



Philips LED Lighting in horticulture

There's more to light



PHILIPS

Philips LED Lighting in horticulture

Solid-state LED lighting offers a number of benefits to the horticulture industry, including increased yields, earlier flowering, faster root growth/germination, better control of plant growth, and more economical use of space. LED lighting is also highly energy-efficient, helping horticultural producers to lower electricity consumption, especially during the high consumption periods of autumn and winter.

Having completed hundreds of projects, Philips Lighting has many years of experience investigating the effects of LEDs (light-emitting diodes) on a range of crops. In every project we are on the lookout for the optimum light recipe. A Philips light recipe is an instruction based on knowledge of how to use light to grow a certain crop under certain conditions. A light recipe indicates:

- Lighting aspects: light level, spectrum, required uniformity, position and time
- Parameters for which the recipe is valid, e.g. climate conditions
- Expected results besides energy saving

Our light recipes are suitable for different segments within horticulture, e.g. vegetable production, tissue culture and young plant production, cut flowers, seedlings and nurseries. Philips Lighting is offering knowledge of horticultural LED lighting around the world to you.



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Royal Philips

Royal Philips of the Netherlands is a diversified health and well-being company, focused on improving people's lives through meaningful innovation. As a world leader in healthcare, lifestyle and lighting, Philips integrates technologies and design into people-centric solutions, based on fundamental customer insights and the brand promise of 'innovation and you'.

innovation  you

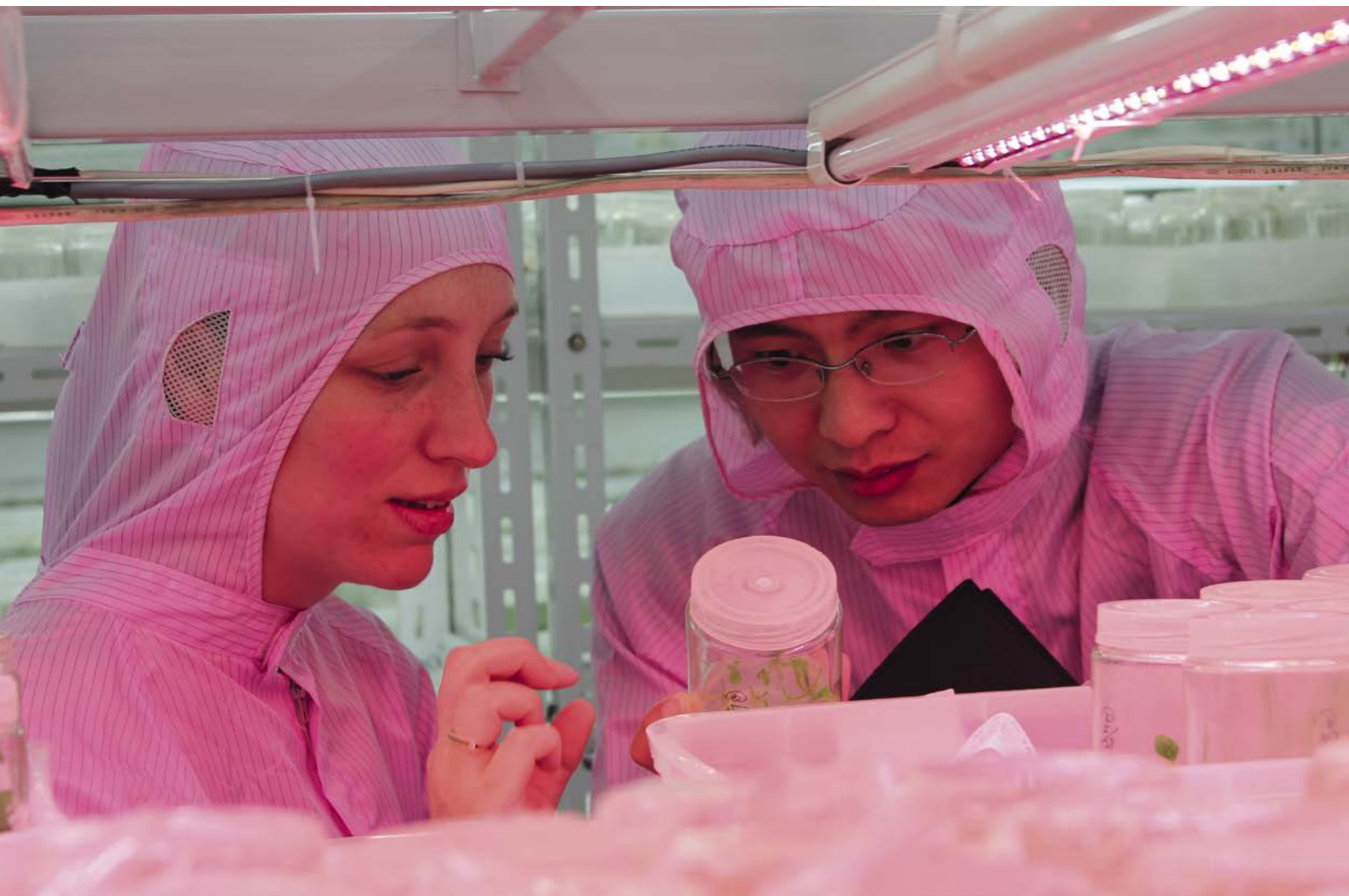
Our Lighting sector is dedicated to introducing innovative end-user-driven and energy-efficient solutions and applications for lighting, based on a thorough understanding of customer needs in both professional and consumer markets. We address lighting needs in a full range of environments – indoors (homes, shops, offices, schools, hotels, factories, and hospitals) as well as outdoors (public places, residential areas and sports arenas). We also meet people's needs on the road, by providing safe lighting in traffic (car lighting and street lighting). In addition, we deliver light-inspired experiences through architectural and city beautification projects. Our lighting is also used for specific applications, including horticulture, refrigeration lighting and signage, as well as heating, air and water purification, and healthcare.

With the rise of new lighting technologies, such as LED, and the increasing demand for energy-efficient solutions, Philips will continue to shape the future with ground-breaking new lighting applications.

Philips is a global leader across its healthcare, lighting and lifestyle portfolio:

- We are number one in lamps in Europe, Latin America and Asia Pacific, and number two in North America. In Automotive lighting, we are leading in Europe, Latin America, Japan and Asia Pacific.
- Philips was ranked by Interbrand as the 40st most valuable brand in the world.
- We came 7th in the Forbes global Top 100 of most sustainable companies in the world, particularly by increasing the energy efficiency of our products.

For more information, visit: www.philips.com



Philips Lighting in horticulture

Philips has been developing light sources for horticulture for many years and continues to invest heavily in horticultural lighting. In R&D for Lamps, Lighting Electronics and LED, a team of engineers works full-time to improve existing lamp and gear concepts and to develop new lighting systems for horticultural lighting. Specialists such as plant physiologists and technical engineers have been trained in the key horticultural countries to provide full support to growers and breeders.

In order to gain a deeper understanding of what is required in greenhouses, Philips maintains close contact with commercial growers, breeders, universities and research institutes. In order to meet the specific requirements for horticulture, we have our own laboratories and test stations. And, to further advance our overall knowledge, we contribute to independent research and field testing. We have established **close partnerships** with globally recognized agricultural research institutes and universities such as Wageningen University, Purdue University, and University of New Hampshire. We also work closely with a number of internationally acclaimed horticulture companies to provide complete solutions. We have a network of certified Philips LED Horti Partners to collaborate with us during the development of light recipes. Our certified complementary partners that collaborate with us during the testing and implementing phase include BVB Substrates, Duchefa, and GreenQ/Improvement Center. This approach has led to the development of highly efficient lighting solutions that are **tailor-made for growers**.

We brought our first specific horticultural light solution to the market in 1995 after an intensive period of research. This was a High Pressure Sodium lamp specially designed for greenhouses. In the following years we expanded the Philips GreenVision/GreenPower range. In **2008** we introduced our first horticulture GreenPower LED solution to the market. Today, our LED range has been extended to a complete family comprising multiple solutions. Philips GreenPower products are designed specifically for applications in horticulture. Besides stable and reliable quality, they display characteristics including long life, low light fading, high waterproof and dustproof factors. Philips is supplying both HID as well as LED technology, including drivers. This allows us to develop the most suitable

and sustainable lighting solution, sometimes combining different lighting technologies, for each application.

