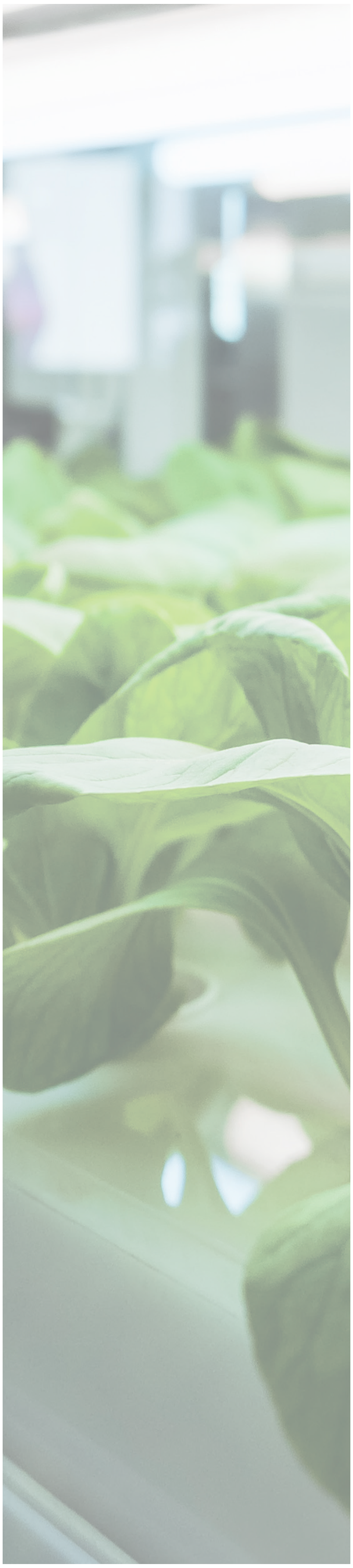
WHY USE LED?



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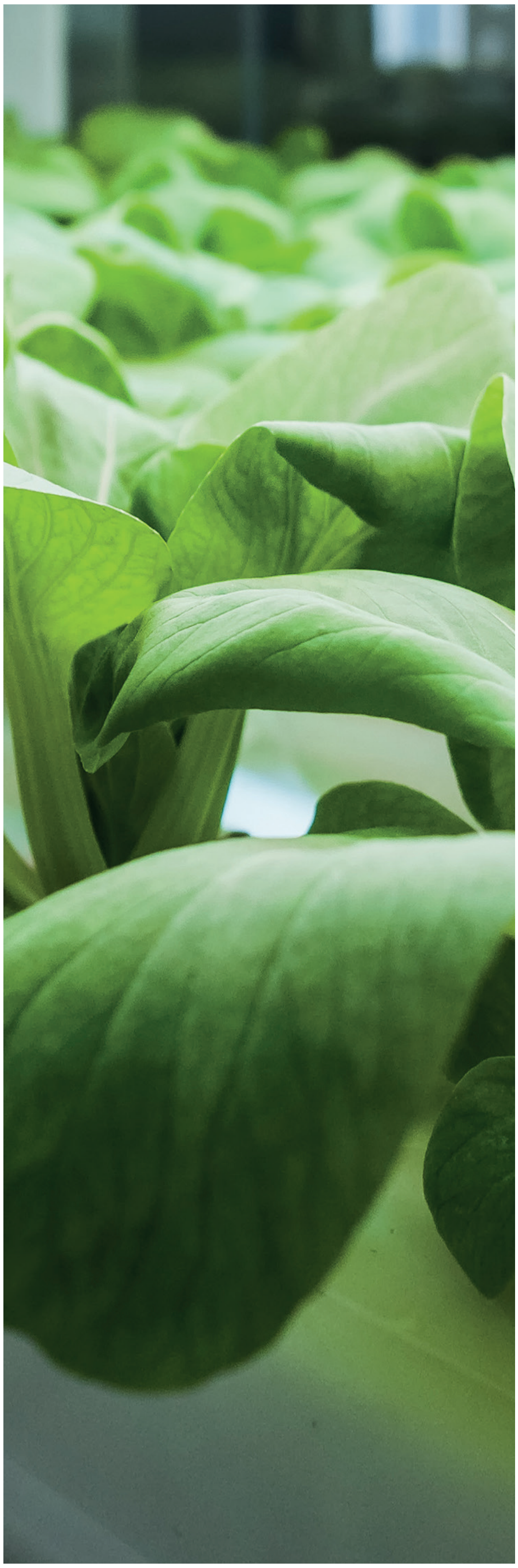
Lighting is in our culture



