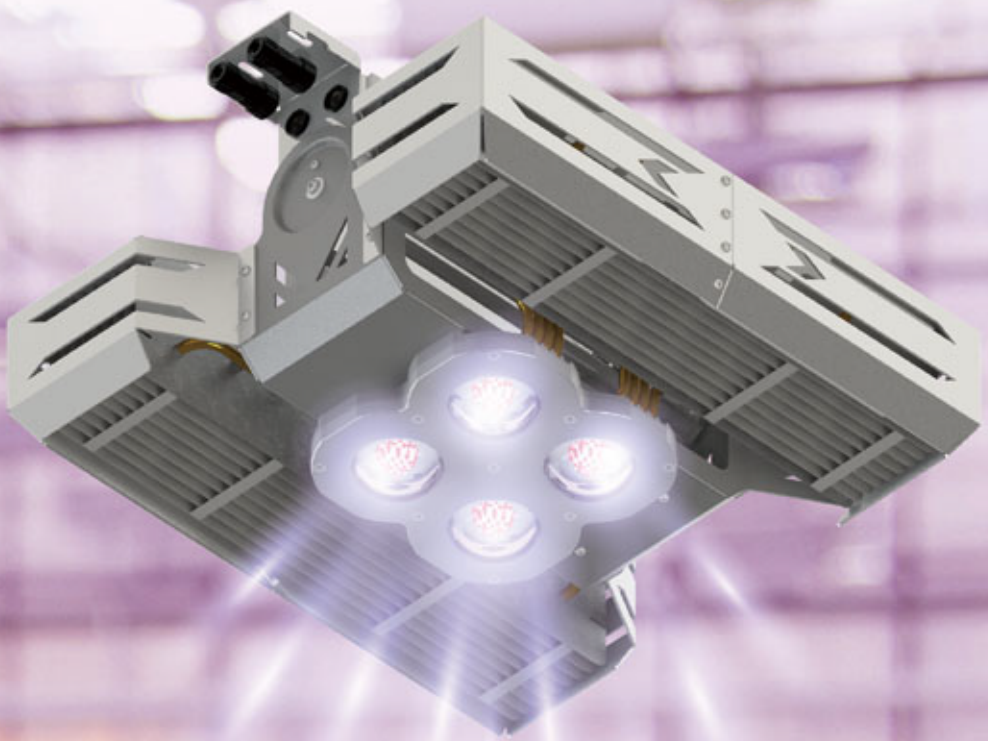
MechaTronix

# CoolFin®

## The Next Dimension in LED Grow Lights



### Performance

- Absolute market leading PPF 1.500µmol/s
- Highest photon efficiency 2.5µmol/J - 2.7µmol/J
- 11 leading growth spectra with highest yields
- Deepest canopy penetration rate

### Modularity

- Freedom in growth spectrum composition
- Upgradable over time
- Unique light distribution with TIR lenses adaptable to your canopy

### Quality

- Extreme lifetime 75.000hrs - L70
- 5 years warranty
- Best thermal management
- Full IP67 waterproof

MechaTronix
www.mechatronix-asia.com

# CoolFin®

The Next Dimension in
LED Grow Lights

## Introduction

The CoolFin® LED grow light offers an absolute market leading PPF of 1.500µmol/s out of 4 individual CoolGrow® LOB (LED On Board) engines.

It is the first LED grow light system which is designed according the Zhaga standards to make it upgradable over time.

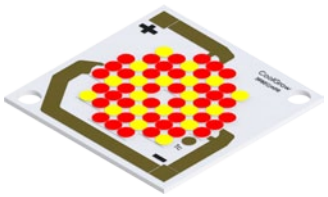
With its unique light distribution though TIR (Total Internal Reflection) technology, the CoolFin® guarantees a deeper canopy penetration which makes it the ideal grow light platform for high wire crops, cannabis cutivation, soft fruits, ornamentals and a wide score of leafy greens.

## Technology – The CoolGrow® LED Engines

The CoolGrow® LOB (LED On Board) is a complete new approach in horticulture LED lighting, and is developed according the Zhaga standards for future upgradability.

The Zhaga consortium came to life with the idea of compatibility standards between luminaires – it has never been deployed yet in horticulture lighting but why not?

Also horticulture LED engines will keep on developing over time at a speed even much faster as these for white lighting.