Anyone who goes into partnership with Philips gets much more than just a product. Thanks to the studies we have conducted into light and plants we now have an improved light recipe database, based on years of practical experience and close cooperation with the horticulture industry. Our **plant physiologists** – we have five based in different locations throughout the world – play a major role in this. They listen to the needs of horticultural users, participate in the development of lighting solutions, follow up on the progress of projects, and offer timely advice. Ultimately, together with clients they pinpoint the ideal **'light recipes'** for plant production. Our application engineers are responsible for the design of lighting solutions, the installation and implementation of products, and technical support and consultancy during the application process. Moreover, they cooperate with our plant specialists to ensure the best feasible and optimal of lighting solutions.

Through **field tests with growers** we have gained a deep understanding of the light required by various plants at different growth phases. But also a great understanding of the grower's business which differs between countries, crops and people. This enables us to offer each grower a customized lighting solution, with precisely the composition of light that their plants make best use of. And not only that: Philips takes work off your hands by providing support during the subsidy application process, and after-care in the form of answers to technical and botanical questions. The result? Greater control over growing conditions and the growth process, better results, and **higher yield**. The effort put in by Philips means one worry less for you and the certainty of a balanced and customized approach to your company and your plants.

A Philips light recipe is an instruction based on knowledge of how to use light to grow a certain crop under certain conditions.

A light recipe indicates:

- Lighting aspects: light level, spectrum, required uniformity, position and time
- Parameters for which the recipe is valid, e.g. climate conditions
- Expected results besides energy saving

Our approach

Step by step to your solution

Our know-how
and network for
your solution



Step 1 → What is your need?



Step 2 → Light recipe



Step 3 → Product, installation and application



Step 4 → Business case and Financing



Step 5 → Agreement, delivery and installation



Step 6 → Implementation check



Step 7 → Follow up

The Philips horticulture Lighting Team
originated in Eindhoven, the Netherlands, and
has since expanded worldwide

Light and plant growth

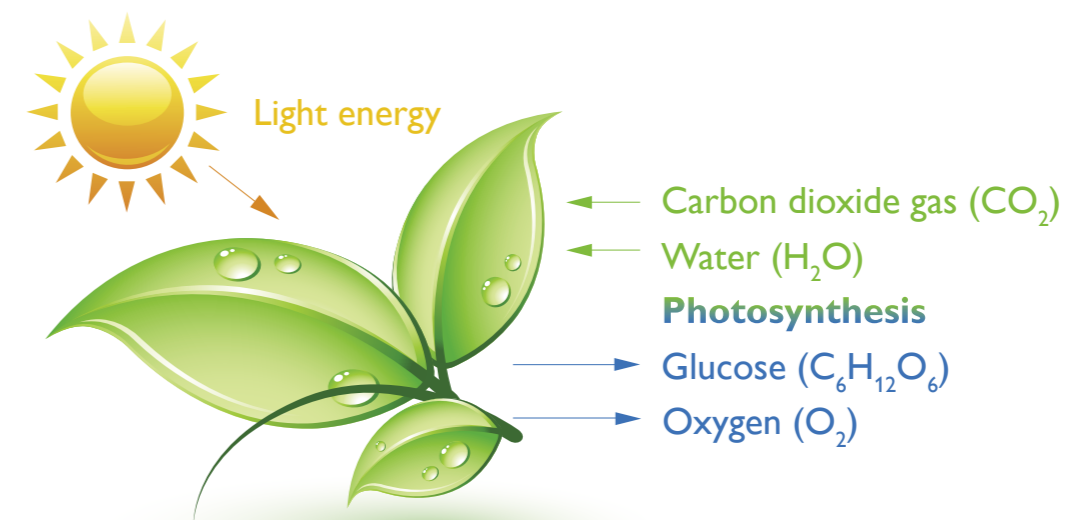
Light is essential for plant growth. Natural sunlight is the cheapest source available, but for horticulture it is not always attainable in sufficient quantities. Therefore, the use of artificial light has become very common in order to increase production and quality.

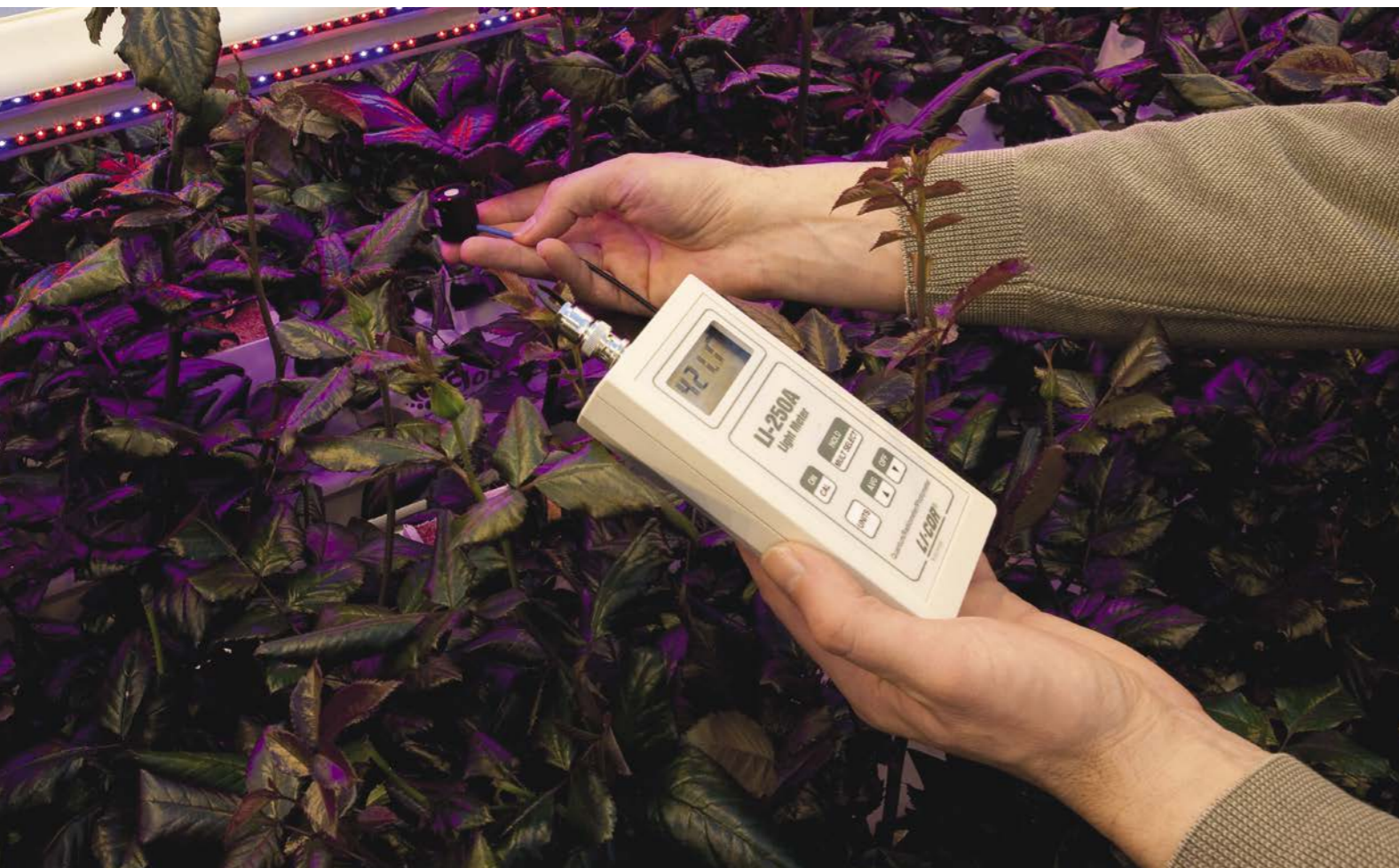
Plants have a completely different sensitivity to light colors than humans. With regard to plant growth, light is defined in terms of small particles, also called photons or quantum. The energy content of photons varies, depending on wavelength (light color spectrum). For one optical energy, almost one and a half as many red photons can be produced compared with blue. This means that often red light sources produce more efficient light photons than blue light sources. However the plant has also various sensitivity for various colors of light, and that influences different light-sensitive activities as well. Using the efficient light sources for plants, effective light recipes are important to obtain the optimal results in plant production.

Plant sensitivity curve for growth light:

The only part of the global radiation spectrum which can be used by a plant for its photosynthesis is between 400-700 nm, this is called the PAR-light (Photosynthetically Active Radiation). The amount of photons in the PAR region are called growth light (indicated in micromol

(μmol)). So, around 45% of global radiation is PAR light. Photosynthesis is the basic process that leads to growth of a plant and light is an essential part of this. This energy is used to form glucose from carbon dioxide gas (CO_2) and water, which are taken up by leaves and roots. This process can be represented as follows:





The main properties of light that make the plant grow well/flower:

Light quantity / intensity

The growth of a plant is strongly determined by the total number of photons that it absorbs in the PAR region. In winter there is often too little natural light for plants to grow and continue to produce good flowers and fruits.

