

High CO₂ and vertical temperature gradient in the semi-closed greenhouse:

What are the effects on crops ?

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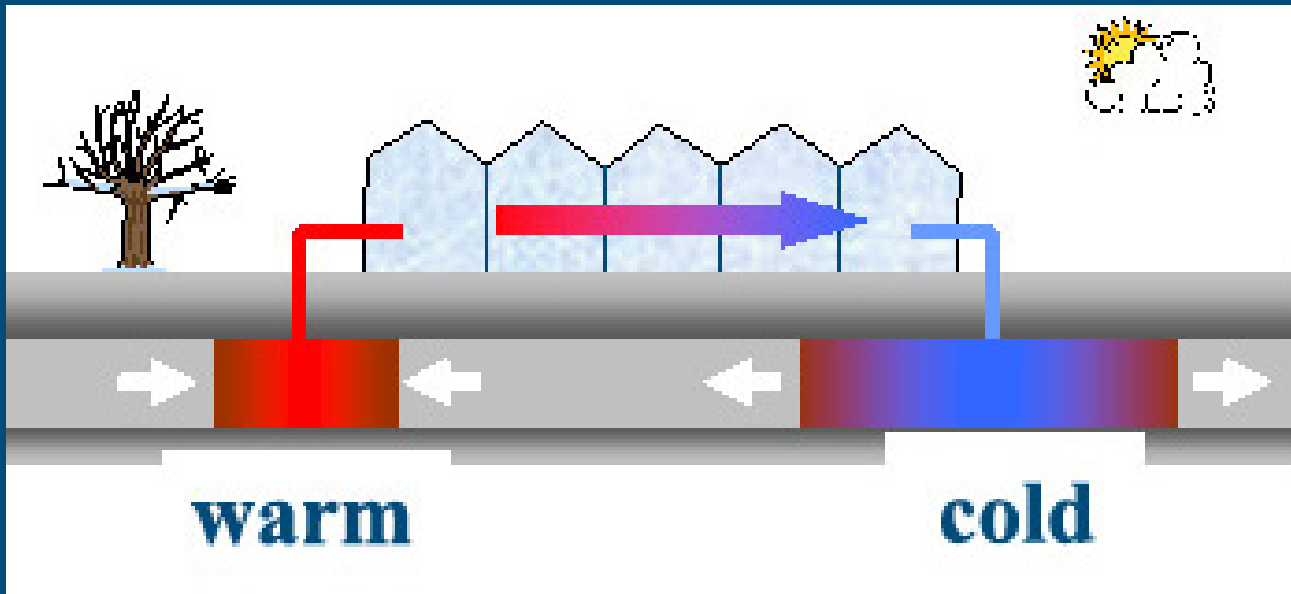
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Supervisors: Dr.ir.J.A.Dieleman and Dr.ir.A.Elings

Wageningen UR Greenhouse Horticulture



Closed and semi-closed greenhouses



Closed greenhouse:

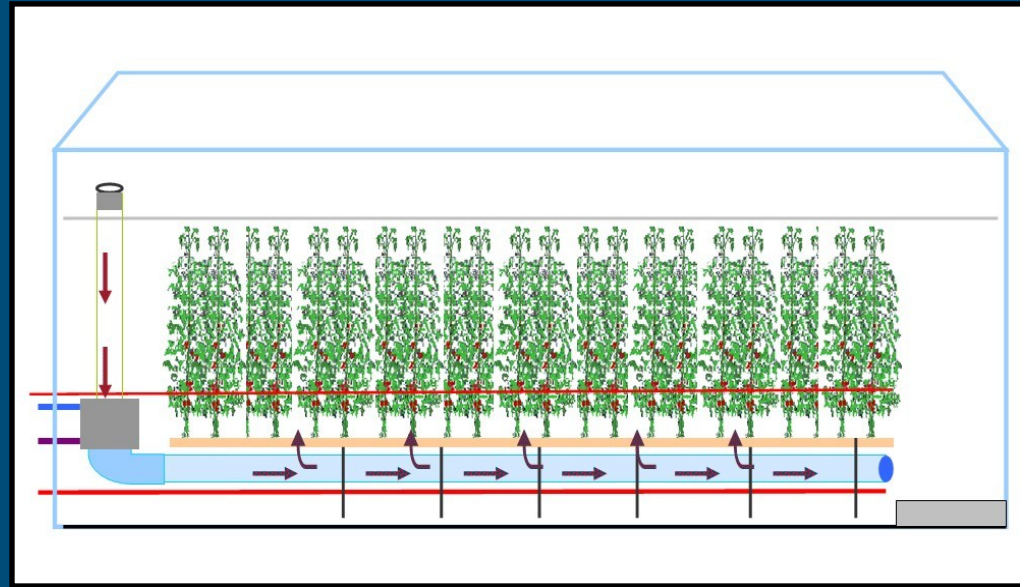
- Closed windows (no ventilation)
- Air Treatment Unit (ATU)
- Energy is stored in **aquifer**

