
LED
INDUSTRIAL GROUP
Let light motivate your flowers

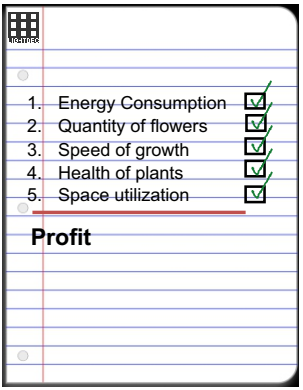
LightDec Horticulture

> “Light recipes from LEDIG are the best in this market. Their recommendations increased my profits in year one by 23%”

LED Solutions from LEDIG

LED Industrial Group (LEDIG) is a member of LIGHTDEC. Having completed a large number of projects we have many years of experience in LEDs (light-emitting diodes) including on a range of plants. In every project we are on the lookout for the optimum lighting guide. A lighting guide is an instruction based on knowledge of how to use light to grow a certain flowers under certain conditions. It indicates:

- Lighting aspects: intensity, spectrum, position and duration
- Parameters for which the guide is valid
- Expected results



German Technology

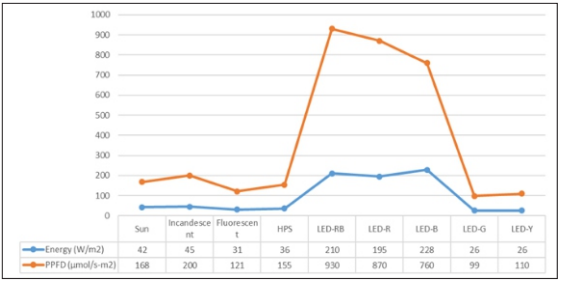
www.ledindustrialgroup.com

Why LED Lighting?

Even if the artificial lighting is as bright as for the human perception, there is a significant difference observed for plants depending on the lights used. As bright as 10.000 lux and in the same conditions, the extent of what plants perceive of LED lighting for growing is several times more effective than with a simple light bulb or a fluorescent lamp.

Concerning photosynthesis application, LED lighting makes it possible to achieve maximum efficiency by just using a narrow wavelength. LED lighting on plants is therefore a successful and valuable necessity.

With LED lighting from LEDIG the grow light can be tuned, which makes it possible to apply the optimum light at the right spectrum duration and intensity. 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.



	Sun	Incandescent	Fluorescent	HPS	LED-RB	LED-R	LED-B	LED-G	LED-Y
Energy (W/m2)	42	45	31	36	210	195	228	26	26
PPFD (µmol/s-m2)	168	200	121	155	930	870	760	99	110

Differences between classic lighting and LED lighting

LEDIG designs 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.

Benefits of LEDs

Spectrum
Provides the best combination at each growth phase

Light intensity
Provides the illumination intensity that plants need

Effective heat management
LEDs produce only a little radiant heat which enables greater control over the climate in the greenhouse or climate chamber and reduces the need for cooling

Energy costs
LEDs use much less electricity

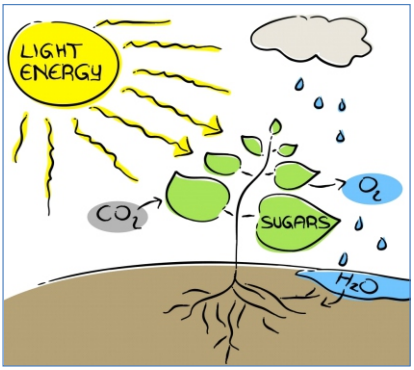
Long lifetime
LEDs much longer than traditional light products

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

Optical design freedom
Since a LED is only a micro-chip, it fits easily into any application

Light is essential

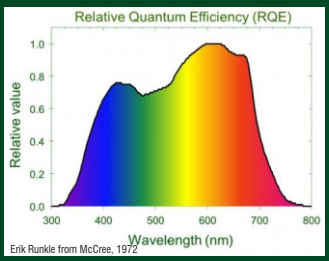
Light is essential for plant growth



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.

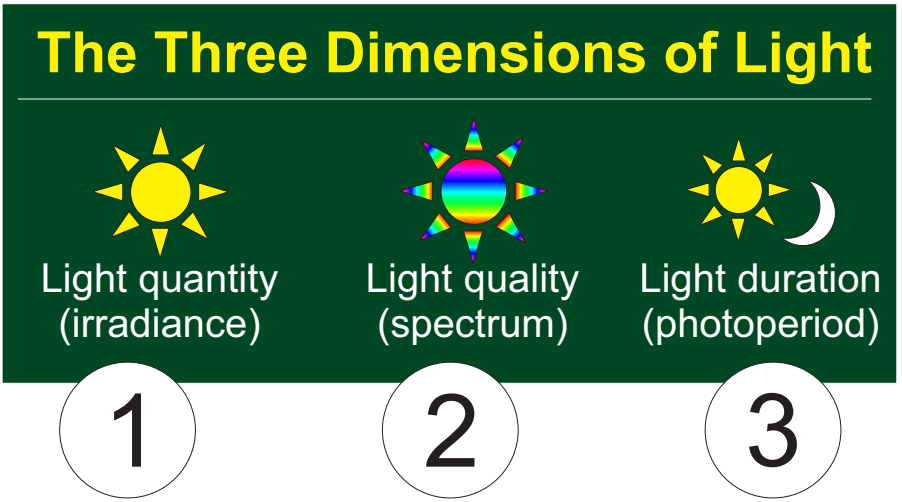
Plant sensitivity curve for growth light