Day length

With many plants, the time of flowering is influenced by the photoperiod. For example, a chrysanthemum plant will only bloom when the night is long. We call them 'short day plants'. However when you apply long day light to them, the flowering will be suppressed.

Spectrum

The mix of colors in the light (spectrum) also strongly influences the development of a plant.

Light uniformity

When using artificial lighting, uniformity and constant quality of the light spectrum is very important for a constant quality of crop production.

An efficient lamp for plant growth must convert as much electrical energy as possible into PAR energy. The term 'daily light integral' (DLI) refers to the number of light particles, or photons, received during one day in the PAR region (400-700 nm). The DLI specifically refers to the amount of photosynthetic light received in an area of 1 square meter (10.8 square feet) each day. The DLI can

have a profound effect on root and shoot growth of seedling plugs, root development of cuttings, and finish plant quality attributes such as stem thickness, plant branching and flower number. The average DLI received outdoors ranges roughly from 5 to 60 mol/m²/day and depends on location and time of year. Inside a greenhouse, light transmission is usually

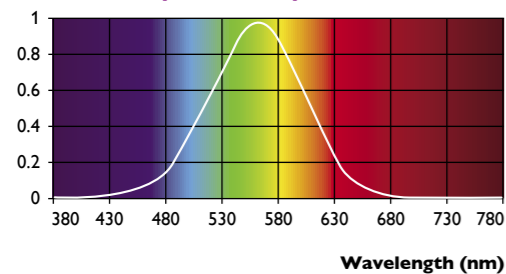
reduced by 35-50%, so it is not uncommon to have an average DLI inside a greenhouse of less than 3 mol/m²/day during the darkest periods of the year. In general, 4-6 mol/m²/day is recommended for propagation of cuttings, and at least 10-12 mol/m²/day is recommended for most bedding plants, perennials and potted crops.

DLI is measured in mol/m²/day, which means the number of moles of light (mol) per square meter (m²) per day. What is a mole of light? A mole is a very large constant number (6,022 x 10²³, which equals 602,200,000,000,000,000,000,000).

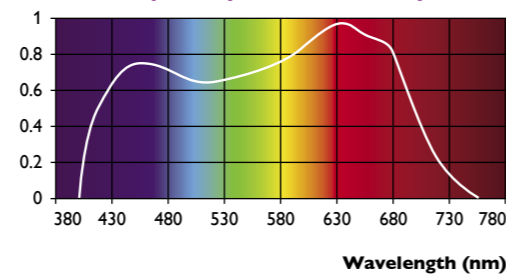
What DLI is needed to grow high-quality transplants and finish plants? The answer depends on the crop, but a common target minimum DLI inside a greenhouse is 10-12 mol/m²/day. Plant quality generally increases as the average DLI increases. In particular, as the DLI increases, branching, rooting, stem thickness and flower number increase, and sometimes plant height decreases.

There are some exceptions: shade crops such as African violets and Phalaenopsis orchids grow well under an average DLI of 4-6 mol/m²/day. In addition, some crops flower earlier when grown under a high DLI compared to a low DLI.

Relative eye sensitivity



Relative photosynthesis efficiency



Example calculation

DLI = Daily light integral (in mol/m²)
 DLI = average light intensity (μmol/m²/s) * time (s)
 / 1,000,000 = mol/m² (/day)
 Time in seconds = hr of hours * 3600

200* 14* 3600/1,000,000 = 10 mol/m²/day

Application fields

We are experienced in your segment - find out below what LED light can do for you!

Floriculture (Cut flowers, potted plants, bedding plants & perennials)

- Provides a safe and reliable supplement or replacement to natural light
- Improves the plant quality and uniformity
- Adjustable and controllable photoperiod to control the vegetative and reproductive growth of plants
- Fully utilizes greenhouse space and the production transportation line
- Effective heat management

Propagation (Tissue culture and seedlings, cuttings & young plants)

- Due to high luminous efficiency, high-power fluorescent lamps can be replaced
- Maintains uniformity of illumination and reduces distance between layers
- Light recipe achieves higher quality to fulfill plant growth needs
- Improves high-quality seeding rate and shortens the production cycle
- Effective heat management, saves on air conditioning costs and extends the service life of the electrical system

City Farming (Leafy vegetables & soft fruits)

- With high and stable yields, reduces production costs and continuously stabilizes supply
- Improves quality, nutrient content and flavor
- Shortens delivery time and provides fresh vegetables from a local supply
- Improves land use rate and increases the yield per unit area by multilayer cultivation
- Energy savings

Vegetables & Fruit (high wire vegetables, leafy vegetables, herbs & soft fruits)

- High wire vegetable production (cucumber and tomato) with interlighting
- Effectively complements natural light with a spectrum and light intensity combination designed to promote plant growth
- Stabilizes and improves plant quality and yield, enabling growers to increase their profits
- The scientifically designed illumination angle and light position allow plants to make maximum use of the light
- Interlighting among vegetables and flowers, by utilizing the low-heat characteristic of LED, to increase production
- Efficient use of energy can effectively reduce the electrical system load and energy costs and many more applications. Every day we are getting new experiences. If your application is not in the list, don't hesitate to contact us or our partner and hear what we can do for you.



Benefits of LEDs

Light is an important horticultural production tool and a key factor in plant research. LEDs (light-emitting diodes) are set to play a major role in horticultural lighting. With LED lighting, the growth light – spectral output – can be tuned, which makes it possible to apply the optimum 'light recipe' at every stage of a crop's growth. This capability, together with effective heat management, long lifetime, high luminous efficiency and energy efficiency, opens up tremendous opportunities for growers and breeders. For the commercial horticulture market this means increased yield, early flowering, faster (root) growth, and more economical use of space.

Philips can design a tailored LED growth light which is the most suitable for the growth of a particular plant. In addition, while producing light, LEDs generate less heat, making temperature control in the plant space easier and more economical. At the same time, LEDs can be installed near plants, to increase planting area in limited spaces.

LED lighting - bringing new opportunities to horticulture

Light spectrum

Provides the best 'light recipe' at each growth phase

Long lifetime

Reduces the need to replace lamps

Light intensity

Provides the illumination intensity that crops need

Energy efficiency

Lowers energy costs and helps protect the environment

Effective heat management

Enables greater control over the climate in the greenhouse or climate chamber and reduces the need for cooling

Robust

Dustproof and moisture-proof, and no risk of glass in your crops

High luminous efficiency

As LEDs produce only a little radiant heat, it is possible to position the light source close to the crop without burning the leaves

Optical design freedom

Since a LED is only a micro-chip, it fits easily into any application and can increase uniformity

Our products

Philips GreenPower LED research module



Philips GreenPower LED research module is specially designed for doing research with light. It allows the use of light as a tool to control plant growth and development. The module's dimming capability allows you to set exactly the level of light you require. It is available in white, red, blue and far-red versions. Red and blue are the most important colors for crop growth, while far-red (barely visible to the human eye) influences the development of specific plant characteristics. With modules in these four colors, it is now possible to apply the optimum light recipe at every stage of a crop's growth.

Philips GreenPower LED production module



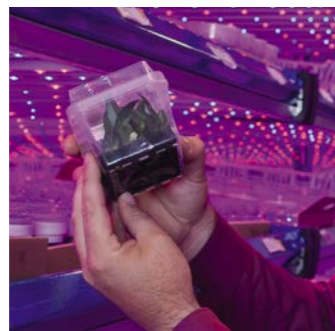
Philips GreenPower LED production module is specifically designed for multilayer cultivation in conditioned environments with little or no daylight. The module ($50-250 \mu\text{mol}/\text{m}^2/\text{s}$) can replace conventional fluorescent lighting, reducing energy consumption by up to 60%. Low radiative heat emission also allows the light source to be installed closer to the plants, thus improving space utilization. Several spectrum versions are available, so the light intensity and color ratio can be selected and reproduced.

Philips GreenPower LED flowering lamp



Philips GreenPower LED flowering lamp is the energy saving alternative for extending day length when cultivating, e.g. bedding plants, producing cuttings from chrysanthemums, kalanchoes and other plants sensitive to the photoperiod. It is also used to break the dormancy state of plants. Compared to traditional incandescent lamps, this flowering lamp saves up to 80% on energy costs. Based on successful field tests, Philips has developed three different lamps with specific light recipes for different plants.

Philips GreenPower LED string



Philips GreenPower LED string is used in tissue culture of Low light intensity ($5-30 \mu\text{mol}/\text{m}^2/\text{s}$) and in seedling storage. The flexible 20 m light belt can be arranged for long tissue-culture shelves. Red, blue, far-red, and white strings are available. Small lamps are connected by a flat-band cable. Even with shelf heights of up to 25 cm, the light distribution on the optical surface is guaranteed to be even. Thanks to LEDs characteristics of low power consumption and low heat, the GreenPower LED string offers significant energy savings.

