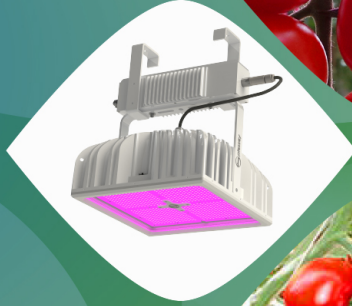




The technology of light

White Paper

Combining LED and HPS
grow lights boosts crop yields





Background

High-pressure sodium (HPS) lights have long been the mainstay of horticultural lighting.

Increasingly now, growers are experimenting with LED lighting, which provides light wavelengths that are better attuned to plant growth, produces less heat and uses less energy than HPS.

Even so, concerns over the cost and performance of LED lighting and the risk of replacing all HPS continue to hold back some growers from investing.

The main concern has been around whether it is economical to invest in LED lights, and what return on the investment can be delivered. One approach is to adopt a hybrid solution, where LED grow lights are added to existing HPS to increase light intensity and give the benefits of both technologies. Now, trials with multiple growers have clearly demonstrated the return on investment when supplementing HPS with LED. In some cases, yields have increased by as much as 35%.

The Research

In 2016, LED lighting specialist Plessey conducted a major trial of LED grow-light technology, with four of the Netherlands' leading growers. The trial, managed by Plessey's head agronomist Maarten Klein, ran from November 2016 to June 2017 and looked at plants grown under HPS lights alone compared to those grown under a mixture of HPS and LED. This "hybrid" installation is potentially an attractive choice for growers who want the benefit of extra light but don't want to completely replace their existing HPS lights.

The growers involved in the trial were Gebr. Koot (part of the Prominent tomato growers' association), Slijkerman Kalanchoë, Villa Gerbera and Together2Grow. The four companies trialled Plessey LED lighting alongside their existing HPS lighting systems for growing their respective crops of tomatoes, cut flowers and ornamental pot plants.



Maarten Klein

Inspecting the tomato crop at Gebr. Koot.

“... the plant was stronger, with higher crop potential, allowing an extra fruit to be carried on each truss.”