Semi-closed greenhouse

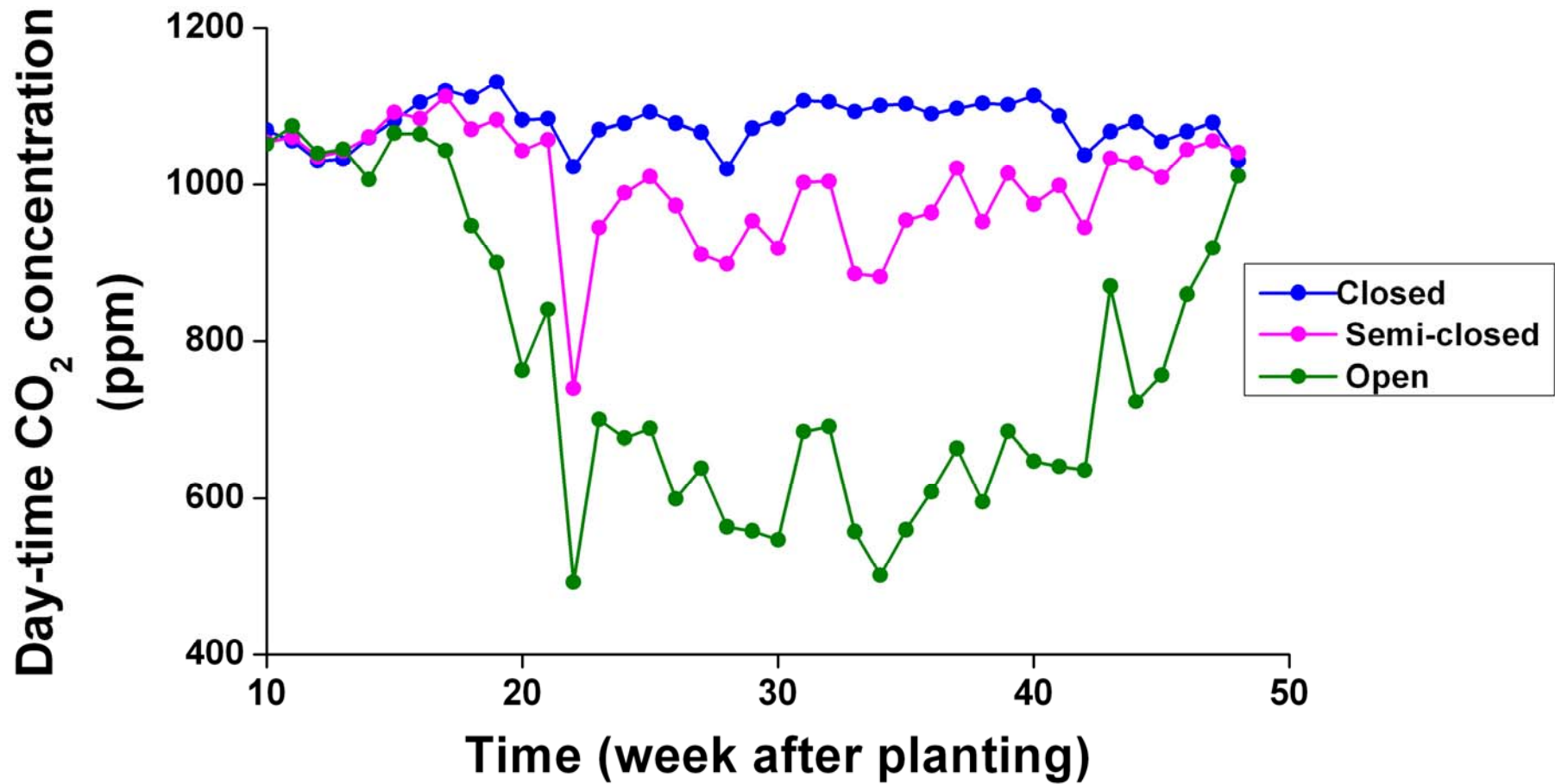
Consequence

■ New climate

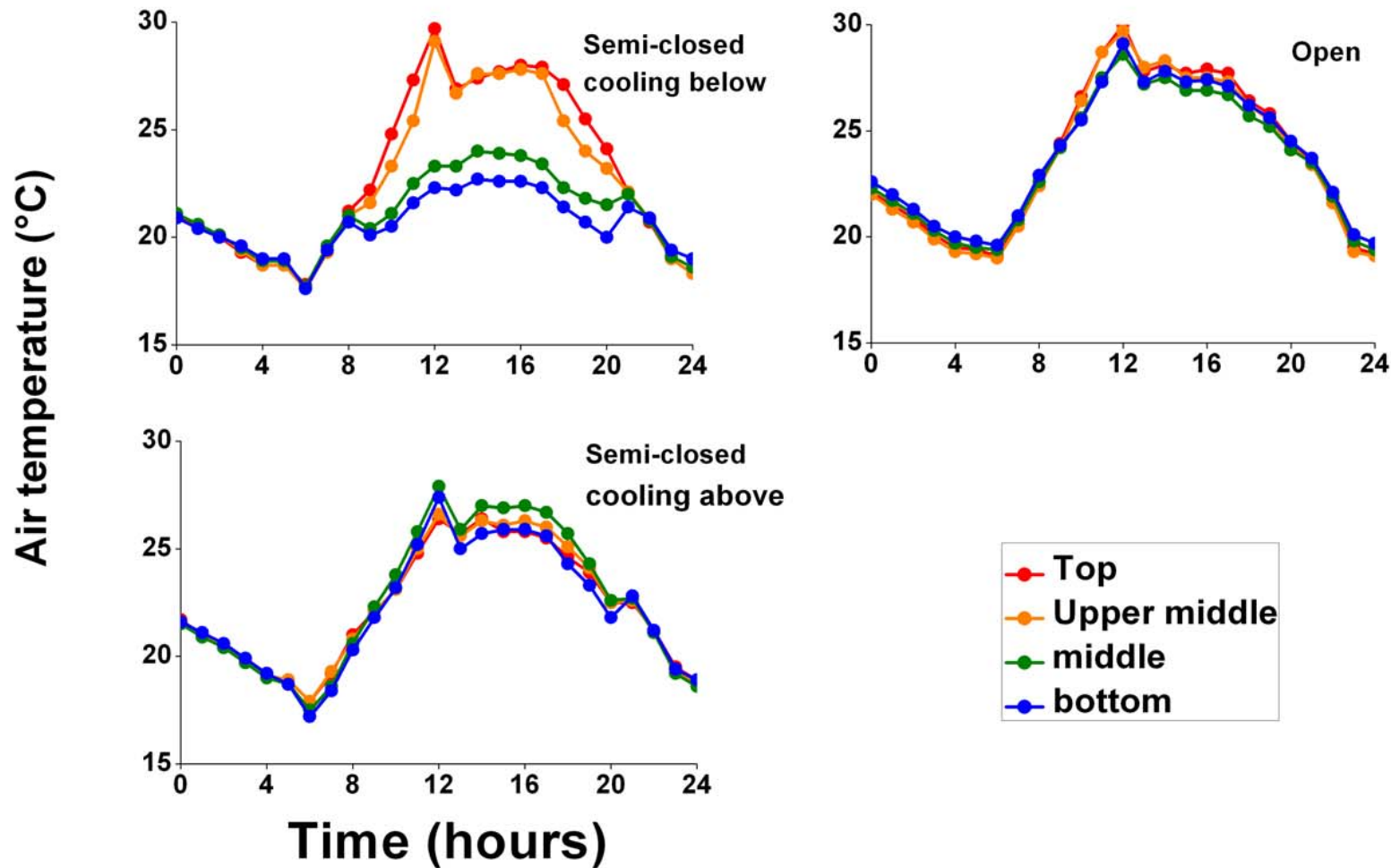
- ● Higher CO₂ concentration
- ● Vertical temperature gradient
 - Higher humidity
 - High radiation + high CO₂ + high temperature