Philips GreenPower LED interlighting module



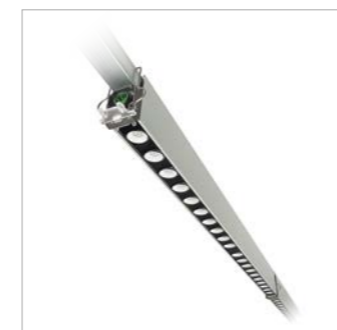
Philips GreenPower LED interlighting module is a unique bi-directional lighting module. It can be applied as an interlight supplement for tall plants (such as tomatoes, peppers, cucumbers and roses) in a greenhouse, encouraging previously shaded leaves to photosynthesize and stimulating the plant's growth potential and efficiency. The interlighting module has a specially designed aluminum shell with a length of 2.5 m. The combination of LED interlighting and HID creates a flexible lighting system. This results in more efficient plant production and considerable energy savings.

Philips GreenPower TLED



Philips GreenPower TLED ($25-100 \mu\text{mol}/\text{m}^2/\text{s}$) offers an extremely effective and efficient alternative in tissue culture to traditional fluorescent lamps, delivering energy savings up to 70% compared to fluorescent lighting. GreenPower TLED also improves tissue culture growth parameters, resulting in a higher multiplication factor, better rooting quality and a shortening of the total growth cycle. On top of energy savings these parameters brings more profit! To improve growth performance dedicated recipes are needed. GreenPower TLED is available in six different versions.

Philips GreenPower LED toplighting module



Philips GreenPower LED toplighting modules are a new step in realizing light recipes for crop growth in the greenhouse. The modules offer a wide variety of opportunities to increase your production and improve crop quality during the year. LED toplight modules can offer typical light levels ranging from typically $40-300 \mu\text{mol}/\text{m}^2/\text{s}$ in a highly efficient way. Finding your X-factors in crop growth and improving your business lead to more earnings than the energy savings only.



Case Studies

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25 Bailey Nurseries Inc.	34 Glenwood Valley Farms
26 Shanghai Dadi	35 Research
	35 Research institutes / Universities



Grower
Marjoland

Sector
Ornamental plant cultivation

Crop
Roses (Passion)

Location
Waddinxveen, the Netherlands

Solution
Philips GreenPower LED interlighting module

Results
Increased development and more efficient production



Philips GreenPower LED interlighting module

“Interlighting is good for the development of rose shoots.”



Marjoland is one of the most progressive nurseries in the rose world. Marjoland has been conducting tests with Philips for several years and has achieved good results with the interlighting of Passion roses with GreenPower LED modules. Several lighting variants were installed at Marjoland rose nursery in Waddinxveen. During the tests the LED modules were combined with HID lamps. The modules were positioned in the crop so as to also light the plant base, where the development of new shoots is

stimulated, and where the leaves that normally receive little light can now also actively take part in photosynthesis. One of the most important advantages of LED interlighting for roses is that faster shoot development can be achieved by using the spectrum and positioning intelligently. What was also found is that not only was more light introduced, but the plants handled the light, more efficiently. In this way the tests showed that the LEDs contribute to greener and more economical production.



Grower
Frank Amodio

Sector
Potted, Bedding Plants, and Perennials

Crop
Tuberous Begonia, Dragon Wing Begonia, New Guinea Impatiens

Location
South Salem, NY, USA

Solution
Philips GreenPower LED flowering lamps

Philips LED Horti Partner
Fred C. Gloeckner & Company Inc.

Results
Uniformity, Consistency, and early bloom time on all crops



Philips GreenPower LED flowering lamp

“Philips LED lights managed to save us time and money while improving our plant quality.”



Valley View sells high quality finished products to local retailers and landscapers. Beginning in early spring with crops like Hydrangea, moving into mid-season with annuals, perennials and nursery stock, then on to the fall production of Chrysanthemums and other late season crops, and finishing up with Poinsettias, Valley View runs a year-round operation. Additionally, Valley View is a rooting station supplying the Northeast region with rooted cuttings for the Winter months. Valley View installed Philips LED flowering lamps in certain areas of the greenhouses. Portions of the crops of non-stop Begonias (95%), Dragon Wing Begonias (25%) and New-Guinea Impatiens (20%) were placed

under the new lights to run a comparison of growth against the same types of plants not placed under the flowering lamps. The lights were a combination of Deep Red and White which were chosen specifically for the crops being grown. The lights were turned on automatically at 7 PM and shut off automatically at midnight during the growing phase of the crops. There were no other changes made in terms of substrate, fertilization, or irrigation during this trial. The begonia baskets and larger pots were lit until March 18th, the 4.5” pots were lit until March 25th. Frank planned the lighting schedule around their ‘market ready’ date, which for Valley View is early/mid May.



Grower
Maatschap Kreuk

Sector
Flower bulbs

Crop
Tulips

Location
Andijk, the Netherlands

Solution
Philips GreenPower LED production module

Philips LED Horti Partner
Van der Laan

Results
Efficient use of space through multilayer system. Improved plant quality and energy savings



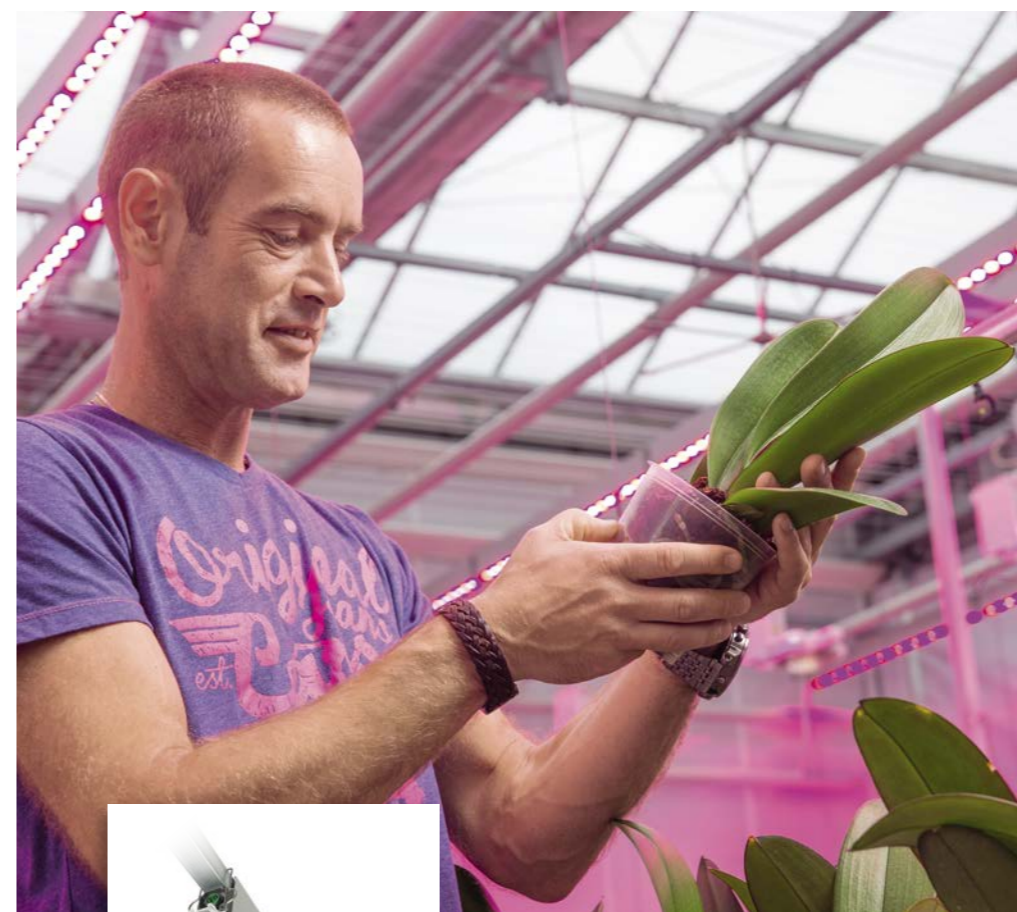
Philips GreenPower LED production module

“Efficient use of space through multilayer system, improved plant quality and energy savings.”



