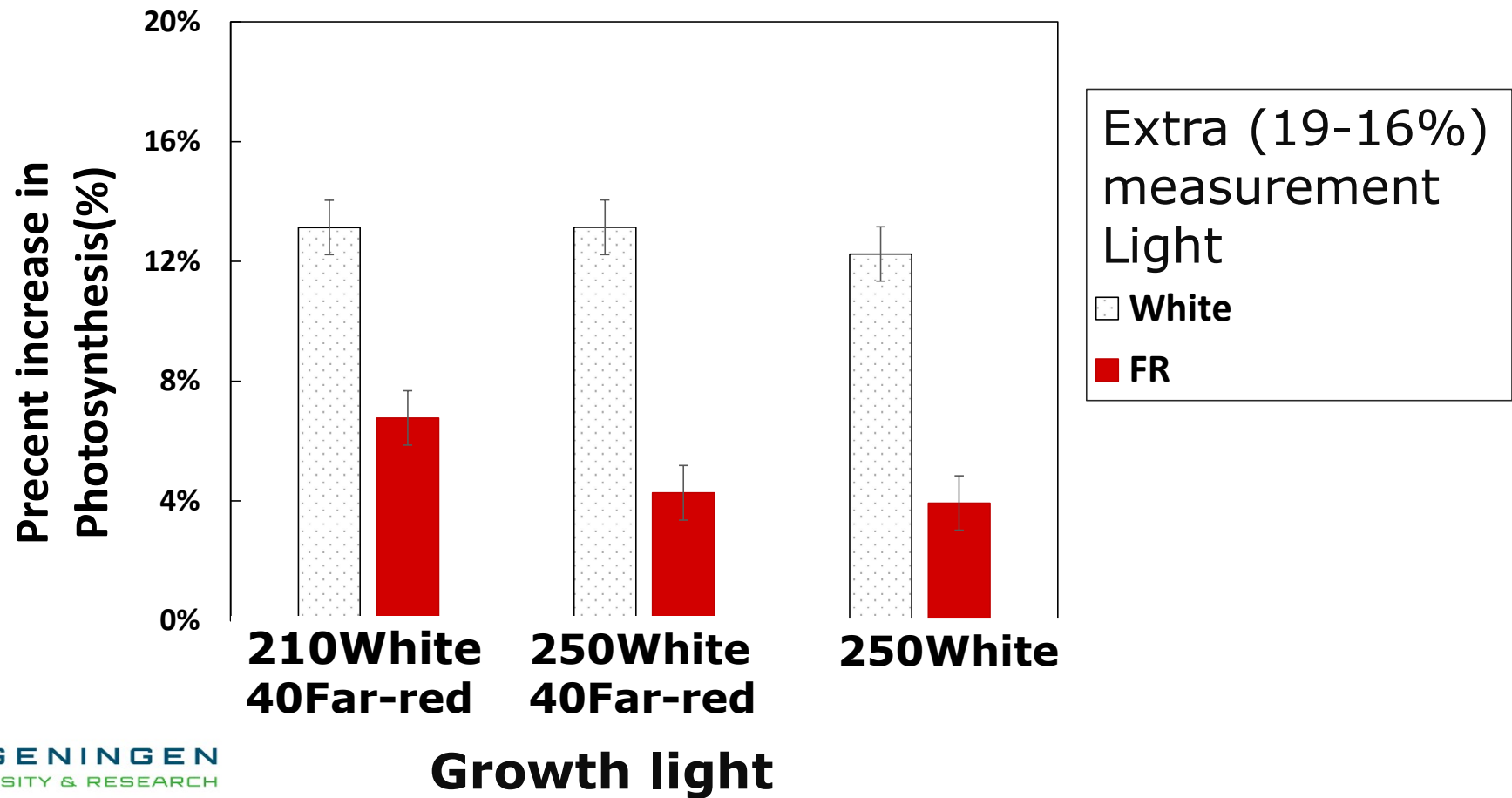
250

210

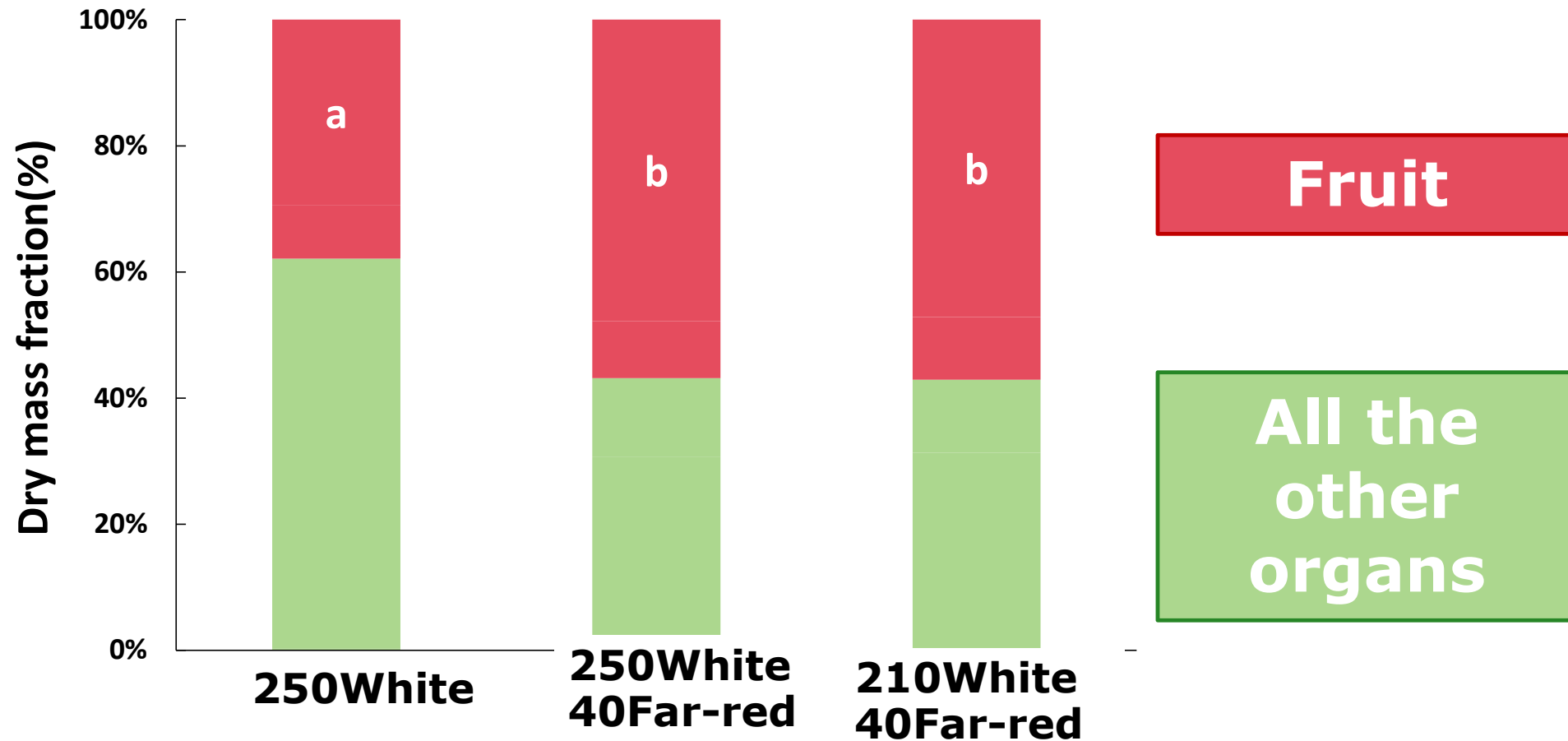