High CO₂ concentration



Vertical temperature gradient

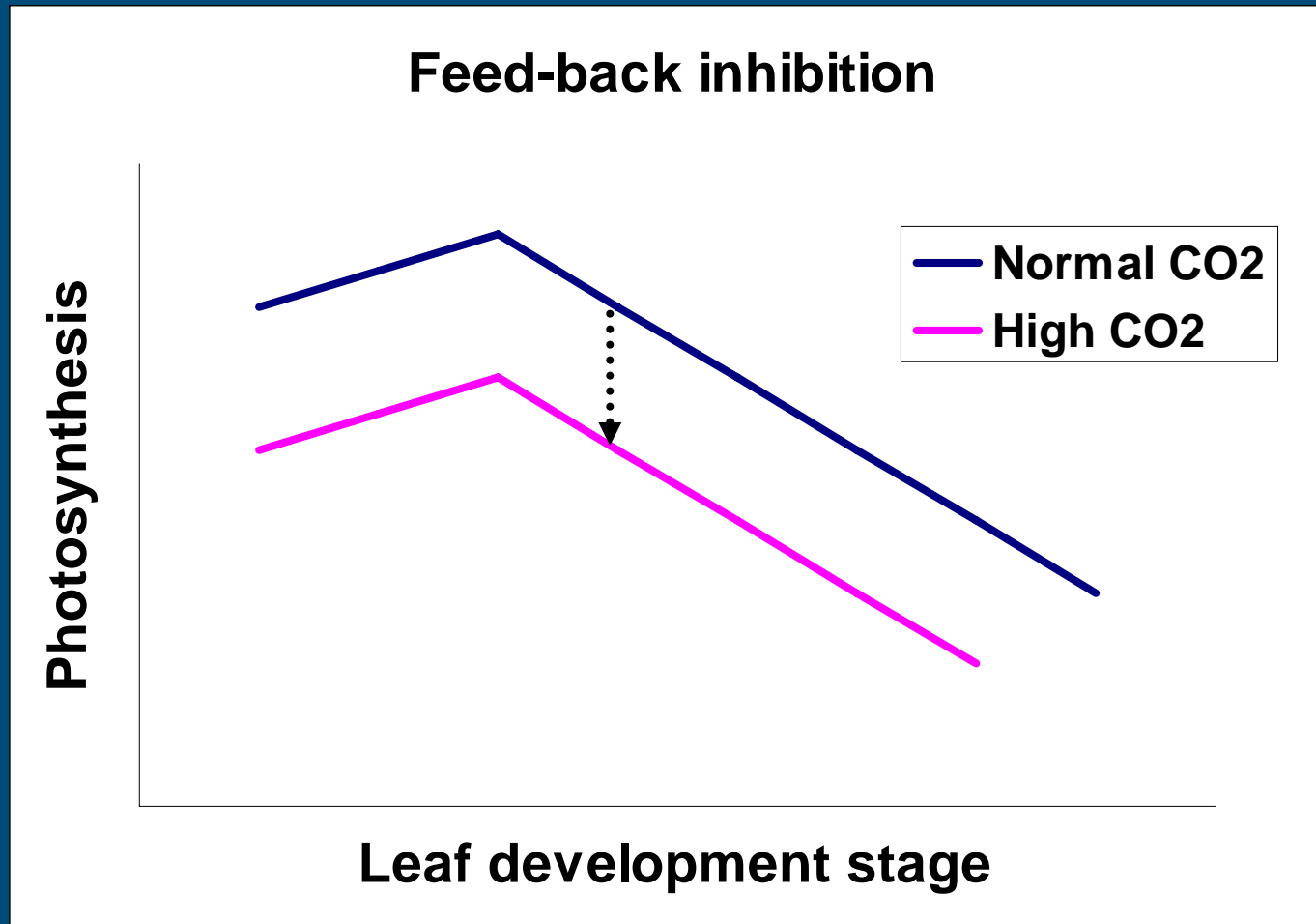


Effect of high CO₂ on photosynthesis

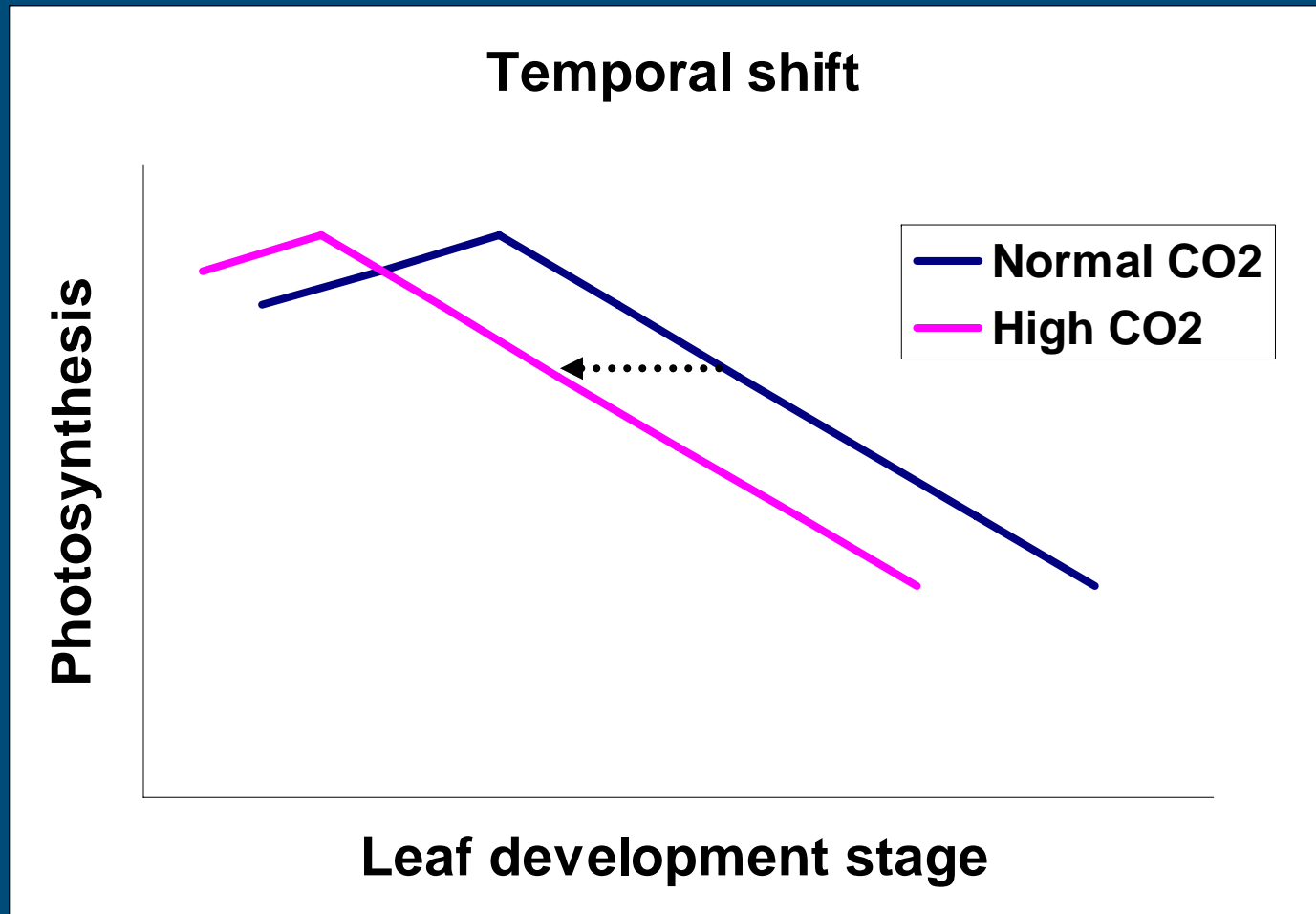
- **Short-term:** more CO₂ → more photosynthesis → more production
- **Long-term:** Photosynthesis acclimation to continuous high CO₂
 - V_{cmax} sugar signaling
 - J_{max} PSII → **cytochrome b/f** → PSI
- **Mechanisms**
 - Feedback inhibition
 - Temporal shift leaf development



Feed-back inhibition mechanism



Temporal shift mechanism



Materials and Methods

■ Tomato Capricia

■ Greenhouses

- Semi-closed greenhouse (1000 ppm)
- Open greenhouse (600 ppm)