Maatschap Kreuk has a cultivated area of 3400 m² in a greenhouse covering 1500 m² due to their multilayer set up. About 9 million stems of cut flower tulips are produced. Kreuk's greenhouse now has three layers, the lowest one fitted with Philips GreenPower LED production modules, the deep red/white type. 'This light combination was selected because the red light provides excellent growth for the tulips while the white light increases visibility of the crops for the

employees. It has a clearly positive effect on the crop, the tulips have a deeper color green and greater elongation.' explains Kreuk. 'The operating costs per square meter are lower because LEDs have a much longer lifespan than a fluorescent solution. It also provides a tremendous difference in energy costs. One 35 W LED module replaces the normal situation with two fluorescent tubes of 58 W each. This represents electricity saving of 65%.'



Horticulturalist / grower
Ter Laak Orchids

Sector
Orchids, potted plants

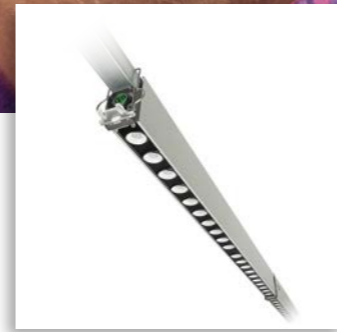
Crop
Phalaenopsis

Location
Wateringen, the Netherlands

Solution
Philips GreenPower LED toplighting module

Philips LED Horti Partner
Arend Sosef

Results
Keeping the number and quality of the branches and the growing period under LEDs at least the same as under HPS lighting. Both with a lighting level of 250 $\mu\text{mol/s/m}^2$



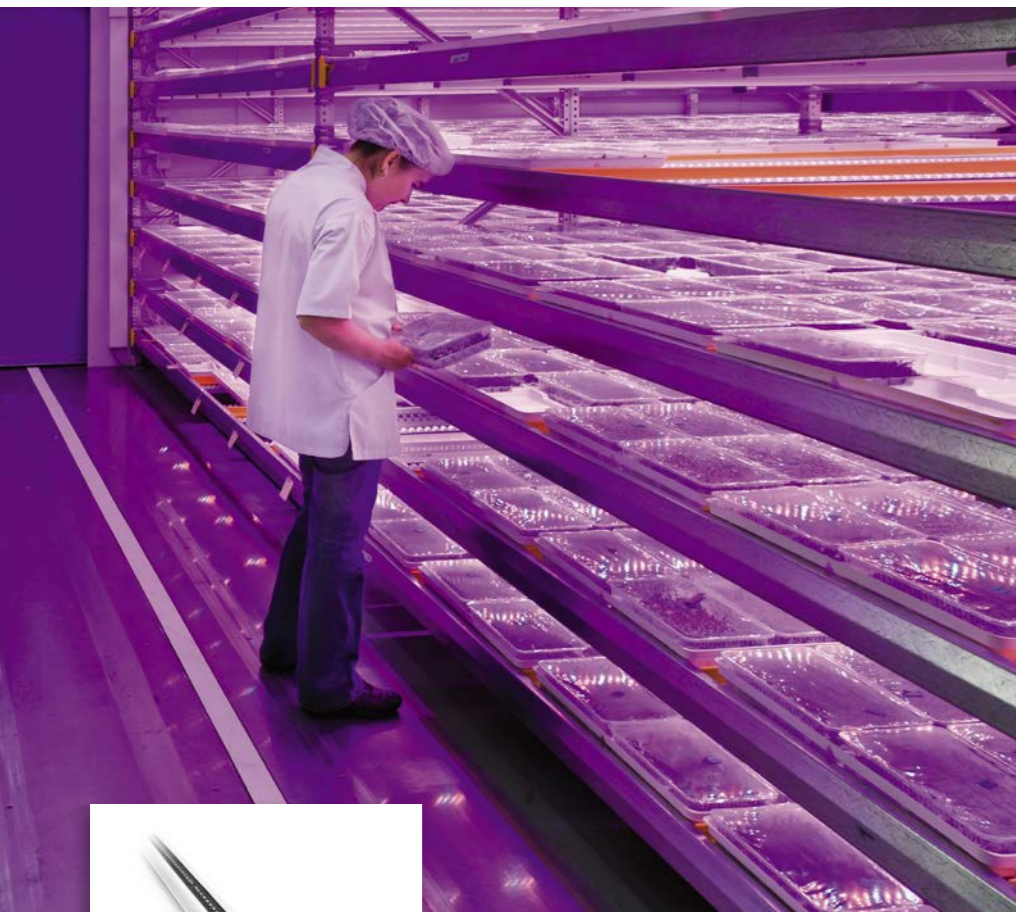
Philips GreenPower LED toplighting module

“Philips’ statement about providing only the light that a plant needs – the light recipe – really appealed to us.”



Ter Laak Orchids – owned by brothers Eduard and Richard ter Laak – have been working with orchids since 1980. Their modern pot-plant nursery in Wateringen covers an area of 78,500 m², with an extra 16,500 m² tier of cultivation above the processing area, and produces 4 million Phalaenopsis plants of pot size 12 cm every year. The use of LED toplighting was prompted by the increased need, at the dark time of year, for more efficient light to ensure healthy and constant plant growth. Thanks to their lower heat emission and the options they offer in terms of light spectrum, LEDs can make a significant contribution to this goal. Philips GreenPower LED toplighting modules are the next step in the development and application of light recipes for crop growth in the greenhouse. They offer considerable opportunities to increase production and

improve crop quality during the year. LED toplighting modules can offer light levels typically ranging from 40-300 $\mu\text{mol/m}^2/\text{s}$ in a highly efficient way. The plants in this project were grown in the greenhouse under HPS lighting and are being cooled in the trial greenhouses. On 5 November 2013 the plants were placed in the two separate compartments; the first day was also the first cooling day (necessary for branch induction). It is assumed that if the plants grow well in the LED-only compartment, there is not likely to be a problem in combination with HPS (hybrid) lighting. If this is the case, it will be possible to install efficient grow light in the form of LEDs in an existing situation. According to Ter Laak Orchids, the project will have been a success if the company can produce the same quality of plants using this configuration.



Grower
Vitro Plus

Sector
Tissue culture

Crop
Ferns

Location
Burgh-Haamstede, the Netherlands

Solution
Philips GreenPower LED production module

Results
Increased production by 33%, better plant quality and substantial savings on energy



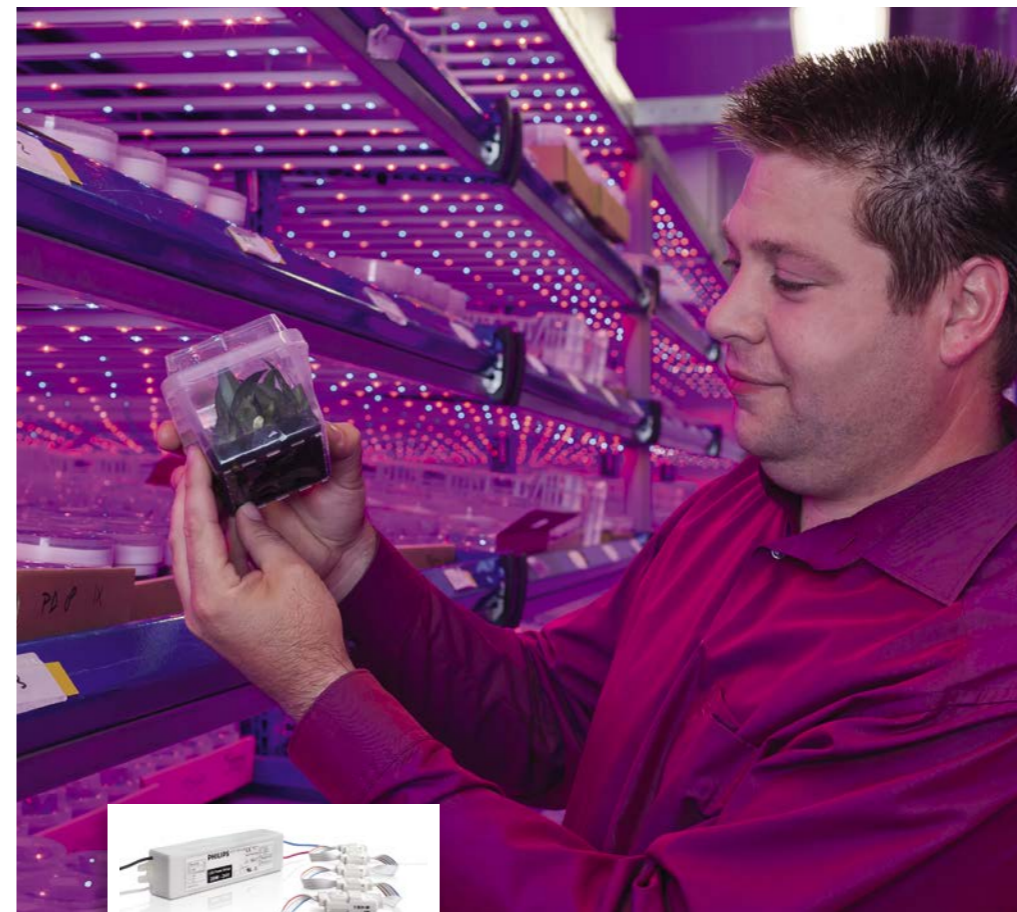
Philips GreenPower LED production module

“Fern propagator Vitro Plus convinced by added value of production-line LEDs.”



