



Effect of carbon dioxide enrichment in a high-tech greenhouse

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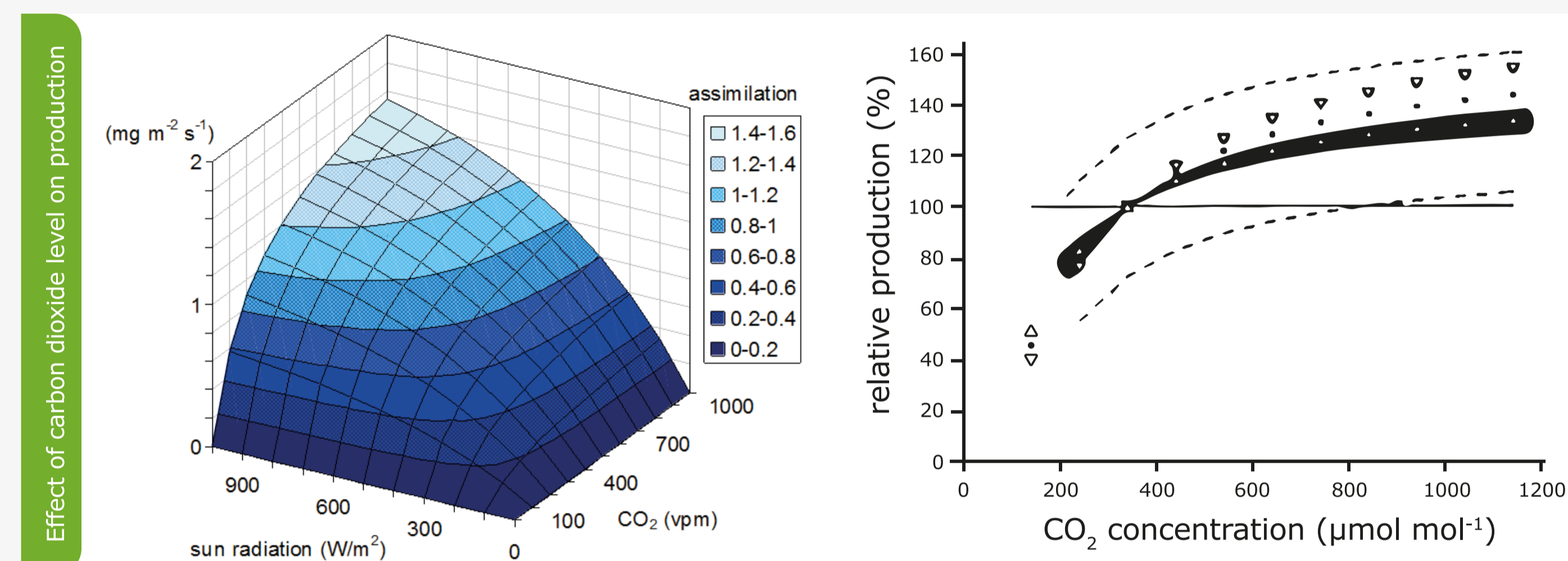
Background

Carbon dioxide is one of the crucial components in the photosynthesis process and therefore the production. The concentration of carbon dioxide expressed in ppm directly relates to the production. In a greenhouse the concentration of CO₂ depends on the ventilation rate, the absorption and release by the crop, release of CO₂ from the ground or substrate, and if applied, CO₂ enrichment. As a result, the concentration can vary between 100 ppm (no ventilation and photosynthetic process working) and 1500 ppm (maximum level when CO₂ enrichment is provided). Outside the average CO₂ concentration is around 400 ppm.

In a closed greenhouse all parameters for cultivation can be controlled including the CO₂ concentration. In the greenhouse at Estidamah, it is possible to show the effect of carbon dioxide concentration where the other factors influencing the production are kept the same in the two greenhouse compartments, providing excellent research results.