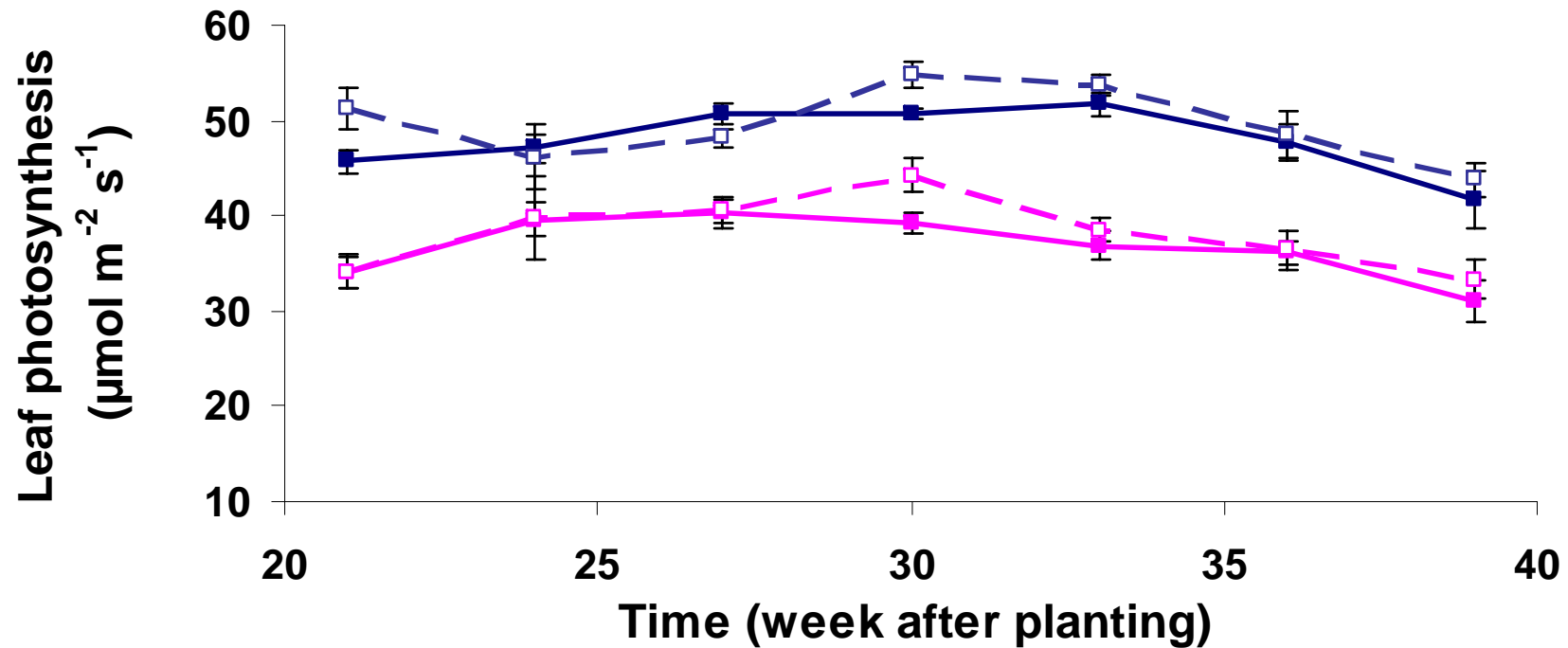
■ Photosynthesis measurement

- Top leaf
- Middle leaf
- Two CO₂ concentrations: 1000 ppm and 600 ppm
- Week 21, 27, 30, 33, 36, 39 after planting