Vitro Plus is a fern propagation company, which is responsible for 70% of all ferns that are supplied to stores throughout the world. Using LEDs brings the distance between each shelf closer, and has enabled Vitro Plus to increase production by 33%. In addition to this, the company is making substantial savings on energy. This is partly because the LEDs consume significantly less energy than the fluorescent lighting previously used, but also because the substantially lower amount

of heat generated by the LEDs means less cooling is required. The quality of the tissue culture has improved as well. ‘We harden off 20,000 plants each week. The quality of the plant growth is constant. We are achieving much better results now than we did with conventional fluorescent lighting,’ said Ard. ‘The plants grow much faster and the growth is much bushier. The measurable results have convinced me that LED lighting is the future.’



Grower
Peerdeman Orchideeën

Sector
Tissue culture

Crop
Orchids

Location
Andijk, the Netherlands

Solution
Philips GreenPower LED string

Philips LED Horti Partner
Van der Laan

Results
Controlled plant development and savings on energy and space



Philips GreenPower LED string

“We have realized both energy savings and better space utilization in cultivation in layers.”



Peerdeman Orchideeën was the very first practical farm on which Philips tested LEDs on tissue cultivation. In the past 3 years the tests have resulted in excellent results. By varying light intensity and color ratio, the best recipe for the orchids was found. The company has now moved part of the process of young plant cultivation to a climate unit with LED light. This makes for a large reduction in energy consumption, better space utilization and eventually, perhaps,

possibilities for controlling plant development with light colors. Peerdeman says: ‘During the first test it was immediately evident that energy savings of 50% are possible compared with fluorescent lighting. In combination with the more efficient space utilization and good growth, this was the deciding factor when we were planning to build a new cultivation unit in Andijk. The choice between fluorescent and LEDs was soon made.’



Grower
Shanghai Xinghui Vegetable Group

Sector
Tissue Culture

Crop
Gerbera

Location
Shanghai, China

Solution
Philips GreenPower TLED

Result
Energy saving of more than 50%, and better control of environmental temperature



Philips GreenPower TLED

“The energy savings are incredible. We will continue testing in order to learn even more about the positive effects of LED on the plants.”



Shanghai Xinghui Vegetable Group is located in Fengxian District, Shanghai, adjacent to Hangzhou Bay. Xinghui is one of the four organic vegetable farms recognized by the city of Shanghai. The Group was named a Leading Organization in Adopting International Standard in Shanghai and a National Model Enterprise for Horticultural Product Exports. Xinghui has also obtained the ISO9001 and HACCP accreditation. The Group continues to innovatively improve horticulture technology, based on a development strategy centering on expansion in both domestic and foreign markets. The Group's Bio-Technology Center provides important technical support for the Group's progress, focusing on tissue cultures for flowers and nursery plants. The Center produces as many as 10 million plants

per year with its 10,000 m² tissue culture building and 10,000 m² greenhouse. Currently, the Center is focusing on Gerbera cultures. After initial meetings with Philips, Shanghai Xinghui Group's Bio-Technology Center expressed intense interest in Philips GreenPower TLED. The Group wanted to record and analyze a test of this technology for a given period, and evaluate the potential of adopting of this technology in all of the Center's tissue culture rooms. Gerbera is the primary product of Xinghui Group's Bio-Technology Center, so the Center performed the test in the Gerbera culture room. At the beginning of this year, Philips horticulture specialists assisted in installing and testing a considerable quantity of GreenPower TLEDs.



Grower
Bailey Nurseries Inc.

Sector
Young plants and cuttings

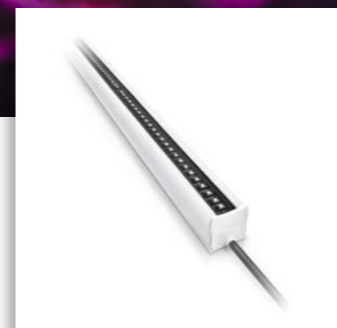
Crop
Multiple crops

Location
St. Paul, Minnesota, USA

Solution
Philips LED GreenPower production module

Philips LED Horti partner
Hort Americas, LLC

Results
Faster propagation, better plant quality, a higher success rate, and energy savings



Philips GreenPower LED production module

“A win-win for the nursery and our customers.”



With the shift from greenhouse to controlled environment increasing the scope for fall and winter production, the energy-saving potential of the GreenPower LED production modules is a significant asset. For most crops, the GreenPower LED production modules in the controlled environment of a growth room allowed better control of the plant growth cycle, compared with the greenhouse, resulting in higher rooting percentages. Quality improved drastically over the previous growing conditions, with more uniform and consistent growth, better roots and stronger plants. Lilacs in particular showed a much higher percentage of successfully rooted plants. Faster growth, shaving a week off the rooting schedule, was attributable to the combined effect of the LED lighting plus the climate and root zone management strategies. The LED

fixtures' lower level of heat generation also eliminated the need to apply additional water. In the winter time the LED lighting clearly freed up the grower: in the greenhouse these crops required hourly maintenance, whereas in the growth chamber the grower only needs to look at the crop once or twice a day. Jean Marc Versolato, from Bailey's Plant Health Department, enthused: 'I tested the GreenPower LED production modules this year. They do work! As an example, tissue culture lilacs rooted quickly and with minimum care under these lights. The result of this trial, amongst others, indicates to me that we will improve plant stand, reduce crop time, increase overall plant health, and also conserve energy during the winter months – a win-win for the nursery and our customers.'



Grower
Shanghai Mother Earth (Dadi) Gardening Seedling Co., Ltd.

Sector
Multilayer tissue culture production

Crop
Gerbera, Limonium Sinuatum, Hosta

Location
Shanghai, China

Solution
Philips GreenPower LED production module

Philips LED Horti partner
Hort Americas, LLC

Results
Stronger seedlings, higher rooting rate, and shorter rooting time



Philips GreenPower LED production module

“The plants cultivated with Philips GreenPower LED were stronger. Beside energy saving and low heat radiation, the unique light recipes for tissue culture from Philips really help the plants to have better and uniformed quality.”



After several rounds of experiments, plants grown under the Philips GreenPower LED production modules were more compact and had greener leaves than those grown under normal fluorescent lights, indicating that the plants cultivated with Philips GreenPower LED were stronger. For some plant varieties, the rooting rate, when cultivated under fluorescent lights, was not satisfactory, but increased dramatically when cultivated with Philips GreenPower LED lighting. Plant rooting times were reduced by 15% compared

with those under normal fluorescent lights, resulting in a shorter production period and increased production efficiency. Shanghai Dadi was very satisfied with these results, specifically the LED lighting's promotion of plant growth and the cooperation with the Philips horticultural LED lighting team. Cooperation between the two companies will continue in the hope of discovering more plant tissue culture applications that can be used in the large-scale industrial production of plant tissue cultures.



Grower
Delicious

Sector
Leafy vegetables/young plant production

Crop
Lettuce with root clump

Location
Venlo, the Netherlands

Solution
Philips GreenPower LED production module

Philips LED Horti Partner
Certhon
Lights Interaction Agro bv

Results
Efficient use of space due to multilayer cultivation, less water usage, increased and consistent plant quality



Philips GreenPower LED production module

“In-house propagation of lettuce plants in closed climate-controlled cell.”



Delicious, a modern lettuce production greenhouse founded by the two brothers Roy and Mark Delissen, wants to find a solution to have a more flexible production in the winter. The lettuce plants are now produced - in seven layers, one on top of the other - from lettuce seed to living lettuce in a special climate-controlled room 20 m wide, 4 m long and 8 m high. The Philips GreenPower production modules with the right light

recipe, were installed inside to ensure uniform growth. By using this new lighting formula Delicious is able to control the entire production process, from lettuce seed to fully-grown lettuce, and to minimize any adverse external effects on quality and origin. This makes it possible to produce more efficiently and enables the company to deliver lettuce of a consistent quality all year round in a reliable way.