+40 Far-red light

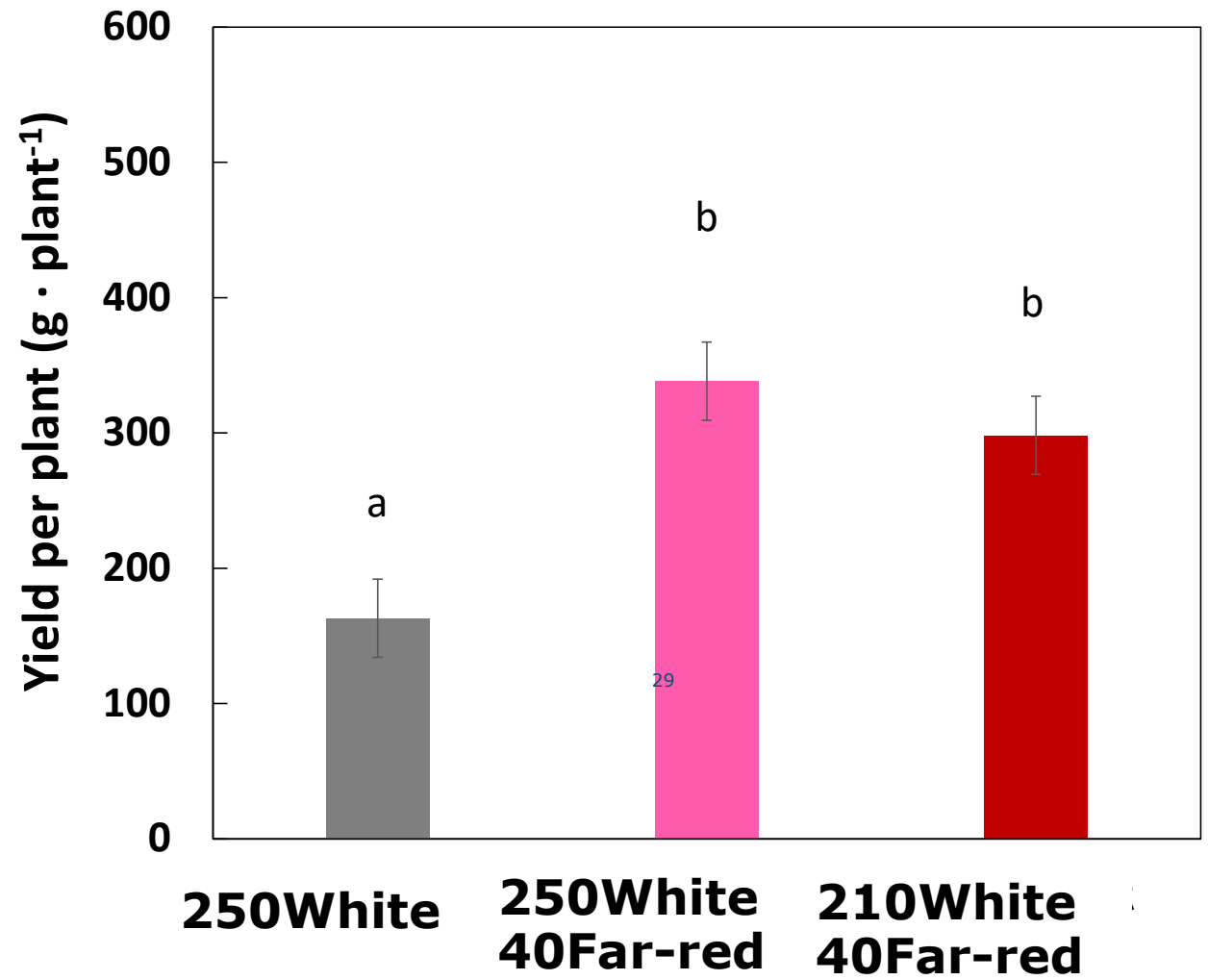