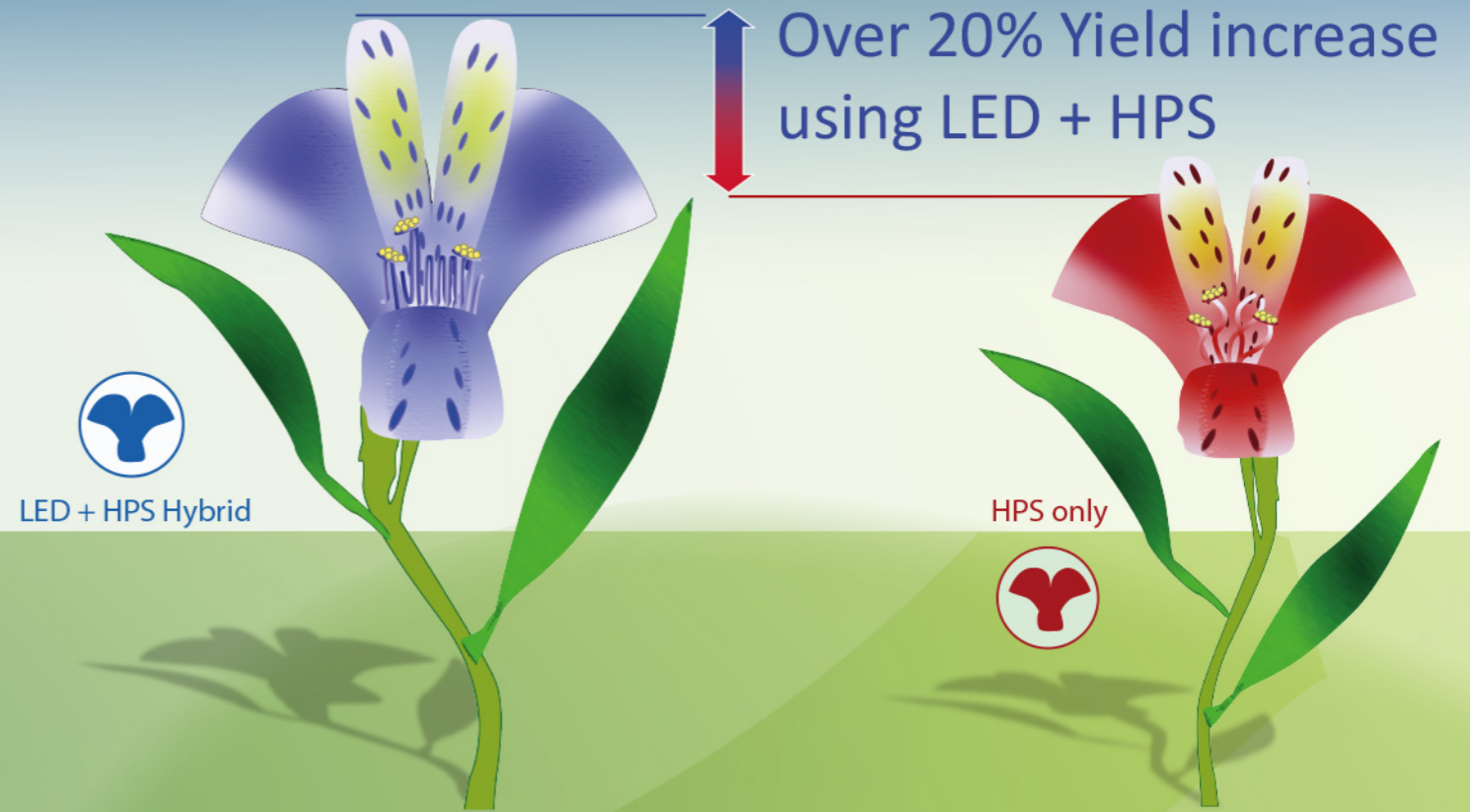


Geert Koot, Gebr. Koot Tomatoes

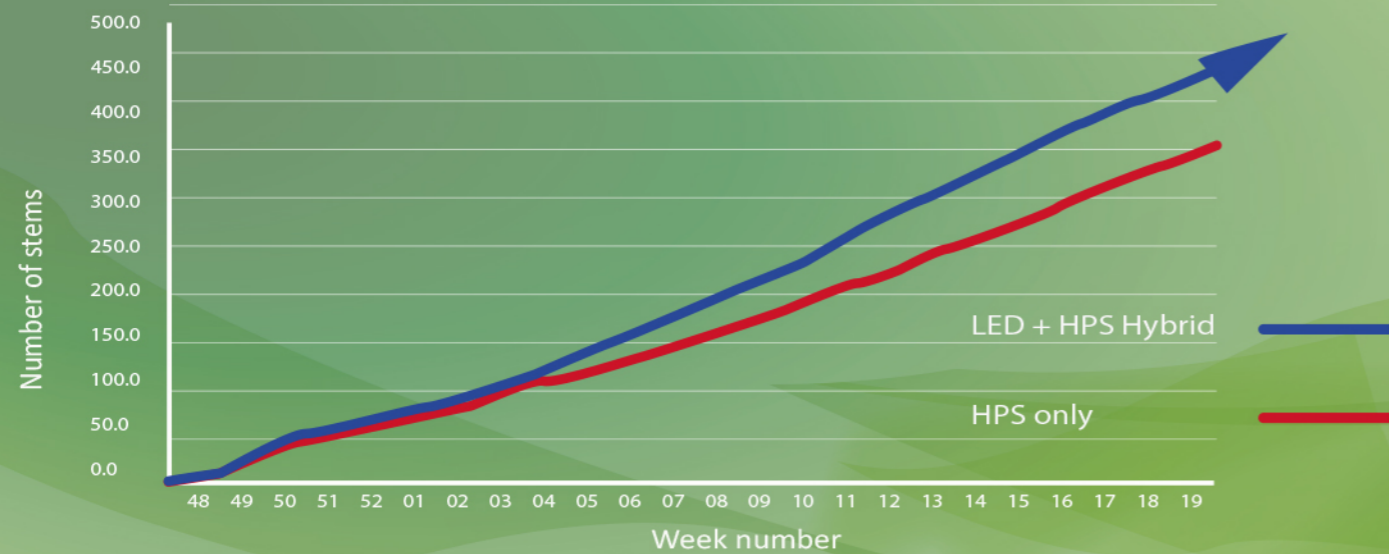




Alstroemeria



Cumulative number of Peruvian lily stems harvested per m²



Graph 1: Cumulative number of Peruvian lily stems harvested per m².

“The stems look bigger and healthier, the flowers are slightly larger and many more flowers were produced for every square metre.”

Bernard Zuidgeest, Together2Grow

The Results

Yield up by nearly a quarter, with bigger, healthier stems

Together2Grow Alstroemeria in Poeldijk, South Holland, specialises in alstroemeria, better known as Peruvian lilies or lilies of the