Results

Top leaf

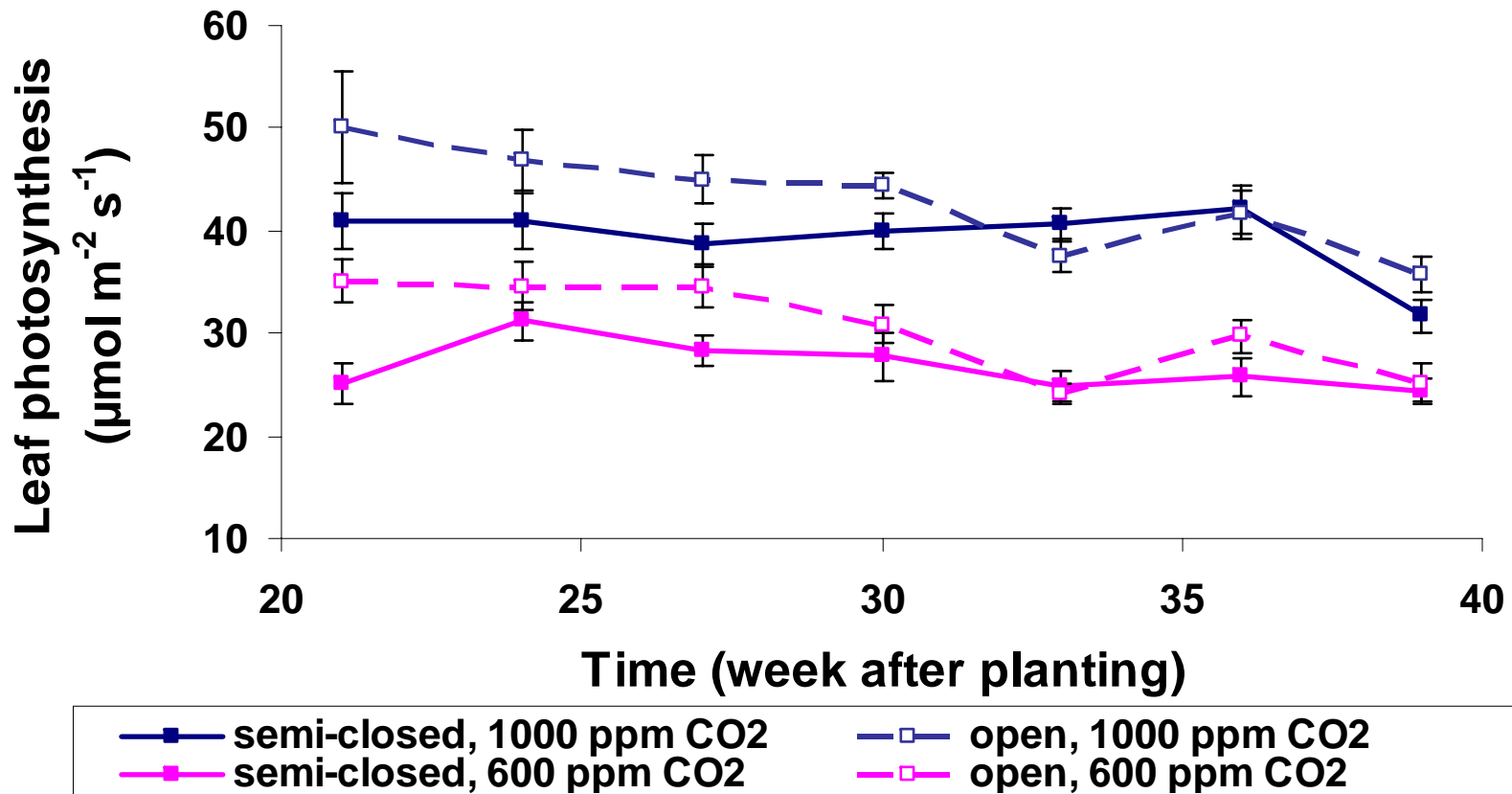


—■— semi-closed, 1000 ppm CO2
—■— semi-closed, 600 ppm CO2

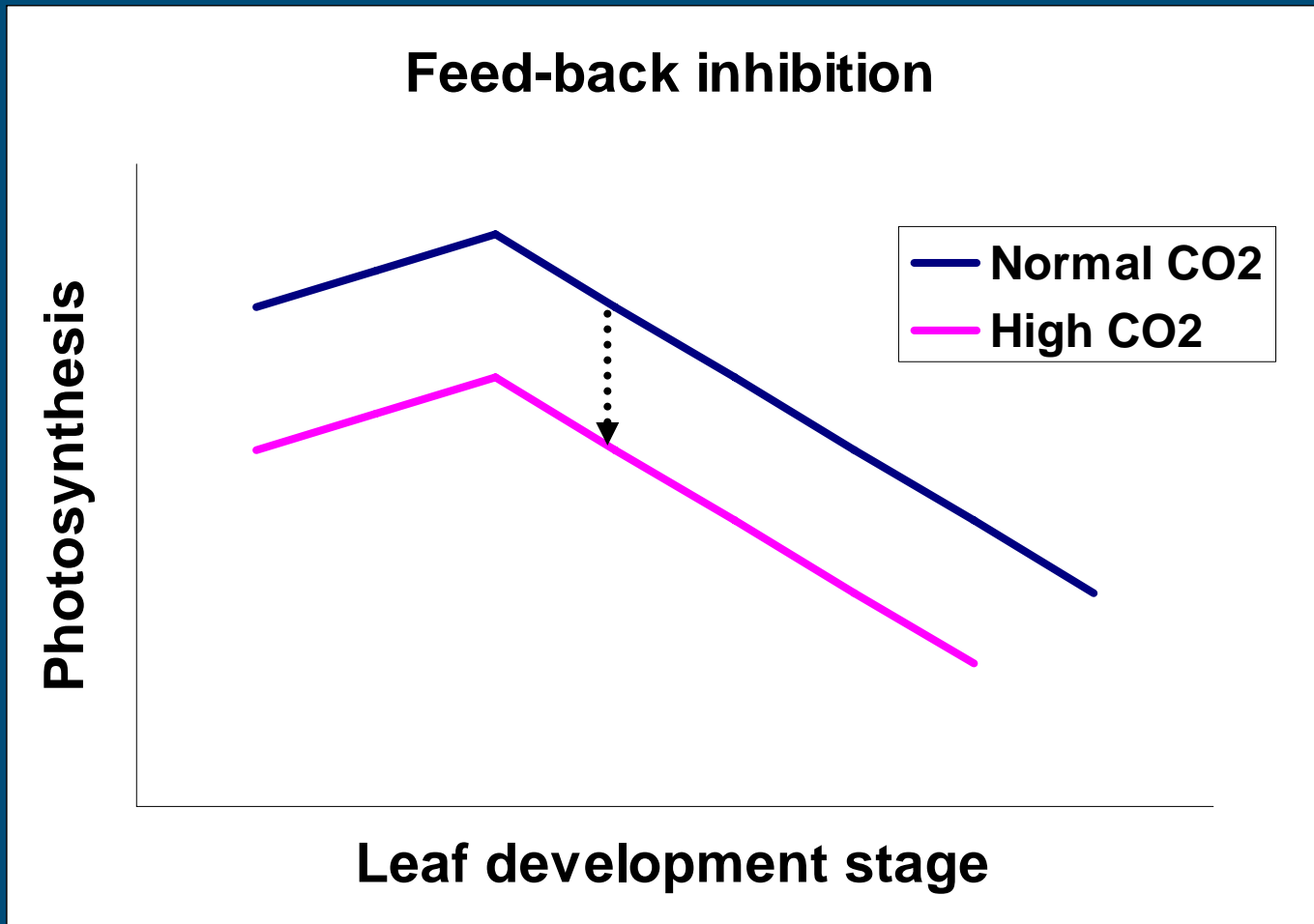
- -□- - open, 1000 ppm CO2
- -□- - open, 600 ppm CO2