+40 White light

Far-red light is photosynthetic active, but less than PAR

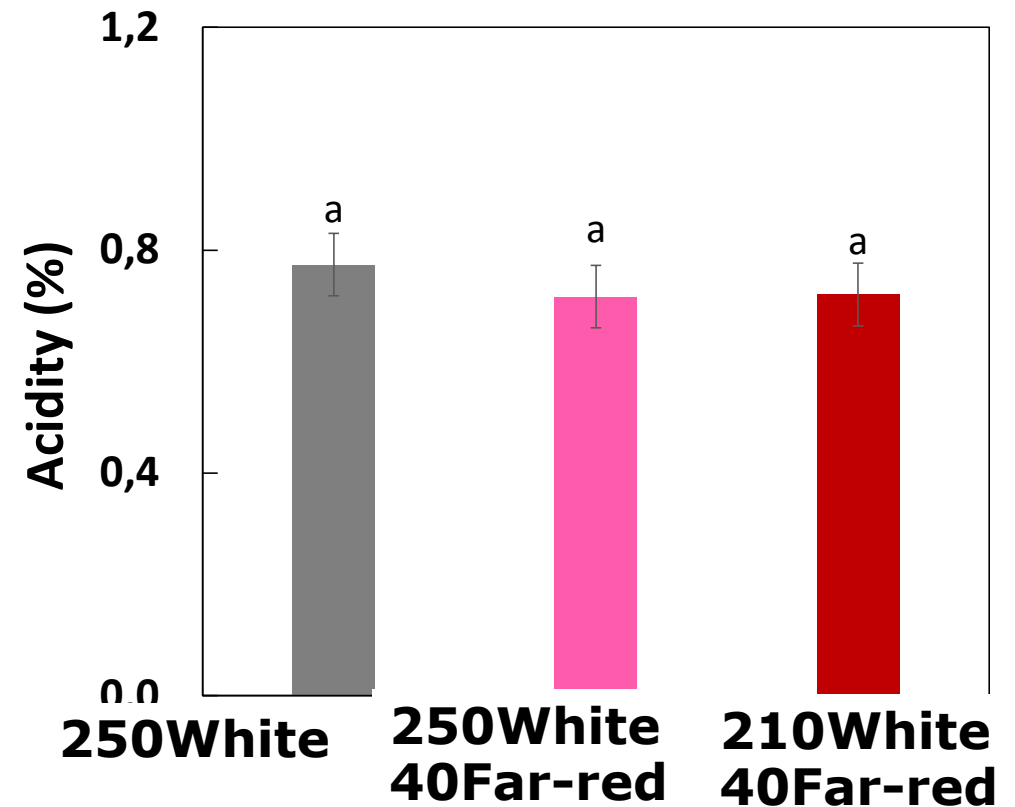
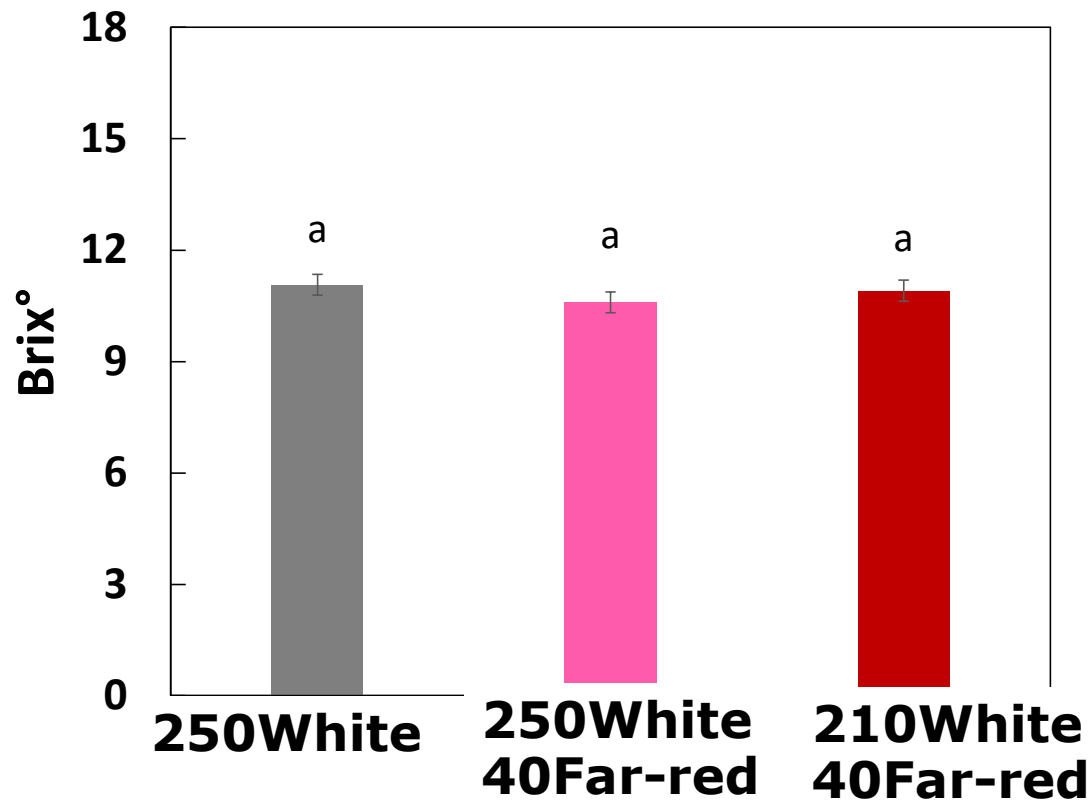