Andes. They introduced 16 Attis 7 lights alongside 1000W HPS lights, nearly doubling light levels from an average of 70 $\mu\text{mol/s/m}^2$ under HPS alone, to 130 $\mu\text{mol/s/m}^2$ under HPS and LED in a trial area of 290m².

Under the combination of HPS and LED, yield increased by many more stems per m² - a rise of over 20% (see graph 1) – and stems were an average of two grams heavier under LED+HPS, compared to the control sample grown under HPS alone. The flowers also had longer “necks”, which is appreciated by florists.

- Grower:** Together2Grow Alstroemeria
- Location:** Poeldijk, South Holland, Netherlands
- Crop:** Peruvian Lillies
- Result:** Over 20% yield increase



Fedor Van Veen & Bernard Zuidgeest
Together2Grow owners

Tomatoes

Yield up nearly 10%, with stronger plants and more plentiful and larger fruits

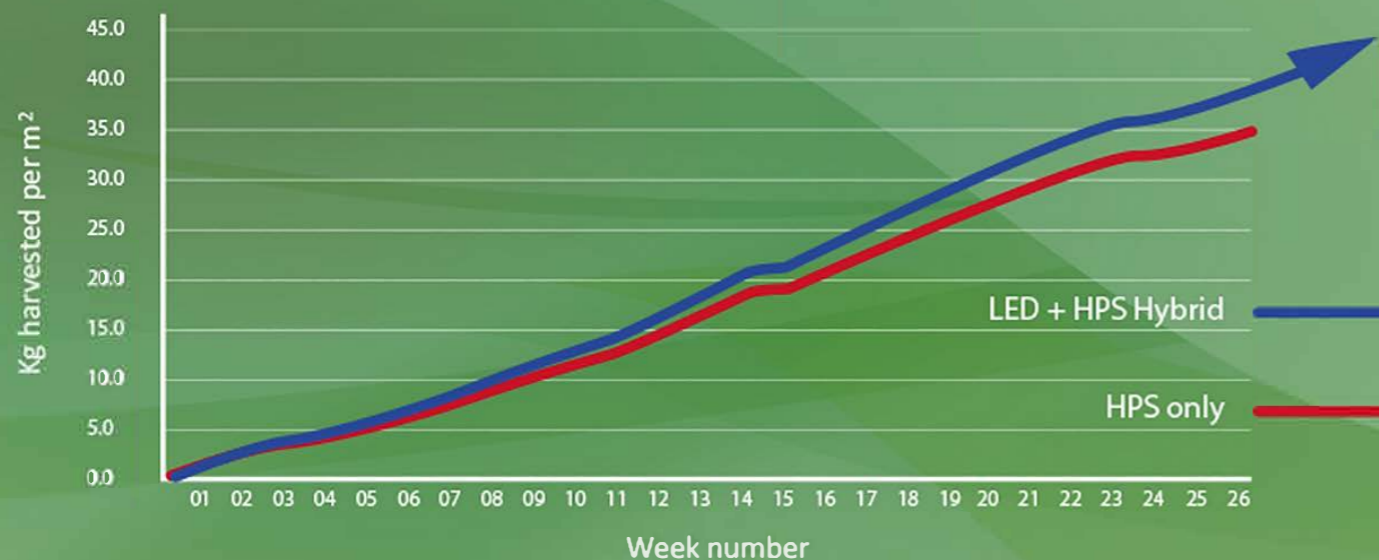
Gebr. Koot, a member of the Prominent group of growers, is a major producer of the briosio variety of tomatoes. In November 2016, it introduced 18 Plessey Attis 7 LED fittings alongside its existing 1000W HPS lights in a 120m² trial area. The existing light intensity of 150 μmol/s/m² from HPS was supplemented with an extra 58 μmol/s/m² from the LED fittings (a 39% increase) to achieve 208 μmol/s/m².