THE FUNDAMENTAL REASONING BEHIND THE USE OF GROW LIGHTS - COMMUNITY CONCERNS

NOURISHING OUR PLANET AND ITS PEOPLE

In the last 50 years, our world population has more than doubled, reaching 7 billion people in 2018, and is projected to increase to over 9 billion by the year 2050.

In order to successfully sustain our growing population, a 60% expansion in food production is essential. The following tactics will need to be implemented:

- These increases need to be accomplished without disregarding the importance of not bringing about more damage to our environment through deforestation, irrigation issues, destruction by pollutants, soil degradation, over-fertilization and waste.
- To allow for an increase in food production, additional arable land is essential. Currently, about 80% of the world's agricultural land suffers from mild to severe soil erosion due to natural occurrences and exploitation by man.
- The production of supplemental crops for consumption by both humans and animals.

Boost crop yield while keeping our environment's protection in the forefront.

INCREASE AGRICULTURAL STIPULATIONS

Urban area population growth

Additional stipulations:

- Organic crop production
- Local horticulture
- Fresh produce

Practice horticulture in areas not conducive to conventional farming practices.

The US Department of Agriculture has appraised the Horticulture field at a present worth of 300 billion dollars

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THE FUNDAMENTAL REASONING BEHIND THE USE OF GROW LIGHTS - THE PROGRESSION OF PHOTOSYNTHESIS

Photosynthesis: Plants possess the capability of transforming light energy into chemical energy by converting the sun's energy, oxygen and H2O into glucose to use as their own food source.

Carbon dioxide is taken in from the atmosphere through the stomata (minute pores in the epidermis of plant leaves) and oxygen is then released as a waste product.

Mesophyll, meaning, « middle leaf », are the layers found in plant leaves where the greatest amount of photosynthesis takes place.

Mesophyll cells are located beneath the upper epidermis where chloroplast cells are found, which is where photosynthesis occurs.

For photosynthesis to take place, allowing for stimulation of plant growth, light is essential.

A green pigment, Chlorophyll, which resides mostly in the chloroplasts, is an essential part of the photosynthesis process, allowing plants to absorb energy from light. Chlorophyll is also what gives leaves their green color through the absorption of blue and red wavelengths of light.

CHLOROPHYLL PIGMENTS, THE PRIMARY PIGMENTS ALLOWING PLANTS TO ABSORB ENERGY FROM LIGHT

PIGMENTS IN PHOTOSYNTHESIS

While both Chlorophyll A and B absorb different color light wavelengths, their ability to convert that light into energy makes them essential for photosynthesis to occur.

ß-carotene or Beta-carotene, a class of carotenoids, is an accessory light-absorbing pigment in the photosynthesis process as well as a photoprotective agent. This allows plants an extended range of light absorption in addition to being better able to manage molecular damage caused by sunlight.