Enhanced biomass partitioning to fruit with far-red light

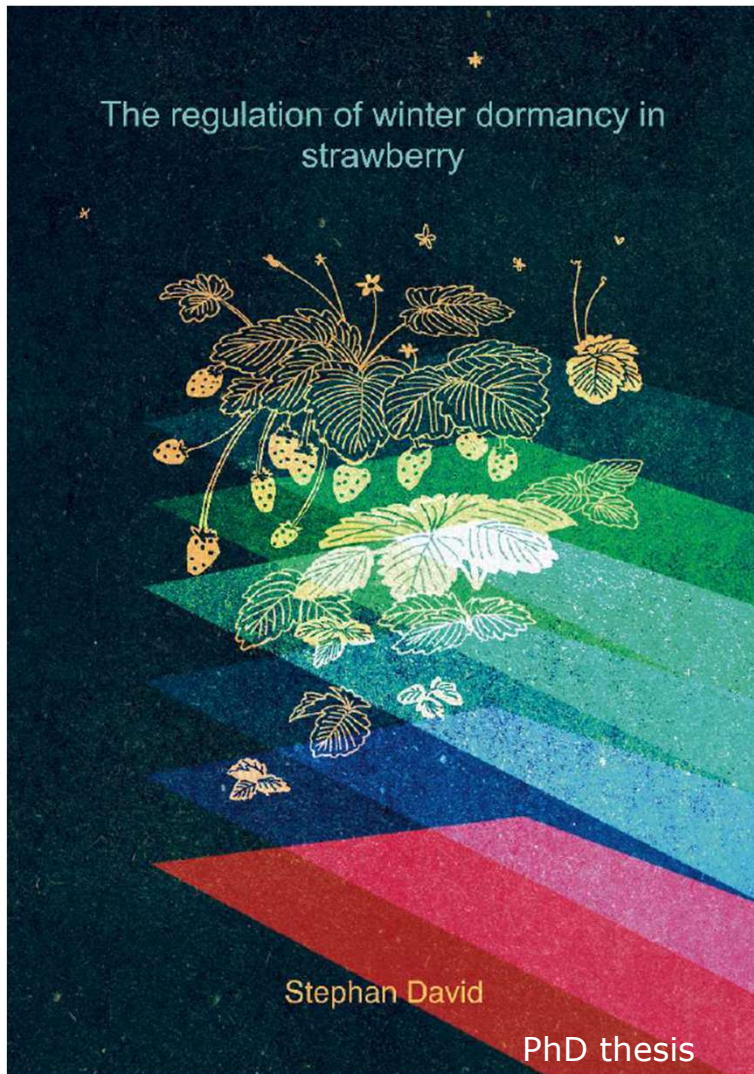




Far-red light increased yield without affecting quality



DAM3, DAM4 genes involved in winter dormancy



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Conclusions

Vertical farm

- Optimal yield and quality control
- Still many improvements possible
- The hype is over: now back to realism

Light has many aspects

- Intensity
- Direction
- Spectrum
- Heat (energy)

All plant processes in control

- Photosynthesis, growth, development
- Quality
- Disease
- Health related compounds

Thank you for
your attention!

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Upcoming courses at Wageningen UR

Vertical farming course
5-30 Jan 2026 (on campus / online)

Three days lighting course: February 2026



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Networking Break

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