In the seven-month trial period, yield for the tomatoes grown under a combination of LED and HPS fixtures was 9.4% higher than for the control sample grown under HPS alone (38.32kg per m² compared to 35.04kg per m² – see graph 2).

The average weight of each tomato was also slightly higher, at 39.2g compared to 38.8g.



Cumulative weight of tomatoes harvested per m² per week



Graph 2: The cumulative weight of tomatoes harvested per square metre per week, showing how the total under LED+HPS lighting is greater than under conventional HPS-only lighting.

Average number of set tomato trusses



Graph 3: The average number of set tomato trusses was comparable under the two lighting setups, demonstrating that the LEDs did not affect pollination.

Under LED+HPS lights, an average of 11 tomatoes were supported on each truss, compared to 10 under HPS-only.

The grower, Geert Koot, observed: "At the beginning of the trial, the crop looked healthy in both lighting environments, but with the added LED illumination, the crop was stronger, with thicker stems and leaves that are darker green. The first trusses under the LED+HPS lighting developed later, but the plant was stronger, with higher crop potential, allowing an extra fruit to be carried on each truss."

The new lighting had no measurable effect on the speed of flowering or the number of flowers that were pollinated by bees to create tomatoes (see graph 3).

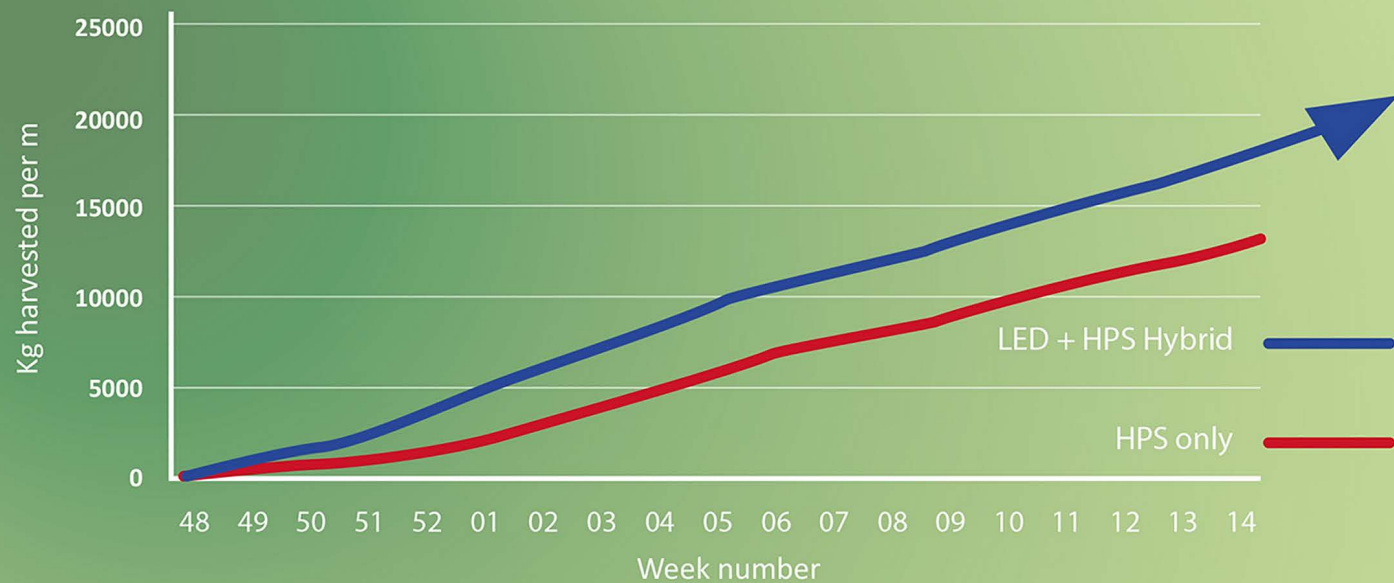
The sugar content of the tomatoes was about the same, showing that the increase in yield from the addition of LED lighting did not come at the expense of flavour.