Results

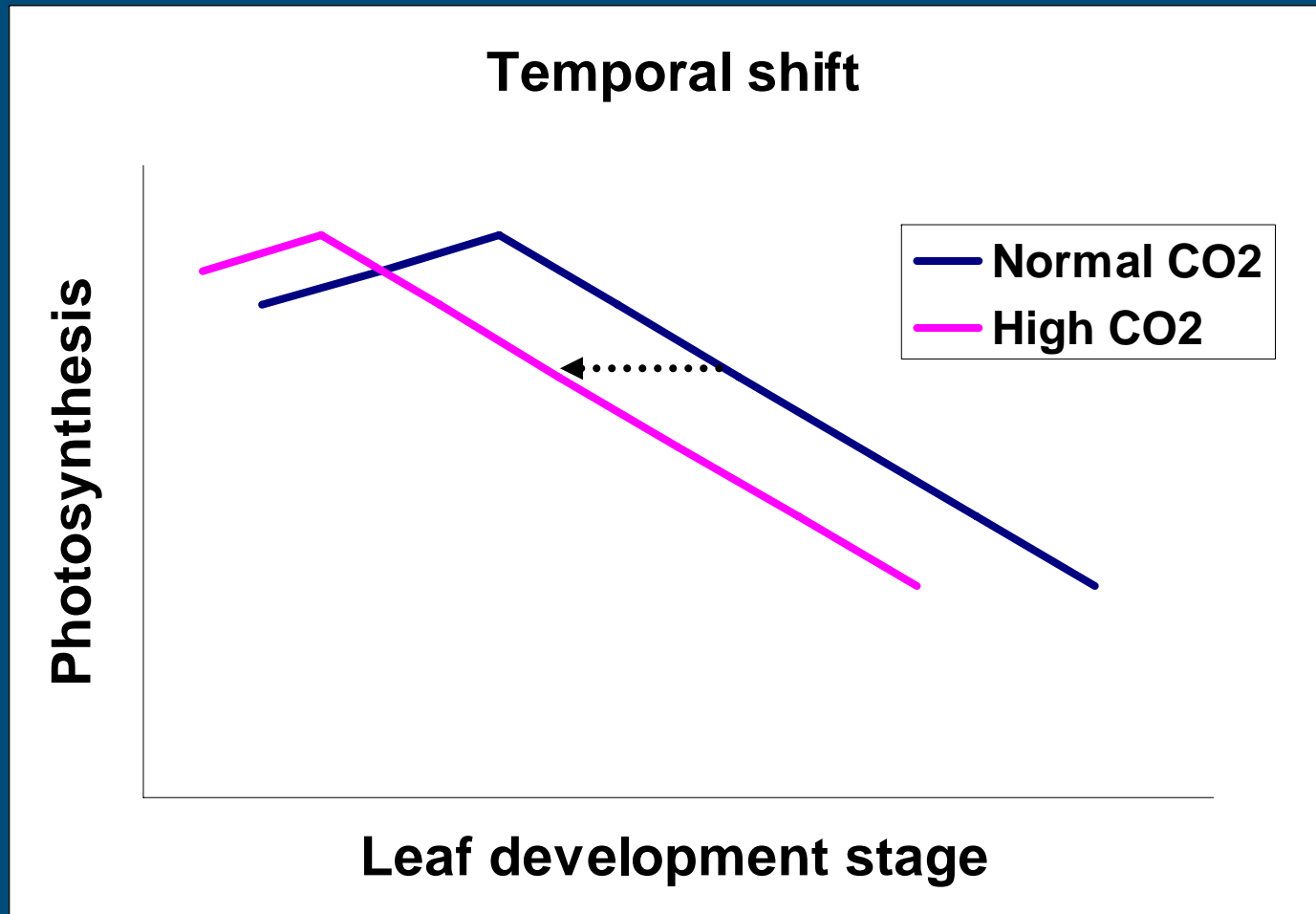
Middle leaf



Feed-back inhibition mechanism

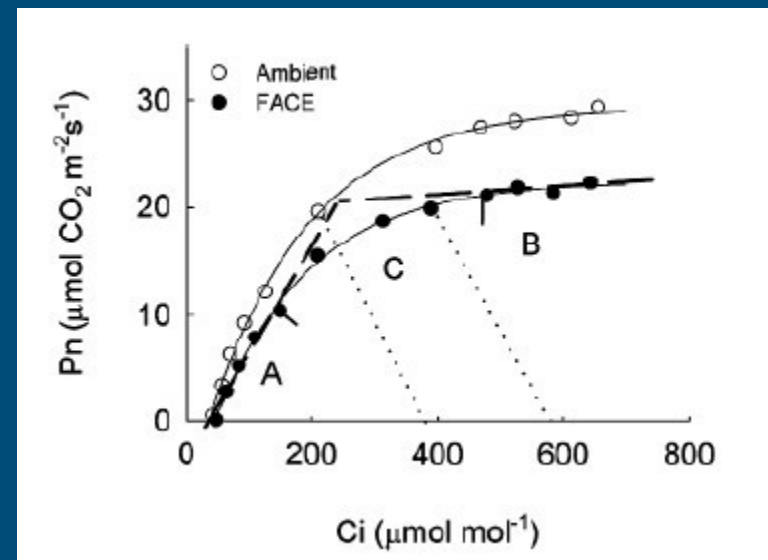


Temporal shift mechanism



Conclusion

- Photosynthesis acclimation in the semi-closed greenhouse
 - At certain leaf
 - mechanism
- Future work
 - Photosynthesis at 5 canopy heights
 - Sugar, chlorophyll, Rubisco
 - ACi curves for V_{cmax} & J_{max}



Effect of vertical temperature gradient on fruit

■ Background information

- After anthesis sensitive
- During fast development rate stage not sensitive
- Ripening stage sensitive

■ Our hypothesis

Lower temperature around the ripening fruits in the semi-closed greenhouse results in bigger fruits