PLANT LEAVES' SUPPLEMENTAL LIGHT-ABSORBING PIGMENTS

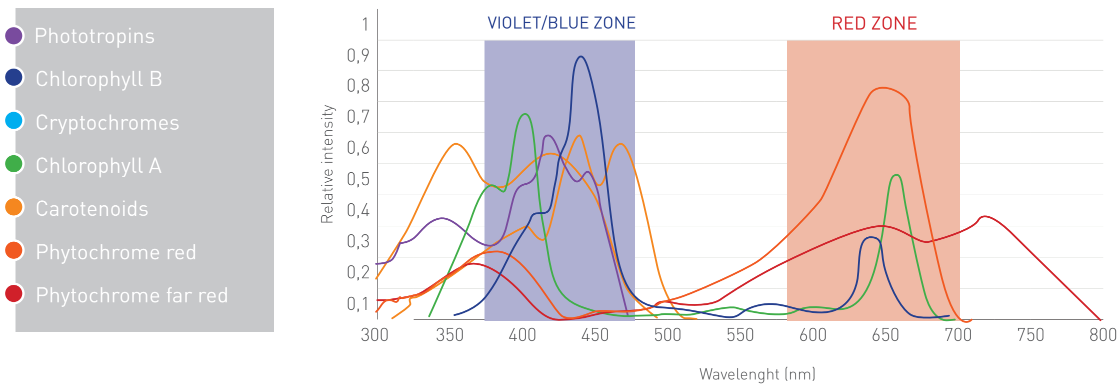
Phytochrome pigments' response to red and far-red light ratio regulates photomorphogenic aspects of plant growth and development, sensing the intensity, duration, color and level of environmental light in order to adjust their physiology. The internal clock, or circadian clock, of a plant is essentially regulated through the phytochrome system. This system is also responsible for shade avoidance by being able to detect and respond to any impending threat of shade so it can alter its growth plan accordingly.

Absorption spectrum: All dominant pigments absorb violet-blue wavelengths (400-470nm). Chlorophyll, being the most abundant pigment found in plants, and phytochrome, absorb red wavelengths (645-750nm).

Phototropins are also accessories to stomatal opening and leaf expansion as some of their roles.

Cryptochromes are also vital to plant growth and development. They are accessories to root growth through their role in the stomatal opening of the plant.

Absorption of light by plant pigments



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THE BENEFITS OF ARTIFICIAL LIGHTING

WHAT IF SUNLIGHT IS LACKING? USE ARTIFICIAL LIGHT (GROW LIGHT)

The entirety of light wavelengths needed for plants to grow is supplied by the sun's spectrum.

To control and enhance plant growth, artificial lighting is used to make up for insufficient natural light.

There are several uses for artificial grow lights:

- Photoperiod lighting: photoperiodism is an important component in the growth and flowering of a wide array of plants. Photoperiod lighting allows for plant photoperiod stimulation response by either lengthening or shortening light duration.
- Supplemental lighting: provides a supplement to sunlight, in greenhouses, when available hours of daylight are low during extended periods of time and insufficient for plant growth such as during the winter season or in countries further north.
- Replacement lighting: when natural light is not available - provides an alternative to sunlight for indoor farming.

GROW LIGHT SYSTEM OPTIONS

CULTIVATION PHASE

- Germination & vegetative phase
- Flowering & fruiting phase

PLANT TYPE

PHOTOPERIOD

- Long day plants
- Short day plants
- Day neutral plants

EXIGENCIES OF GROW LIGHT

- Spectrum range
- Light intensity
- Light duration
- Luminous efficiency
- Color temperature

Various elements require consideration when selecting the most advantageous grow light system.

VARIOUS APPLICATIONS OF GROW LIGHTS

GREENHOUSE

INDOOR / VERTICAL FARMING

MULTILAYER CULTIVATION

Horticultural lighting applications

INTER LIGHTING

STADIUM
LAWN MAINTENANCE

HOME FARMING

INCREASE HIGH-VALUE CROPS!

BENEFICIAL FOR URBAN AGRICULTURE!

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LEDS VS. ALTERNATIVE ARTIFICIAL LIGHT SOURCES

HPS (High Pressure Sodium), MH (Metal Halide) and CFL (Compact Fluorescent Lights) are three types of alternative artificial grow lights that don't tend to match the pigment absorption spectra that is part of the photosynthesis process.

LEDs are considered highly efficient compared to other grow lights as they allow for minimal wasted energy, from lights not having been absorbed by plants, due to the capability for growers to use a customized light spectrum most beneficial to the plants. Lower wasted energy/light means lower electrical bills.