Furthermore, it is likely that even higher yields could be achieved by increasing greenhouse temperatures to take advantage of the increased potential in the crop.

Grower: Gebr. Koot
Location: Poeldijk, South Holland, Netherlands
Crop: Briosio tomatoes
Result: 9.4% yield increase

Kalanchoe pot plants

Cumulative harvested cuttings of kalanchoe pot plants



Graph 4: The total cumulative harvested cuttings of kalanchoe plants under the hybrid LED+HPS setups, compared to a traditional HPS-only lighting installation.

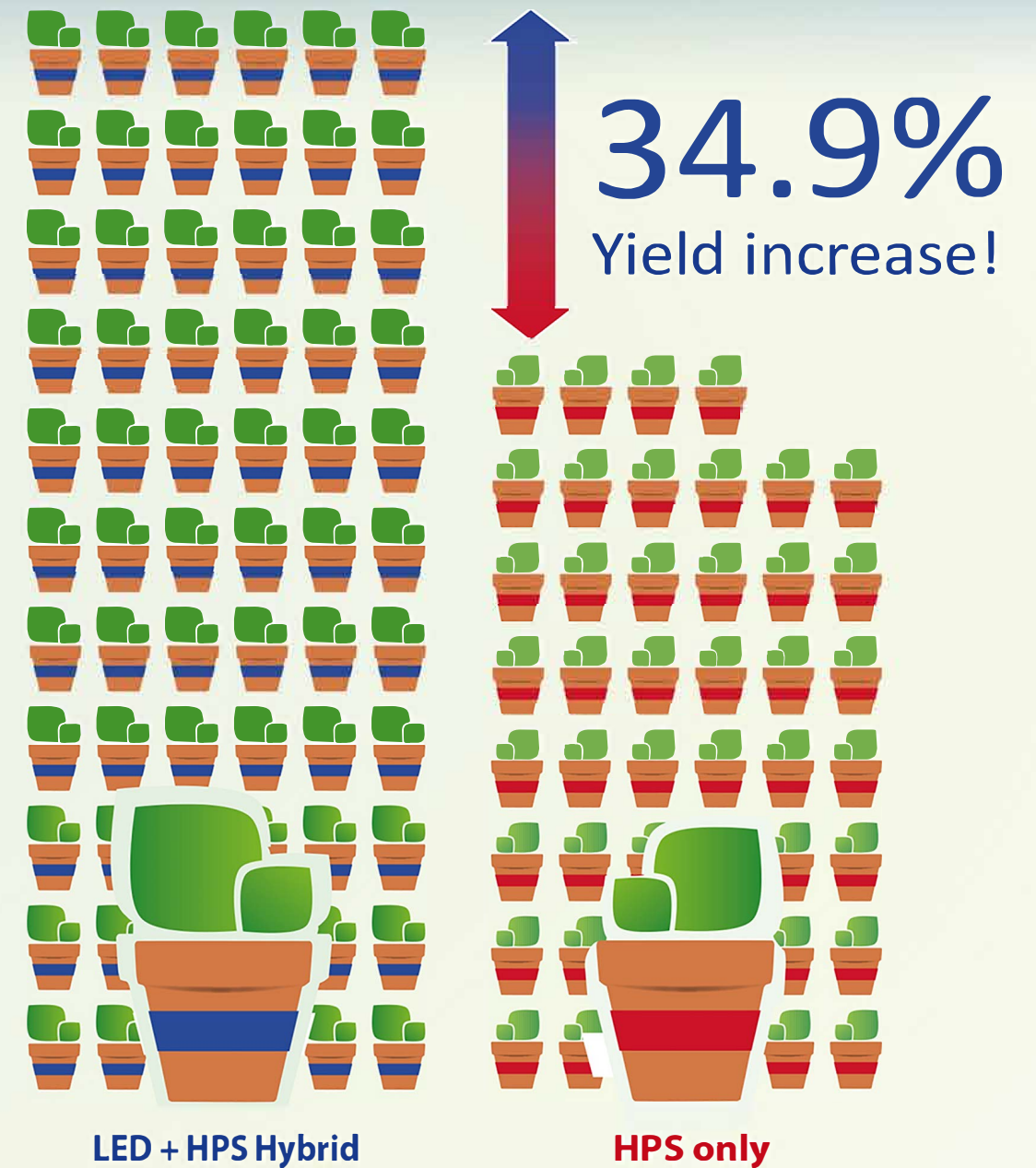
Yield up by more than a third, with healthier, faster-growing plants.

