



Effect of supplementary light on growth and yield of two tomato cultivars grown in High-Tech glasshouse

Alharbi A., Babiker O., Voigt W., Campen J.B., van der Heide H., Abdelaziz M.E., Scheffers K., Tsafaras I., Qaryouti M., de Zwart F.

Background

Sustainable horticulture is a challenging task since the world-wide increase in population, accompanied by increasing food demand, and the current consensus is that we must move towards more sustainable practices. This challenge leads to a need for higher production yield in agriculture that in turn rises energy demand of the agricultural industry. Therefore, greenhouse cultivation became the main supplier of fresh vegetable worldwide. Light is the most important source of energy for plant photosynthesis and a vital signal for plant growth and development. However, plant response to light varied with light quantity and quality. Conventionally, high-pressure sodium (HPS) lamps are used in commercial greenhouses as a supplemental lighting source above plants.

Objective

Saudi Arabia produced more than 270000 tons of tomatoes from open field planting with an area of 11684 hectares, while tomatoes production from greenhouse cultivation was 91 thousand tons and the planted area was 1149 hectares. This study aimed to optimize efficiency of Hi-Tech greenhouse under Riyadh climate condition and enhance tomato growth, and yield using supplementary light application.

Methods

- Two tomato (*Solanum Lycopersicon L.*) cultivars "Cluster" and "Dafnis" were set in two diffuse glass greenhouses (400 m² each) under controlled conditions (1 ±23°C /day and 1 ± 20°C / night), with 2.5 plants per m² plant density.
- Each greenhouse is supported with air conditioning providing enough cooling power to refrain from ventilation with outside air. Also, carbon dioxide was injected to the greenhouse at 800 ppm.
- For artificial light, top high-pressure sodium lamps was installed using (PAR, 210 μmol m⁻² s⁻¹) for 6 hrs. (6:00 - 12:00 am).



Results

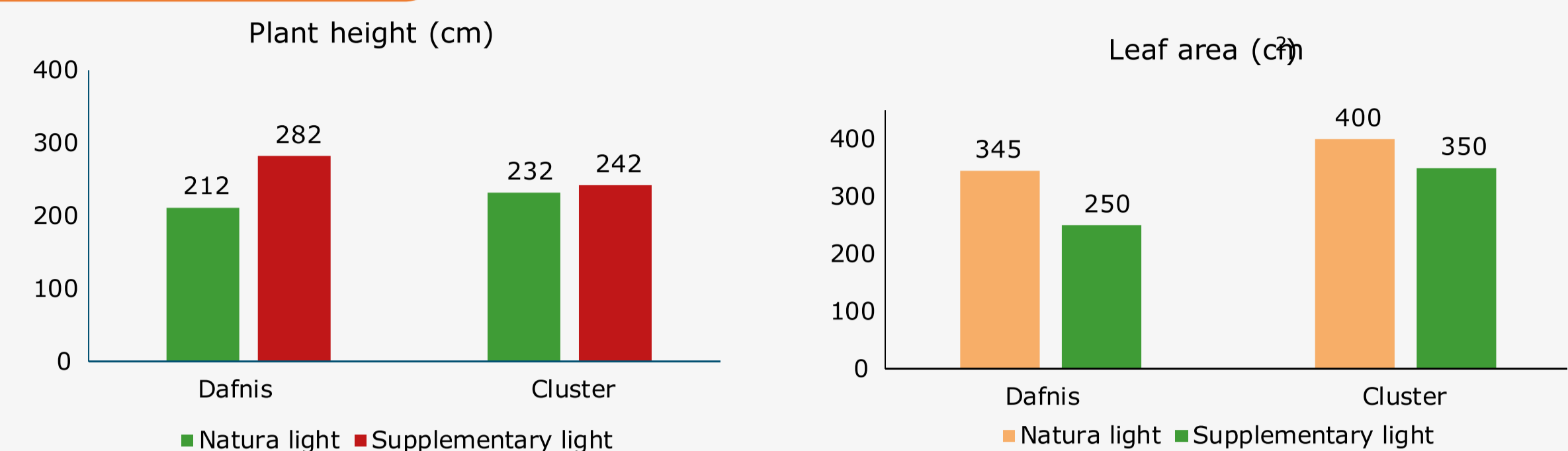


Figure 1. Effect of light source on plant height and leaf area of two tomato cultivars grown in Hi-Tech greenhouse.