Erik Runkle from McCree, 1972

The only part of the global radiation spectrum which can be used by a plant for its photosynthesis is between 400-780 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 (CO2) and water, which are taken up by leaves and roots.

Light Recipes



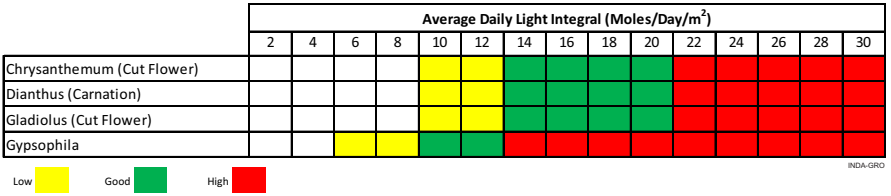
Light intensity
The growth of a plant is strongly determined by the total number of photons that it absorbs in the PAR region. In winter there is often too little natural light for plants to grow and continue to produce good flowers and fruits.

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

Duration
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 (short day plants). However when you apply long day light to them, the flowering will be suppressed.

Light Quantity 1

Light intensity or light quantity refers to the total amount of light that plants receive. It is also described as the degree of brightness that a plant is exposed to. High light intensity means it is brighter compared to low light intensity. Some terms that are used with reference to light intensity are open or full sun, partial sun or partial shade, and closed or dense shade.



Light is an absolute requirement for plant growth and development. However, different plants have optimum requirements and both deficient and excessive light intensities are injurious. During summer when light supply is abundant and almost continuous in Alaska, potatoes and cabbages of enormous sizes have been produced.

Deficient light intensities tend to reduce plant growth, development and yield. This is because low amount of solar energy restricts the rate of photosynthesis. Likewise, excessive light intensity should be avoided. It can scorch the leaves and reduce crop yields.

The unit of light intensity for plant responses is μmol m-2s-1. It describes the number of photons of light within the photosynthetic waveband that an area of 1 sq meter receives per second. The daily light integral (DLI) measures the number of photosynthetically active photons (photons in the PAR range) accumulated in a square meter over the course of a day.

Speed of growth or number of flowers?

Example: by using LED lights from LightDec for almost 20 hours during rooting promoted the rate of development until the visible bud stage. Giving then a lower light treatment after rooting significantly increased the leaf numbers, and number of flowering shoots in the plants.

LED recipe A

Percent rooting week 2	34%
Percent rooting week 3	94%
Days to visible bud	26
Days to first open flower	46

Start LED recipe B after rooting

Length of main shoot	103
No. of nodes to first open flower	28
No. of lateral flowering shoots	16

Spectrum 2

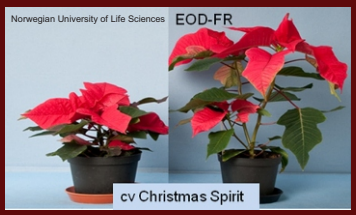
Light is vital to a plant's growth and survival. Chlorophyll in the plant foliage absorbs light to provide energy for all of the plant's needs. Flowering plants use the full spectrum of visible light, but some wavelengths are more important than others. The right light spectrum, light intensity and light duration all work together to trigger plant flowering, growth and reproduction. Different wavelengths are used for specific plant functions, but all wavelengths in this range are absorbed in varying amounts.

Effect of LED light on plant growth

Category	Plant	Radiation	Effect on growth
Vegetable	Lettuce	RBW	Increased nutritional value and growth
	Basil	B	Increased amount of essential oil
	White mustard, Spinach, Green	R + W	Increased vitamin C content
	Sweet pepper	R + Fr	Far Red light increased plant height with higher biomass
Flower	Marigold	R	Increased dry weight of seedlings
		B	Increased stem length
	Crown of thorns	B; R + Fr; B + Fr	Stimulated flowering
	Petunia, Snapdragon	R + Fr	Promoted flowering
Fruit	Tomato	B	Increased fruit yield, improved quality and disease resistance

(Abbreviations: R=Red LEDs, B=Blue LEDs, W=White LEDs, G=Green LEDs, Fr=Far red LEDs) University of California Spring 2016

Far red LEDs



Effect of using far red LEDs from LightDec for 30 min end of day treatment for 11 weeks.