Slijkerman Kalanchoë in Heerhugowaard, North Holland, which grows kalanchoe pot plants, introduced Plessey's Attis 7 LED lights alongside its existing 600W HPS in a 550m² trial area where cuttings were taken.

Light levels under the LED+HPS lights were three times higher than under HPS alone, at about 96 $\mu\text{mol/s/m}^2$, and cuttings yield was up by a massive 34.9% compared to the control sample grown under HPS alone (see graph 4).

The grower, Stefan Slijkerman said: "The plants grown under LED light looked fuller and healthier and the cuttings were heavier and longer. This meant they were ready to be harvested two-to-three days earlier."

Grower: Slijkerman Kalanchoë
Location: Heerhugowaard, North Holland, Netherlands
Crop: Kalanchoe succulent plants
Result: 34.9% yield increase



"The plants grown under LED light looked fuller and healthier"



Stefan Slijkerman



Gerbera daisies

Cumulative gerbera daisy stems harvested per m²



Graph 5: The cumulative number of gerbera daisy stems harvested per square metre. The hybrid LED+HPS setup saw 27.3 more stems harvested than under HPS-only lighting.

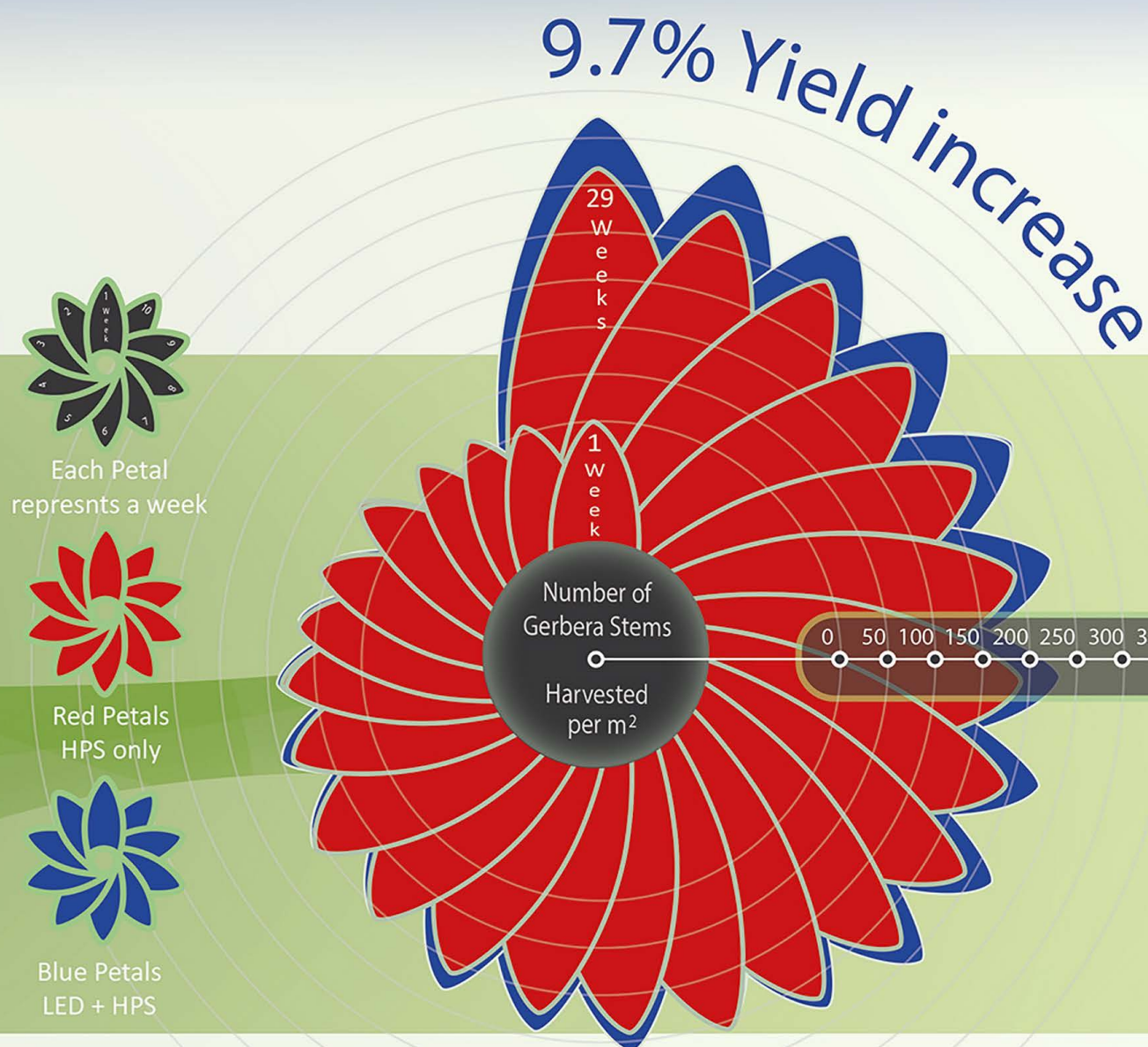
Yield up 10%, with potential for even bigger gains

Villa Gerbera in Honselersdijk, South Holland, which grows gerbera daisies, added 28 Attis 7 fittings to its existing 1000W HPS installation in a 440m² trial area. Light levels with HPS and LED combined were up by about 43% to 165 $\mu\text{mol/s/m}^2$. The low heat generated by the LEDs allowed them to be lit for longer than the HPS. An extra 27.3 stems per m² were harvested, representing an increase in yield of 9.7% compared to the control sample grown under HPS alone (see graph 5).

The average diameter of the flowers was slightly larger under LED+HPS, at 10.6cm compared to 10.4cm and the average weight per stem was slightly higher at 33g/stem compared with 32g/stem. The grower, Andre Zuidgeest, said:

“The plants are bigger, healthier and of better quality. We achieved a significant increase in yield, and by increasing the temperature, there is potential for even greater gain.”