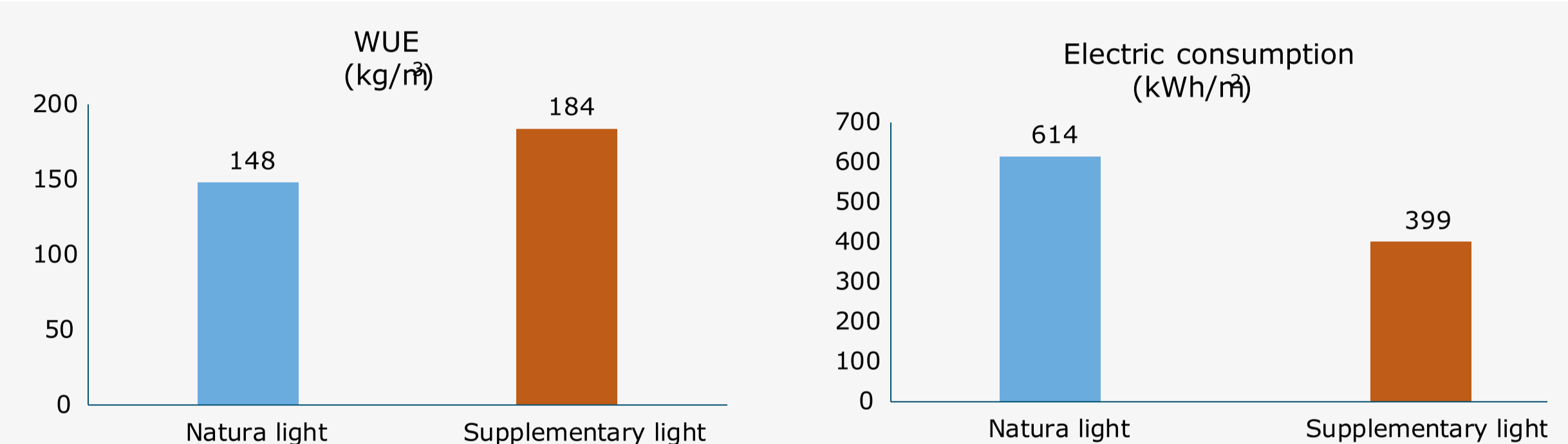


Figure 2. Water use efficiency (WUE) and Electric consumption of two tomato cultivars grown in Hi-Tech greenhouse under supplementary and natural light.

Traits	Total Yield (kg/plant)		Average fruit number per plant		Average fruit weight (g)	
	Dafnis	Cluster	Dafnis	Cluster	Dafnis	Cluster
Supplementary light	10.5	10.7	98	204	109	53
Natural light	10.8	10.9	60	121		

Table 1. Effect of supplementary light on tomato yield in Hi-Tech greenhouse.

- Supplementary light significantly increased plant height of Dafnis and Cluster cultivars in comparison to the natural light treatment by %13 and %18, respectively (Fig. 1).
- Total fruit number per plant was significantly improved up to %63 and %68 for Dafnis and Cluster cultivars, respectively under supplementary light, while average fruit weight was significantly reduced by %41 in both cultivars by supplementary light (Table 1)
- Water use efficiency was significantly reduced (%20) with supplementary light application as compared with natural light only (Fig. 2).

Discussion

- Supplementary light increased fruit number and yield of two commercial tomato cultivar in comparison to the un-supplemented. Obviously, significant increase in average fruit number of Cluster than Dafnis cultivar were obtained.
- Used electricity in the greenhouse with natural light was %35 less than supplemental lighting. Here, supplementary lightings consume a substantial amount of electric energy and thus, create high operational costs.
- The costs of a supplementary lighting with high-pressure sodium lamps (HPS) can exceed the additional profit. However, the electricity use efficiency (kWh m⁻²) was improved by using natural light %36 compared to supplemental lighting.

Conclusion

- Supplementary light application under Hi-Tech greenhouse showed favorable effects in terms of tomato growth, quality and water use efficiency, however, further work should be done to optimize tomato fruit yield under Saudi Arabia climate conditions

