High intensity LED light, diffuse glass and improved climate increased Alstroemeria photosynthesis and production

Nieves García Victoria, Kees Weerheim, Adilson Filho, Feije de Zwart

Background

Greenhouse production in the Netherlands is at present highly dependent on energy from fossil sources. Fossil free horticulture is a major goal to be achieved in The Netherlands by 2050. An all-electric (fossil fuel free) and emission free cultivation system for Alstroemeria was designed and tested with the working title “Alstroemeria Cultivation of the Future”. Among other energy saving innovations, the system incorporated high intensity full LED light and diffuse glass.

Objective

Evaluate the performance of the designed all-electric (fossil fuel free) and emission free cultivation system for Alstroemeria, “Cultivation of the Future” (CF), in comparison to a “standard” growing system (Ref.) in The Netherlands.

Methods

The two cultivation systems were implemented in experimental greenhouse compartments at the WUR Business Unit Greenhouse Horticulture and Flower Bulbs (Bleiswijk, The Netherlands) with the Alstroemeria varieties Noize and Virginia on cocopeat. Main elements of both systems are indicated in table 1. Climate data, energy demand and supply, crop production data and plant parameters were collected. Photosynthesis was measured in both summer and winter conditions.

Figure 1. Experimental greenhouse compartments Ref. (Left) and CF (right)

System Components	Reference	Cultivation of the Future
Covering material	Clear glass (float)	Diffuse glass (70% haze) with double anti-reflective coating
Assimilation lights	HPS, 80 $\mu mol.m^{-2}.s^{-1}$	LED, 200 $\mu mol.m^{-2}.s^{-1}$ (8%B,13%W, 67%R, 12%FR)
Heating system	Natural Gas	Electricity (heat from lamp, latent heat and heat from soil cooling machine)
Screening (isolation)	1 Screen (black out)	2 screens (black out + energy)
Humidification	Misting system (150 $g.m^{-2}.h^{-1}$) with 10 g/kg VD as set point	Misting system (150 $g.m^{-2}.h^{-1}$) with 7 g/kg VD as set point

Table 1: Main system components

Figure 2. Li-6800 during photosynthesis measurements.

Figure 3. Left, flowering stems of the variety Noize, right of the variety Virginia,

Results

Production

	Production (flower stems.m⁻²)				Increase (%)	
	Ref.		CF		Production	Light Sum
	Noize	Virginia	Noize	Virginia		
1st year	336	256	453	375	39.9	31.5
2nd year	380	317	605	532	63.1	29.2

Table 2: Production (flowering stems.m^{-2}), production increase (%) and PAR sum increase (%) obtained at the first and second cultivation years on CF and Ref. systems.