Grower: Villa Gerbera
Location: Honselersdijk, South Holland, Netherlands
Crop: Gerbera daisies
Result: 9.7% yield increase



“The plants are bigger, healthier and of better quality. We achieved a significant increase in yield, and by increasing the temperature, there is potential for even greater gain.”

Andre and Mike Zuidgeest with Plessey grow light team

How does it work?

LED lighting provides more suitable light spectrum that plants are able to absorb for use in photosynthesis compared to HPS, but without as much radiant heat.

This means that adding Plessey LED light fixtures to an existing HPS lighting system enables growers to apply greater light intensity to their crop, for longer periods, with little extra heat production to create an optimal greenhouse climate.

In particular, LEDs produce very little radiated (infrared) heat. This means the heat they generate is dissipated upwards, rather than down towards the plants. This is particularly beneficial for crops such as leafy plants, which thrive in cooler temperatures.

When used in a combined HPS and LED lighting installation, the plants continue to get radiant heat from the HPS lights, but also gain the advantage of light wavelengths unique to the LEDs being used, including far-red, deep-red and blue spectrum light. These are better matched to the light spectra that plants need to grow. In this way, growers can increase the size and weight of their crops and benefit from faster growth of plants and roots, earlier flowering and germination, better colour, better uniformity, longer lifetime for cut flowers and better control of growth.

And because LED lighting doesn't generate excessive heat, they can also lengthen the growing season for summer crops to the darker months, by having lights on for longer without overheating glasshouses. Energy costs, for the same amount of light, are around 40% lower for LEDs than for HPS lighting. When less daylight is available and artificial light is required, especially in autumn and winter, growers can make big savings.

What do the trial results mean for growers?

This study provides clear evidence that, for four very different crops, the combination of LED and HPS grow lights can produce bigger, healthier plants, faster.

In all four trials, adding LED lights boosted crop yields significantly, with increases ranging from 9% to 35%. This shows that LED lighting offers a strong return on investment for growers. The success of combined HPS and LED solutions shows that growers can benefit, even without making a full switch to LED. The study joins a growing body of scientific research on the benefits of LED lighting for horticulture.

Plessey's 6-year investment into LED grow lighting technology is already delivering great results for a wide variety of growers. To estimate the potential ROI on introducing LED in a hybrid installation with HPS, growers need to consider:

- Yield and potential increase in the number, quality and weight of fruits, flowers, stems and cuttings
- Electricity and maintenance costs
- Cost of equipment and installation
- Growing strategy adjustments, such as increasing the greenhouse temperature to take advantage of the higher crop potential.

Given the results of the four recent trials in increasing yield, and the competitive pricing of Plessey's LED grow lights, an investment in LED can pay for itself in a short period of time.

Plessey LED lighting continues to improve

Since the trials in the Netherlands began, the performance of Plessey's LED grow lights has improved further. Plessey's new Hyperion™ high power grow light produces in excess of 1000 micromoles/s/m².

Hyperion™ is the first one-for-one replacement for sodium – a significant breakthrough that enables growers to make the transition to LED with less cost and disruption.



Plessey's new Hyperion 1000 micromole/s LED grow light. For more information visit:

 www.plesseysemi.com/hyperion

Plan your LED project with Plessey

Besides specialising in Hybrid LED plus HPS solutions, Plessey can support growers, greenhouse producers and installers with lighting plans that are 100% LED. It is easier to manage glasshouse temperature with an LED-only installation and as a result, light the crop for longer. By delivering supplemental lighting efficiently during darker months, plant growth and development can be maintained and the year-round quality of any given crop optimised according to the proven spectrum that Plessey's innovative and high-performance LED fixtures offer.



The technology of light

Contact us for more information about Plessey's horticulture LED grow lights:

Tamerton Road, Roborough | Plymouth, Devon | PL67BQ, UK
T: +44 1752 693000 | sales@plesseysemi.com | www.plesseysemi.com