Grower
LED4CROPS at Stockbridge Technology Centre (STC)

Sector
Research institute

Crop
Multiple crops

Location
Yorkshire, UK

Solution
Philips GreenPower LED production module and Philips GreenPower LED research module

Philips LED Horti partner
CambridgeHOK

Results
To deliver applied research and technology transfer to growers

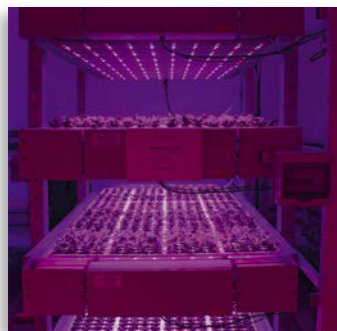


Philips GreenPower LED production and research module

“LED technology opens the door to the concept of urban farming.”

A number of factors are driving significant change in the world of food production. The idea of ‘sustainable intensification’ is a relatively simple concept aimed at maximizing production efficiency in terms of external resource input on the smallest necessary land area. LED technology can make a decisive contribution toward this goal. The STC board has invested in the development of an applied R&D facility, LED4CROPS, in partnership with Philips Lighting and Cambridge-HOK. The new LED4CROPS facility is housed within a 200 m² building and has over 40 benches with LED lights in a multitier array. This all to enable light spectrum adjustment and flexibility, for growing a range of low level

crops such as herbs, leafy salads, flowers, strawberries and plants in propagation. STC science director Dr Martin McPherson is enthusiastic: ‘LED technology opens the door to the concept of urban farming. You can grow crops in multi-storey warehouses, close to point of consumption’. LEDs will offer growers great flexibility, he adds. ‘You can schedule the crops. If you want to bring them on, you can do so. If you want to slow them down, you can reduce power.’ According to his colleague, STC CEO Graham Ward, the prospects for growers are bright: ‘A normal lettuce grower can produce five crops a year. With this system, we can grow fifteen’.



Grower
GreenQ Improvement Centre

Sector
Research/vegetable production

Crop
Tomato, Komeett

Location
Bleiswijk, the Netherlands

Solution
Philips GreenPower LED interlighting and toplighting module

Philips LED Horti Partner
Certhon

Results
Positive effect on overall development and increased production



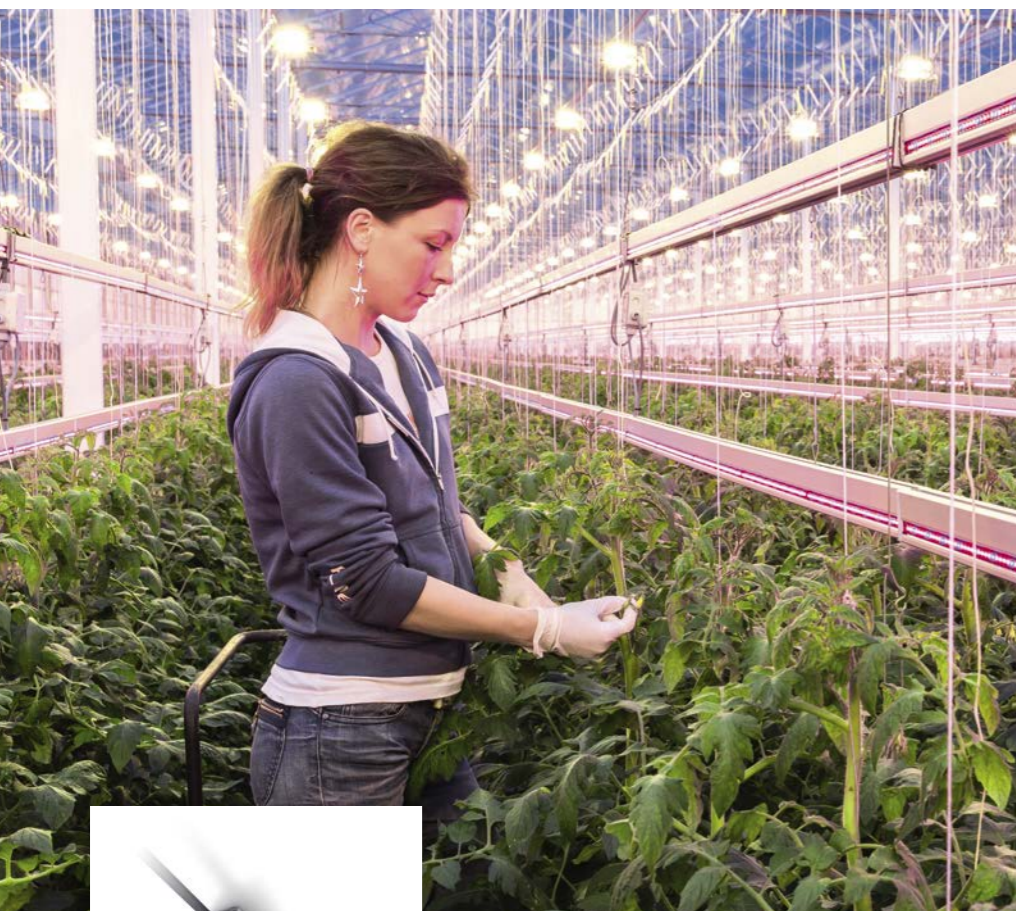
Philips GreenPower LED interlighting and toplighting module

“GreenQ Improvement Centre achieving impressive results with interlighting for tomatoes.”

GreenQ Improvement Centre is a modern greenhouse complex in which new cultivation concepts and technical installations from all over the world are developed, tested and demonstrated. Last year the objective of the cultivation was to harvest 79 kg of tomatoes per m² with an energy reduction of 30%. The setup is comparable to those used by tomato growers that use lighting in practice. This year the test again shows that LED lighting in the crop has a positive effect on fruit weight and total production. The energy saving achieved during the winter period is largely due to

the intelligent use of the LED lighting in combination with the HID lighting. Interlighting with LEDs helps to supplement the light requirement deeper in the crop and in this way bring the entire crop to higher production. As a member of the supervisory committee, grower Robert Zwinkels commented ‘The results have pleasantly surprised me. The LED light was used 30 to 40% more efficiently than if we had used extra HID lamps. That resulted in quite a few extra kilos.’





Grower
Van Nature / Jami VOF

Sector
Vegetable production

Crop
Tomato, Komeett

Location
Bergschenhoek, the Netherlands

Solution
Philips GreenPower LED interlighting module in combination with Philips GreenPower/Vision HID 1000 W Plus

Philips LED Horti Partner
Lights Interaction Agro b.v.

Results
Increase in production, especially rise in winter production



Philips GreenPower LED interlighting module

“We feel that this system is the future and that it will contribute to our enterprise's yield.”



Jami VOF, a member of growers association Van Nature, will light 3 hectare of its tomato crop with a hybrid lighting system from Philips. The hybrid lighting system consists of a combination of Philips GreenPower Plus 1000 W top lighting (HID) and Philips GreenPower LED interlighting module. This combination is ideal both for the plant and the eventual operating profit. Because in this way the temperature can be kept at the correct level even in the cold months, and optimal tomato production can be achieved in every season. Tests with the hybrid system

have demonstrated that it can increase production by means of more efficient light absorption. With LEDs you get about 1.46 times greater efficiency than with HID. Particularly in the winter months this provides the plant with better growing conditions. 'Another reason why we are very enthusiastic is the system's energy efficiency. So the Philips hybrid system is the ideal solution for us,' says Michel Zwinkels.



Grower
Melrow Salads / Flavourfresh Salads

Sector
Greenhouse production

Crop
Tomato

Location
Landsdale Nursery, United Kingdom

Solution
Philips GreenPower LED toplighting and interlighting module

Philips LED Horti Partner
Cambridge HOK

Results
Achieving a high production of healthy and tasty locally grown tomatoes using energy-efficient lighting



Philips GreenPower LED toplighting and interlighting module

“This lighting installation will allow us to extend the UK season, improving consistency in flavour and increasing the yield of speciality tomatoes.”



Lancashire-based Melrow Salads has a recognized track record of varietal development and trialling of crop production technologies. They are recognized as a leading supplier of protected salads to the retail and processing industries. There has been contact between Philips and the Flavourfresh Salads Landsdale Nursery site in Lancashire for several years. After visiting the 3 ha project of Jami in Bergschenhoek, Netherlands, they were convinced about the potential benefits of LED interlighting. As far as toplighting is concerned most of the greenhouses in the UK have lower ceilings than those in the

Netherlands, so HPS lighting is not always an option. Addressing this issue, Melrow Salads is trialling the Philips hybrid LED top/interlighting system on a small cherry-type tomato cultivar (30-35 gr fruit weight) at Flavourfresh Salads' Landsdale Nursery site the 2013/2014 winter. The aim is to learn about the opportunities and potential to extend the season, improve consistency in flavour and increase the yield of speciality tomatoes. After two days of 'hybrid-lighting' the plant already looked stronger, with darker leaves, more purple anthocyanin in the head, and a stronger truss.