Photosynthesis

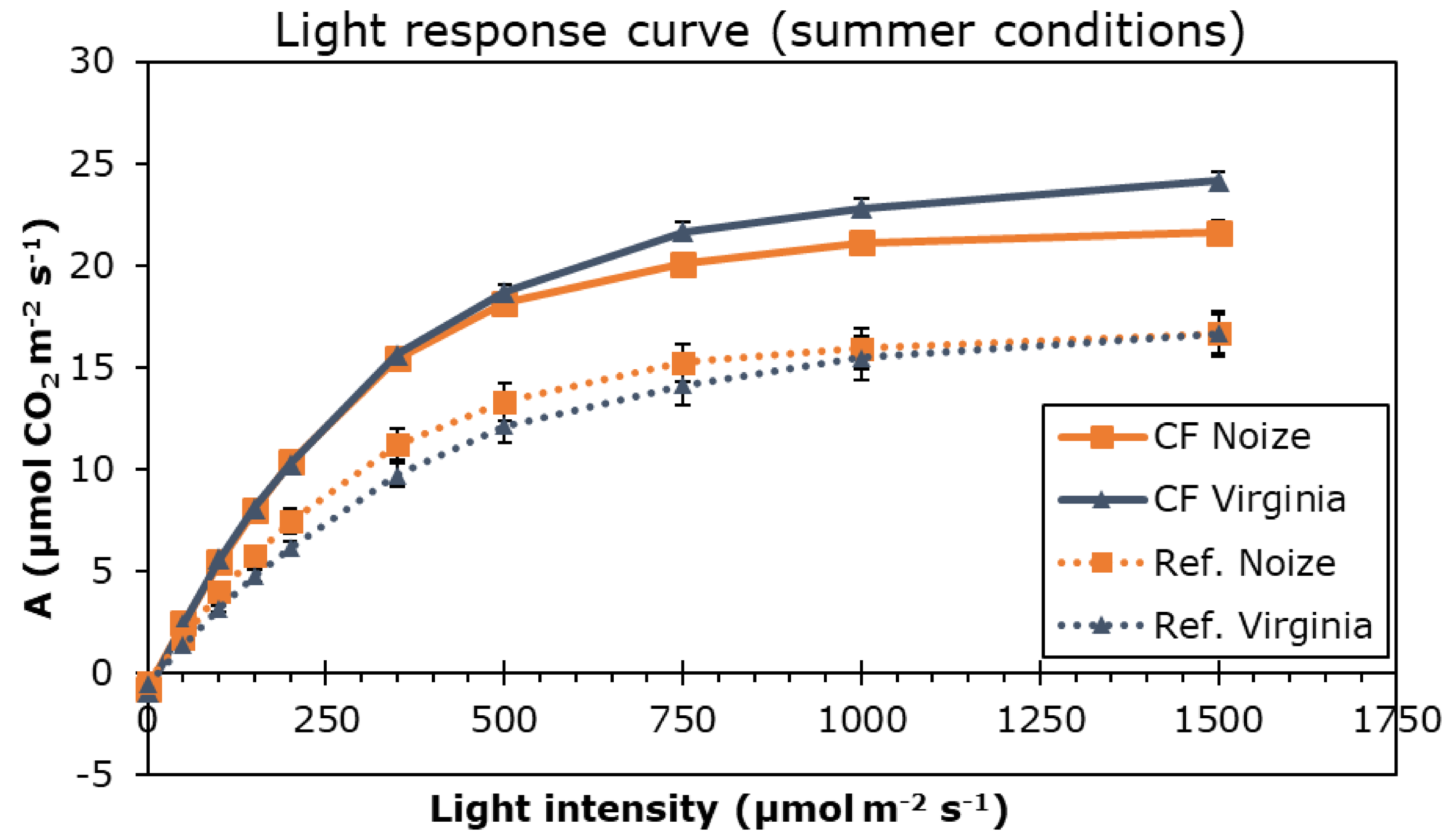

Table 3: Light response curves obtained for cultivars Noize and Virginia grown on the CF and Ref. systems (summer conditions).

Stomatal conductance

Noize		Virginia	
Ref.	**CF**	**Ref.**	**CF**
0.11 ± 0.01	0.17 ± 0.02	0.12 ± 0.03	0.18 ± 0.02

Table 4: Average Gs ($mol.m^{-2}.s^{-1}$) under light intensity levels of 1500 $\mu mol.m^{-2}.s^{-1}$ in plants grown on the CF and Ref. systems (summer conditions)

Conclusions

- The “Cultivation of the Future” with full LED in high intensity and diffuse glass increased production of Alstroemeria by 51.5% (23 months) compared to the reference.
- The production increase was higher than the 30.3% increase in PAR sum (more crop per mol PAR). This can be attributed to:
- 1. the diffuse light and increased misting that enabled 47.5% higher stomatal conductance and higher photosynthesis capacity of the plants in summer, and
- 2. to the large differences in light sum and 5-9% higher light interception by the crop in the winter situation, when the difference in photosynthesis capacity (*not shown*) was small.

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Wageningen University & Research
Business Unit Greenhouse Horticulture
Violierenweg 1, 2665 MV Bleiswijk, The Netherlands
Contact: nieves.garcia@wur.nl Tel. +31 (0)6 12 34 56 78
www.greenhousehorticulture.wur.nl