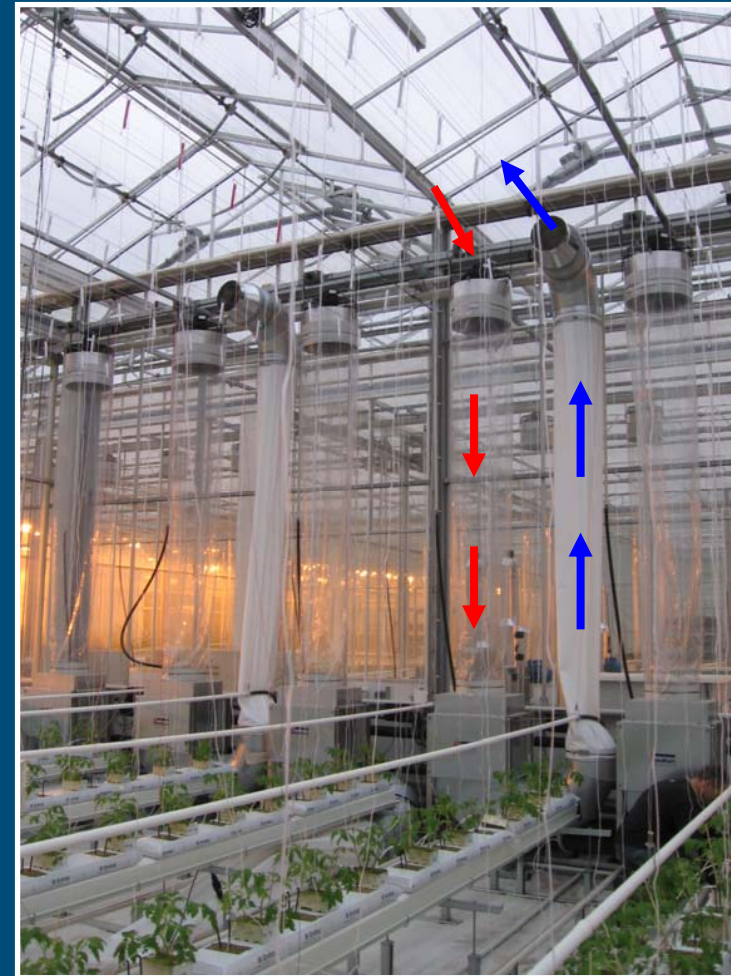
Materials and Methods

■ 2 semi-closed greenhouse

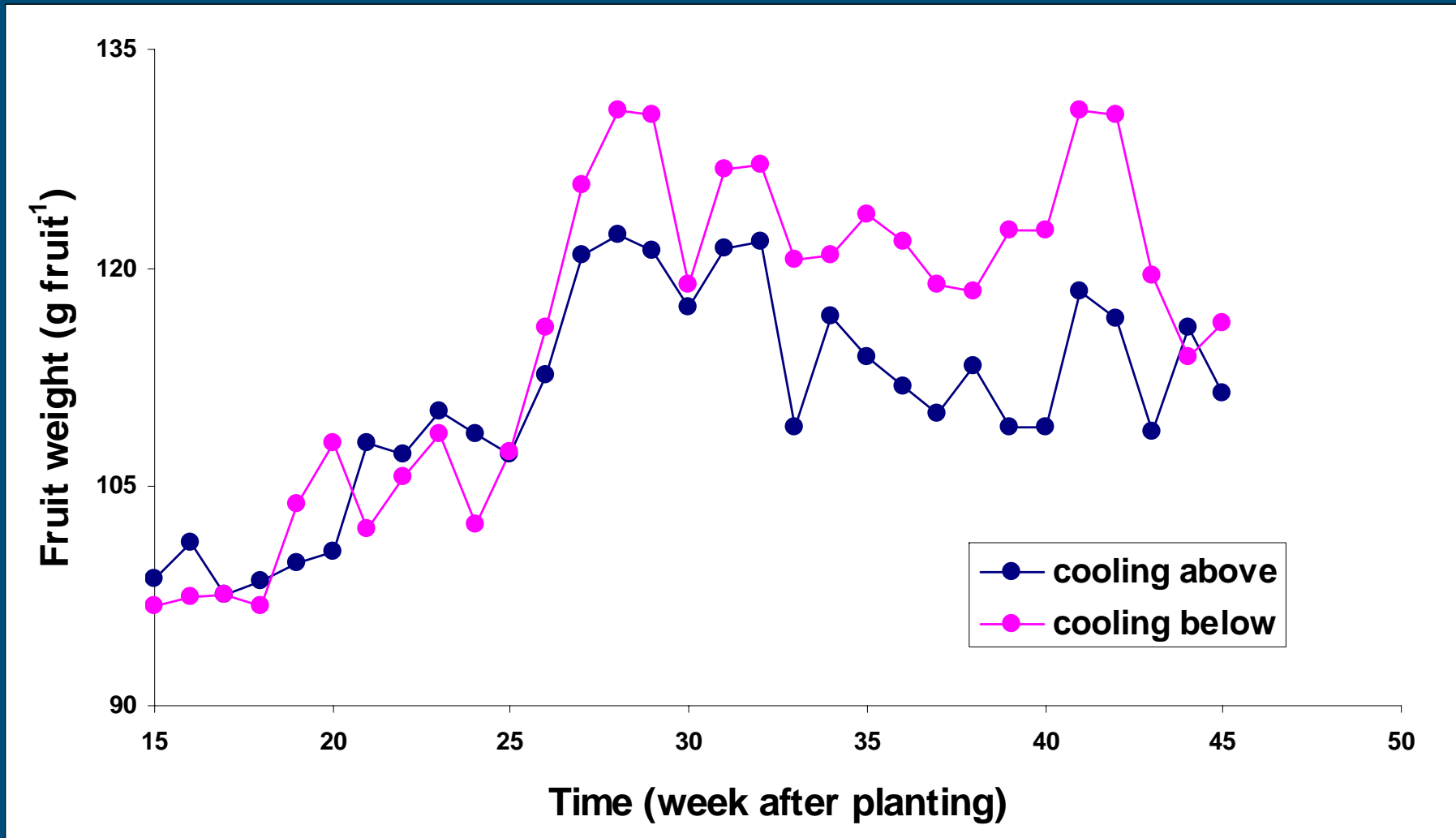
- Semi-closed with cooling air from **below**
- Semi-closed with cooling air from **above**

■ Weekly harvest

- Total harvested fruit weight
- Fruit number
- Individual fruit weight



Result



Conclusion

- Lower temperature during ripening stage → bigger fruit
- Future work
 - Heating chamber
 - Individual fruit size and weight
 - Increase temperature at different development stages



Thank you

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