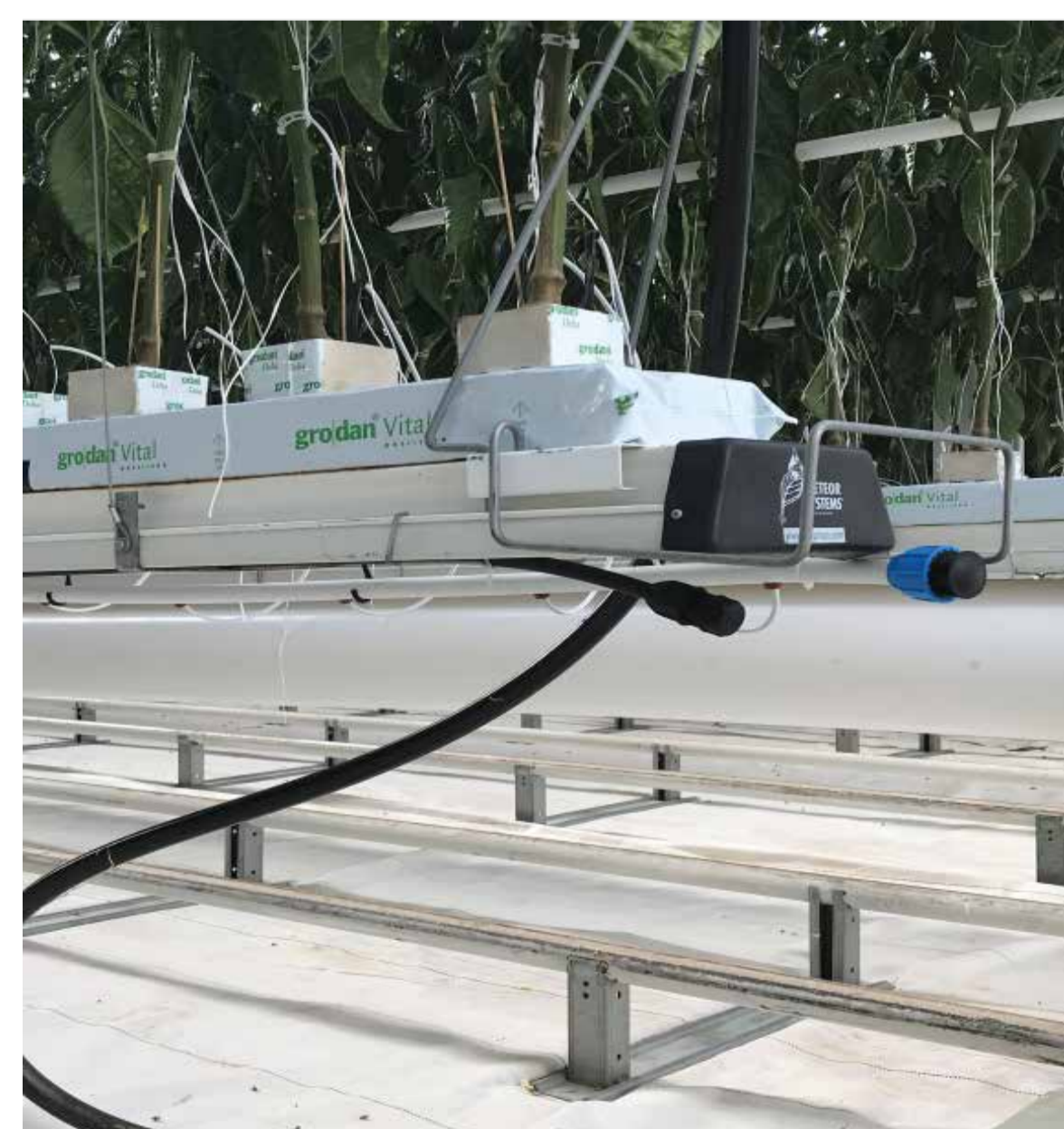
The closed greenhouse is the most water efficient greenhouse possible. The economic feasibility of this type of greenhouse must be justified though. For this the use of resources must be determined exactly and the resulting production must be recorded. Through this experiment more insight will be provided on this aspect.

In this experiment it was determined what the effect and use of carbon dioxide in relation to the production of tomato for two different concentrations for two different varieties.