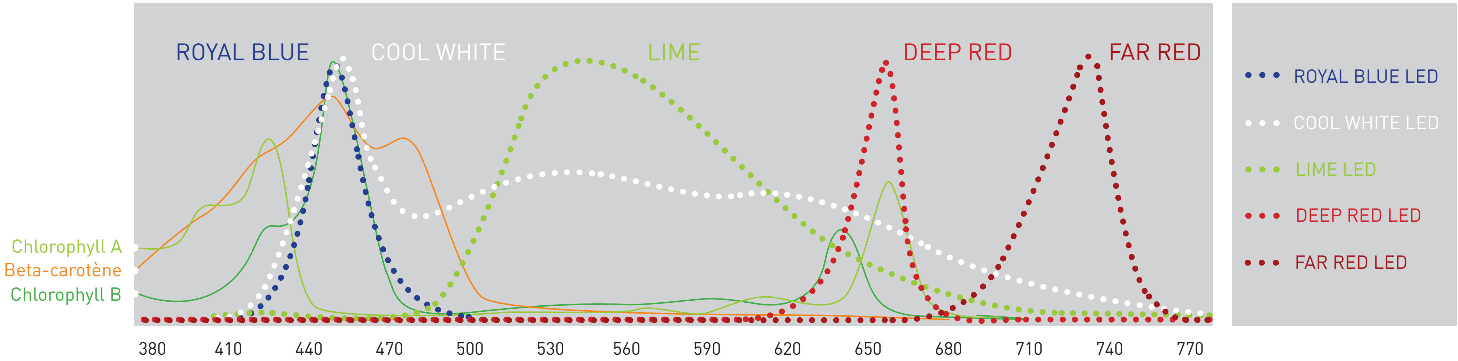
Growers using LEDs are able to pick the spectrums of light they need for optimum results based on the plant pigment wavelength absorption and the stages of plant growth.

LEDs as light sources in an indoor grow space are more suitable than other grow lights, such as HPS, MH and CFL, whose peak emissions broadly vary from the plants' absorption spectrum while LEDs supply full spectrum emission.

Recognizing LED technology for it's botanical superiority, the horticulture industry is at a great advantage.

Growth lights & Pigments

LEDs emit wavelengths that correspond perfectly to the plant's key pigment absorption peaks.



LIGHTING SOURCES - DIFFERENCES

Comparaison of light sources

	Wavelength control	Dimming	Heat	Price	Energy consumption	Environemental aspect	Lifetime
Fluorescent	Not suitable or not performed	Good compliance	Good compliance	Good compliance	Good compliance	Not suitable or not performed	Could be improved
Metal Halide	Not suitable or not performed	Not suitable or not performed	Not suitable or not performed	Could be improved	Not suitable or not performed	Not suitable or not performed	Could be improved
HPS	Not suitable or not performed	Not suitable or not performed	Not suitable or not performed	Could be improved	Not suitable or not performed	Not suitable or not performed	Could be improved
LEDs	Good compliance	Good compliance	Could be improved	Could be improved	Good compliance	Good compliance	Good compliance

Legend : Good compliance - Could be improved - Not suitable or not performed

LED grow lights tend to be more expensive initially, however they may be less expensive over time as they do not need to be replaced as often as traditional lights.

Only being able to provide a single color spectrum, both MH and HPS grow lights generate elevated amounts of heat while also maintaining significant surface temperatures.

All bulbs, aside from LEDs, contain mercury and must be disposed of carefully to prevent toxic leakage. LEDs do not contain any mercury at all, nor any other toxic gasses.

The heat generated by LEDs needs to be efficiently transferred through a conductive thermal transfer path. The LED luminaire must be designed with optimal thermal management critical to ensuring that the desired operating performance maintains long term stability.

Wavelength customization, reduced energy consumption, more environmentally friendly, and low maintenance are some of the key benefits of using LEDs instead of other grow lights.

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