**Grower**

Alfred Pedersen & Søn ApS (Pedersen)

Sector

Greenhouse production

Crop

Piccolo tomatoes

Location

Denmark

Solution

Philips GreenPower LED interlighting module in combination with Philips GreenPower/Vision HID 1000 W Plus

Results

In winter production – improved yield, faster ripening and increased fruit weight



Philips GreenPower LED interlighting module

“Within two weeks of starting to use the LEDs we saw production increase. Two fruits more per truss, faster ripening and higher fruit weight.”



Alfred Pedersen & Søn ApS is the biggest tomato grower in Denmark and sells mainly to Danish retailers. In total, the company grows five different product types: loose round, large plum, cherry on the vine, mini plum on the vine, and snack tomatoes. Pedersen has 12 hectares of tomatoes in total, and each type has its own specific growth requirements. The company is well known for always being at the forefront of innovation. In February 2013 it installed, together with Philips, a hybrid system which combines their existing HPS (High Pressure Sodium) system with new Philips GreenPower LED interlighting modules.

In addition to the increased yield during winter months, Pedersen is also set to increase production in the summer, using the LED lights for only a couple of hours in the morning. This seems to be an effective way of activating the crop while being economical with energy, and Pedersen is very happy with the results so far. As the cooperation between Pedersen and Philips continues, it is expected that the two companies and other greenhouse growers will benefit more and more from these hybrid systems in the near future.

**Grower**

Alain Lutz

Sector

Fruit cultivation

Crop

Strawberry

Location

Melsele, Belgium

Solution

Philips GreenPower LED flowering lamp

Results

The LED flowering lamp proves to be ideal successor to (cyclic) incandescent lamp



Philips GreenPower LED flowering lamp

“The improved results and low energy consumption compensate for the higher purchase price of the flowering lamp.”



Incandescent lamps are now being phased out so strawberry growers are having to find an alternative solution. Lutz chose the Philips GreenPower LED Flowering lamps to illuminate his 10,000 m² of strawberries. The installation was supplied by Mais and installed by Elektravon Haket. Lutz grows an early variety of strawberries and therefore uses the type of flowering lamp with a spectrum made up of deep red, white and far red. He chose this type of lamp because tests carried out on it at a number of trials showed that far red is essential to ensure good stem elongation. The specific type of LED flowering lamp with the spectrum combination that includes

far red clearly produces the desired stem elongation, and even makes it possible to achieve a higher yield of early strawberries with a low percentage of malformed fruit. Apart from being good for the plants, the flowering lamps are also much more energy efficient. They deliver an energy savings of 82-85% compared to the incandescent lamp. It was also very important to him that the light from the lamps was white, and not red or purple. This means that people can also work under this light and the light people see from outside the greenhouse is in keeping with their expectations.



Grower
Glenwood Valley Farms

Sector
High-wire crop

Crop
Mini-cucumbers

Location
Langley, British Columbia, Canada

Solution
Philips GreenPower LED interlighting module

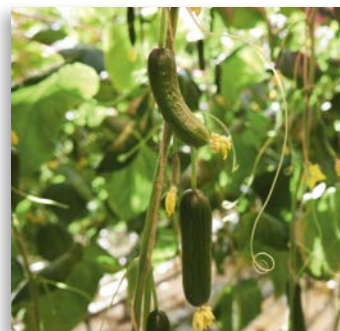
Philips LED Horti Partner
CLP

Results
Faster maturation and slightly larger fruits resulting in higher production



Philips GreenPower LED interlighting module

“We’re very happy with the LED trial results, they were above expectation. I’m thinking about going for the full LED lighting system in the future.”



Glenwood Valley Farms are established greenhouse growers of hand-picked, locally grown vegetables. The company has 14.5 acres of greenhouse in Langley, Canada, growing Long English cucumbers, mini-cucumbers, eggplants, and a variety of peppers. The average increase in production of the LED treatment was 19% (kg/m²), while adding only 8% extra light. This indicates that highly efficient use is made of the LED light. The extra production could be seen in faster maturation of the fruits and slightly larger fruits. Also, the positioning and size of the leaves were different: the leaves in the LED trial group were darker and smaller, and

they were also positioned less horizontally, and facing more towards the LEDs. At the end of the crop cycle it could be seen that much energy was given by the crop. The grower thinks that more can be realized when irrigation and climate can be optimally controlled for this crop. Tests with hybrid systems such as the Glenwood Valley system have shown an increased production by means of more efficient light absorption. Particularly in the winter months this provides the plant with better growing conditions. But also in the summer there are opportunities of keeping a crop under control.



Universities and Institutes
Wageningen University (WUR)
Utrecht University
Radboud University Nijmegen
Hasselt University
Groningen University

Sector
Research

Crop
Multiple crops

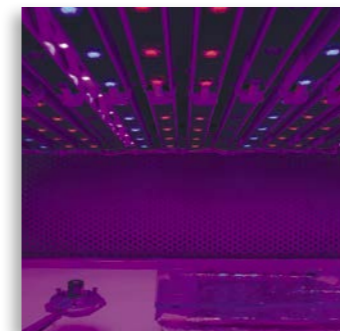
Location
The Netherlands and Belgium

Solution
Philips GreenPower LED research and production module



Philips GreenPower LED research and production module

“The GreenPower LEDs offer great controllability and freedom to our tests.”



Philips has been closely cooperating with the world’s top universities and research institutes. In Europe, Philips not only jointly develops light recipes with agricultural universities and research institutions, but also provides these institutions with high-quality lighting solutions for scientific research. Wageningen University, Utrecht University and Hasselt University are some good examples. Wageningen University and its Research Center enjoy a very high reputation in the global field of agricultural research. Dr. Wim van Leperen from Wageningen University commented the cooperation with Philips like this ‘The nature of our research projects

determine the high demand we have for our light sources. We need reliable, high-quality and convenient light sources, while horticulture lighting solutions provided by Philips meet all our needs. The GreenPower LEDs offer great controllability and freedom to our tests.’ Utrecht University also installed Philips LED lighting modules in its new climate room, aimed to achieve uniformed light distribution. Hasselt University, after cooperating with Philips on tests, decided to install Philips LEDs in its two new climate rooms. These two climate rooms were built to provide for students to research light and plant morphology.



Our network

PHILIPS

LED Horti Partner

Of course, we don't do everything on our own. We work with reputable partners that have specialist experience. Philips supports its certified partners in commercial projects and field tests to find new light recipes for a wide variety of crops and applications. These partners are exclusively trained by Philips in the field of LED lighting in horticulture. This is done by our plant physiologists, for light recipes, and application engineers, for the design and supervision of projects. Our valuable experience of light plans and our installation know-how are shared with our certified partners as well. This provides them with the necessary knowledge to realize LED solutions together with Philips.

This innovative partnership program creates a worldwide network and allows growers to work with a certified partner in their own region – a partner who is trained in engineering, light recipes and programs to deliver the best results. This unique cooperation between growers, partners and Philips guarantees the best possible light solution for every growth situation.

Depending on your preference, you can connect to:

- Philips LED Horti Partners; certified Philips LED Horti Partners, trained in engineering, light recipes and programs. Linked to Philips technical specialists and/or account managers.
- Complementary Partners; business/plant recipe partners who have earned our trust in joint projects in specific areas.
- Philips account managers or plant specialists.



Complementary services

Anyone who goes into partnership with Philips gets much more than just a product. Philips offers know-how and support. Our plant physiologists and application specialists know the best approach for your specific situation, and every plant gets a unique light recipe. And not only that: Philips takes work off your hands by providing support during the subsidy application process, and after-care in the form of answers to technical and botanical questions, light measurements, and help if you are experiencing problems with the installation.

We can even support you with our financing solutions. In these times when it can sometimes be difficult to obtain financing, we can offer Philips Lighting Capital. We understand better than anyone just how important it is to invest in new technology. It is the only way to stay ahead of the competition. Thanks to Philips Lighting Capital, you can benefit from innovative lighting straight away, without having to make substantial investments in advance.

Philips Lighting Capital is a cash-flow-friendly solution. It has been developed specifically to ensure growers have

access to the proven advantages of state-of-the-art lighting solutions, without having to make hefty investments upfront. The total cost of the lighting plus the installation cost are added together and spread over a period of three or five years, for example.

This means you pay a fixed sum each month until the entire project has been paid off. In the meantime, you benefit from the many advantages of the light recipe, such as energy savings, efficient use of space, and better and more consistent plant quality.

PHILIPS LIGHTING CAPITAL



For more information about Philips horticulture visit:

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