Duration 3

Light duration is important, especially during the blooming period. For indoor plant growth under artificial lights, a minimum 12 to 14 hours of light per day is usually needed. Darkness is important to allow the plant to rest and trigger the flowering response. Some flowering plants, known as short day plants, need long periods of darkness to bloom. Short day plants such as poinsettias and chrysanthemums bloom in the spring when days are shorter and nights are longer. Long day plants, such as carnations and hibiscus flower at the end of summer when days are long and nights are short. Day neutral plants bloom without regard to the length of darkness, but usually do best with longer light durations.

Cosmos is a short-day plant is shown here received 0, 5, 10, 15, 20, 25, or 30 inductive short days before being placed under non-inductive long days. Photo provided by Ryan Warner, Michigan State University.

Tailored Light Recipes

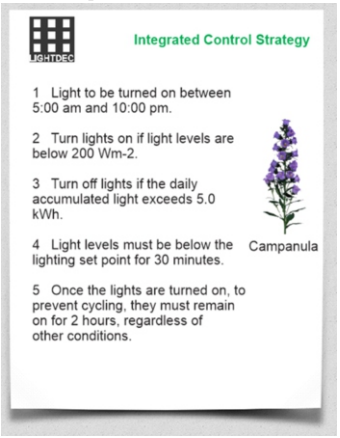
Growing plants is about constantly balancing all variables influencing growth to get the best business results.

Step by step we develop the light recipe for your needs in close cooperation with you and your partners.

Benefits

- Energy savings
- Increased production
- Quicker Harvest Cycle
- Longer Lifespan of lights
- Guaranteed healthier plants
- Better space utilization
- Accelerated hardening phase
- Better germination rate
- Higher multiplication factor
- Higher survival rate in rooting
- Improved growing process

Example:



LIGHTDEC

Integrated Control Strategy

1 Light to be turned on between 5:00 am and 10:00 pm.

2 Turn lights on if light levels are below 200 Wm-2.

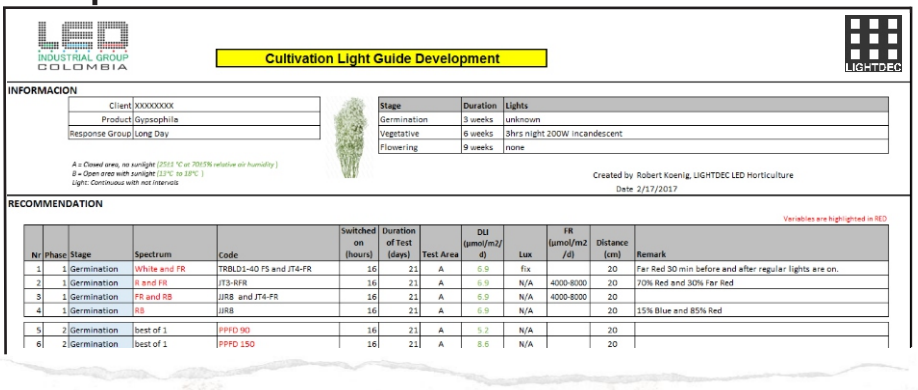
3 Turn off lights if the daily accumulated light exceeds 5.0 kWh.

4 Light levels must be below the lighting set point for 30 minutes.

5 Once the lights are turned on, to prevent cycling, they must remain on for 2 hours, regardless of other conditions.

Campanula

Example:



LED INDUSTRIAL GROUP COLOMBIA

Cultivation Light Guide Development

LIGHTDEC

INFORMACION

Client	XXXXXXXX
Product	Gypsophila
Response Group	Long Day

Stage	Duration	Lights
Germination	3 weeks	unknown
Vegetative	6 weeks	3hrs night 200W incandescent
Flowering	9 weeks	none

A = Closed area, no sunlight (25±1 °C at 70±5% relative air humidity)
B = Open area with sunlight (13°C to 18°C)
Light: Continuous with not intervals

Created by Robert Koenig, LIGHTDEC LED Horticulture
Date 2/17/2017

RECOMMENDATION

Variables are highlighted in RED

Nr	Phase	Stage	Spectrum	Code	Switched on (hours)	Duration of Test (days)	Test Area	DLI (µmol/m2/d)	Lux	FR (µmol/m2/d)	Distance (cm)	Remark
1	1	Germination	White and FR	TRBLD1-40 FS and JT4-FR	16	21	A	6.9	fix		20	Far Red 30 min before and after regular lights are on.
2	1	Germination	R and FR	JT3-RFR	16	21	A	6.9	N/A	4000-8000	20	70% Red and 30% Far Red
3	1	Germination	FR and RB	JJRB and JT4-FR	16	21	A	6.9	N/A	4000-8000	20	
4	1	Germination	RB	JJRB	16	21	A	6.9	N/A		20	15% Blue and 85% Red
5	2	Germination	best of 1	PPFD 90	16	21	A	5.2	N/A		20	
6	2	Germination	best of 1	PPFD 150	16	21	A	8.6	N/A		20	