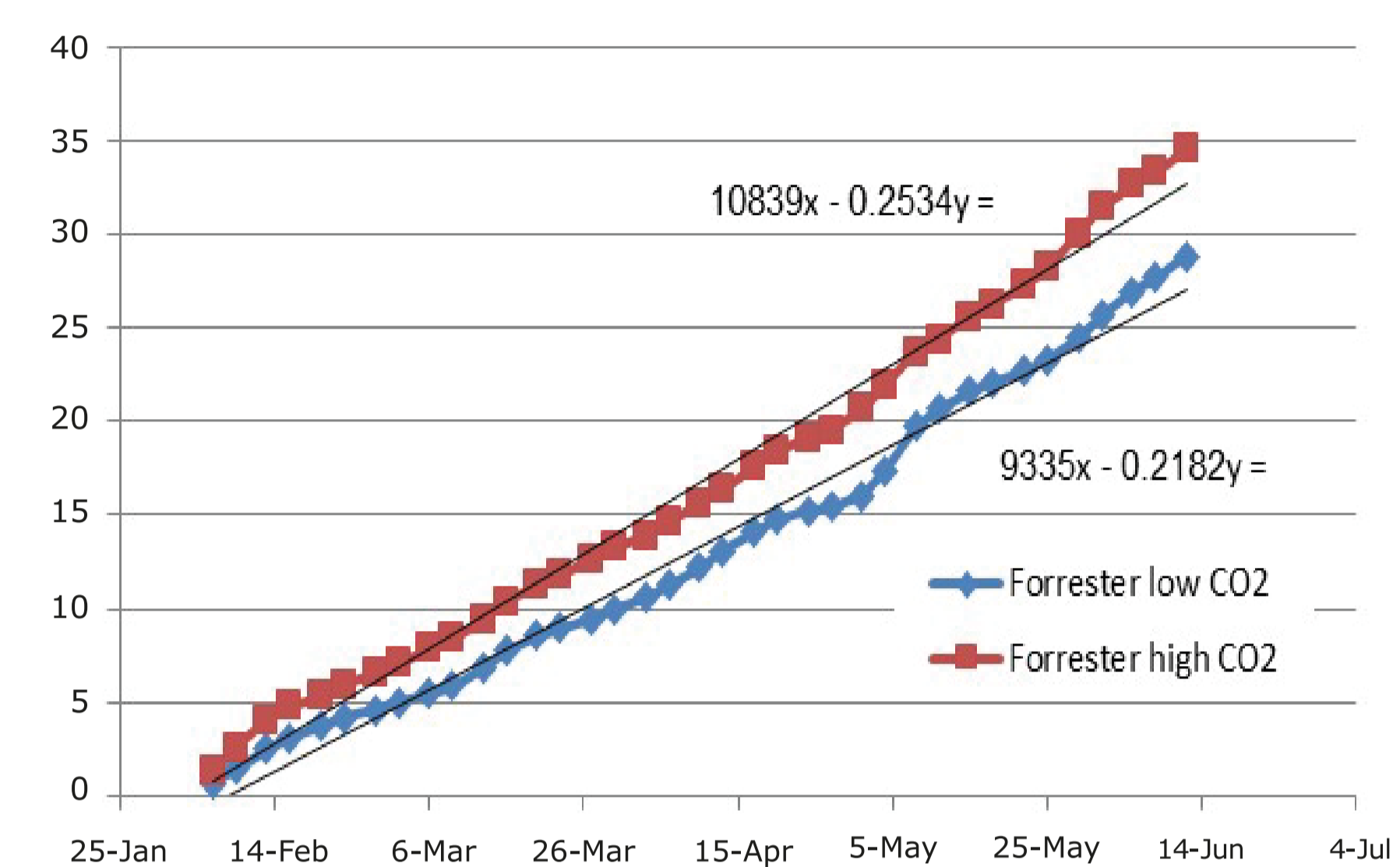
Methods

- One tomato variety was used for this trial: Forrester from Enza Zaden Seed company, beef tomatoes. Plant density 2.5 plants/m² is applied which is the typical layout in the greenhouse
- Sowing was done on 7 November 2016 and the plants were transplanted in the greenhouse on 5 December 2016. The first harvest was on 6 February 2017.
- The same climatic conditions were maintained in both greenhouses (temperature, relative humidity, screening)
- The Carbon dioxide concentration was set to 400 ppm in one compartment (H3) and 800 ppm in the other compartment (H4)
- Production measurements per gutter and from 12 individual plots, good and bad quality
- Data collection: water consumption, energy use (cooling), and CO₂ use.



Results

- In total 34.3 kg was produced with a high CO₂ level and 28.9 kg with the low CO₂ level per square meter of greenhouse (a %19 increase). 4.9 kg/m² vs 7.6 kg/m² of CO₂ was supplied
- 130 mol of light is needed in the low CO₂ concentration to produce 1 kg of tomato,
- While 112 mol of light is needed for the high CO₂ concentration to produce 1 kg of tomato,



Production

Low CO ₂	28.2 kg/m ²
High CO ₂	34.5 kg/m ²
	22%

Water use

Low CO ₂	172 l/m ²
High CO ₂	237 l/m ²

Water use efficiency

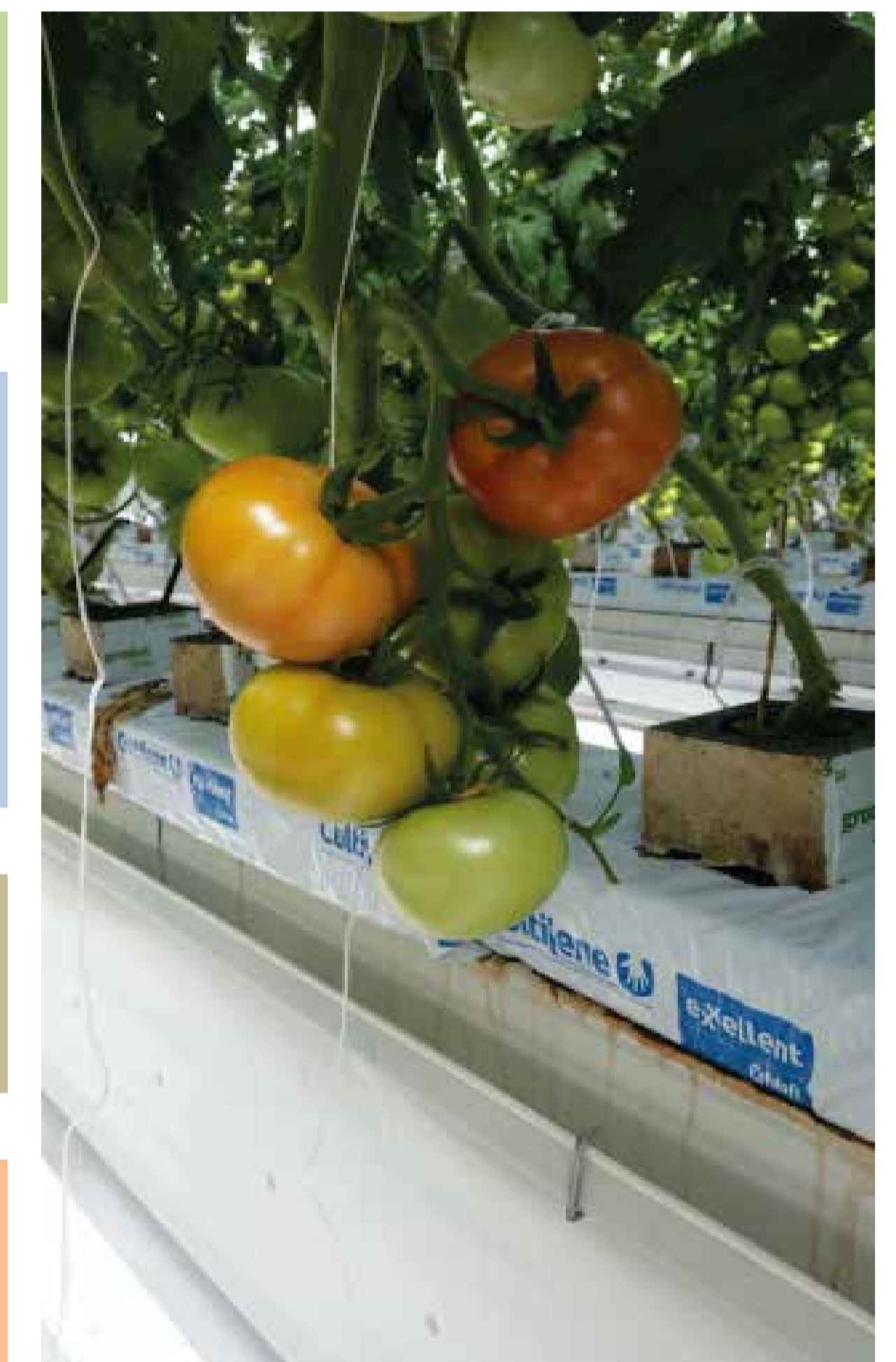
Low CO ₂	6.1 l/kg
High CO ₂	6.9 l/kg

CO₂ use

Low CO ₂	4.9 kg/m ²
High CO ₂	7.6 kg/m ²

Electricity use (cooling, COP 3)

Low CO ₂	207 kWh/m ²
High CO ₂	205 kWh/m ²



Conclusion

- The production increase %22.3 due to the higher CO₂
- Increasing CO₂ concentration decrease water use efficiency to 6.9 l/kg
- About 200 kWh of electricity is required so 6 kWh/kg
- The theory on the effect of carbon dioxide enrichment was proven valid and the additional costs for CO₂ supply were much lower than the value of the additional production.
- Growers with a closed greenhouses like the High-Tech greenhouses can be advised to supply CO₂.