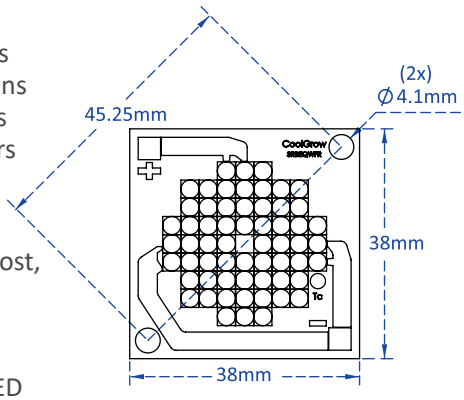


*CoolGrow® LOB*

When we look back we see that the efficacy in horticulture LEDs has been increased with over 50% in just the last 24 months – that means that you could run your grow light LED installation today at 35% less power consumption than the grow lights you bought just a few years ago!

And that's what makes the CoolGrow® unique – at any time in the future the LED engines, which count for less than 25% of the total cost, can be upgraded to the technology and efficacy of that time.

So the CoolFin® is not just an investment in todays possibilities in LED grow lights, but offers a system which grows with you over time.




*Zhaga design guarantees upgradability over time*

# Technology – TIR Light Distribution for a deeper canopy penetration

The importance of light distribution in LED grow light systems is many times seriously underestimated.

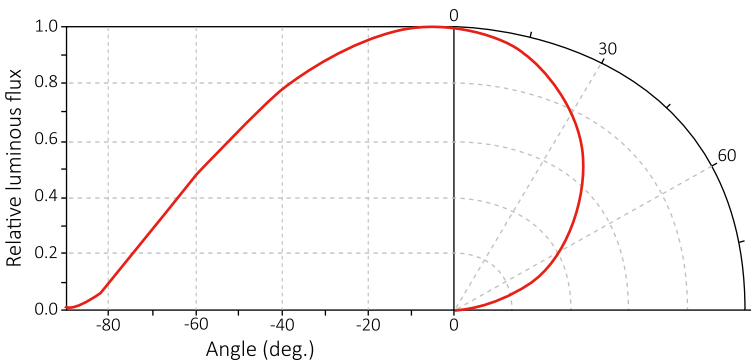
Certainly plants which are sensitive to fluctuations over the canopy in received PPFD like most ornamentals are in absolute need of a proper light distribution.

A perfect even light distribution over the plant canopy from a single luminaire is still something most brands seem to have difficulties with to manage.

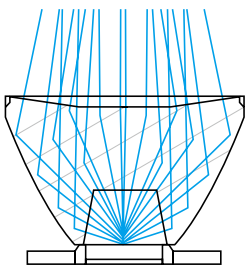
A lot of horticulture LED applications use LED emitters on an extruded heat sink without use of any optics to control the beam distribution.

A LED package without secondary optics has a typical light distribution angle of 120° or 80°.

This means that when the energy directly under the light fixture = 100%, you will have a light and energy decrease to 80% at 30 degrees left and right, and a further erosion to 40% at 60 degrees left and right of the luminaire.




*Light decrease in function of beam angle of a 120° LED package without secondary optic light distribution.*



*Total internal reflection (TIR) lens*

By using TIR or Total Internal Reflection technology, the light output of the LEDS is scattered in a high efficacy translucent borosilicate optics lens and redistributed to the plant canopy.

With TIR lenses the light distribution of a LED grow light can be completely scattered and adapted to the plant canopy, what creates an even spreading of the photons and makes a much deeper plant canopy penetration.

Besides an even light distribution, TIR optics also enables a deeper light penetration in the plant canopy.

In 2014 Dr. Hemming and Dr. Li published their studies about possibilities in hazing and diffusing light to obtain a major spatial improvement in canopy reach.

*Light is more homogeneously distributed under diffuse light (B) compared with direct light (A) where many sun flecks in the middle and lower part of the canopy are seen. (Hemming et al., Li et al., 2014a/b, photo courtesy of Wageningen UR Greenhouse Horticulture, Bleiswijk)*

Mainly higher crops and those with a leafy structure like most cannabis cultivars, tomatoes, bell peppers, piccolino basil,…, all show similar effects under grow lights without advanced optics – in general less than 35% of the leafs are reached by the produced light photons.

By diffusing the light in TIR lenses, an improvement of over 50% of leaf penetration can be realized, direct resulting in stronger growth results.

Mainly plant varieties with a good stomatal opening see direct result of this technology.

## Technology – More PPF output for reduced installation costs

While the easiest way to compare grow lights is probably the price per µmol, there are many variables which make comparisons between various systems somewhat difficult.

One of the biggest influences on total project cost comes as a result of the output of the grow light expressed in PPF or Photosynthetic Photon Flux.

Since each luminaire needs to be cabled and preferably with not only the mains power but also smart controls wiring, the output of the grow light and required PPFD on the plant canopy immediately implements an extra cost on installation.

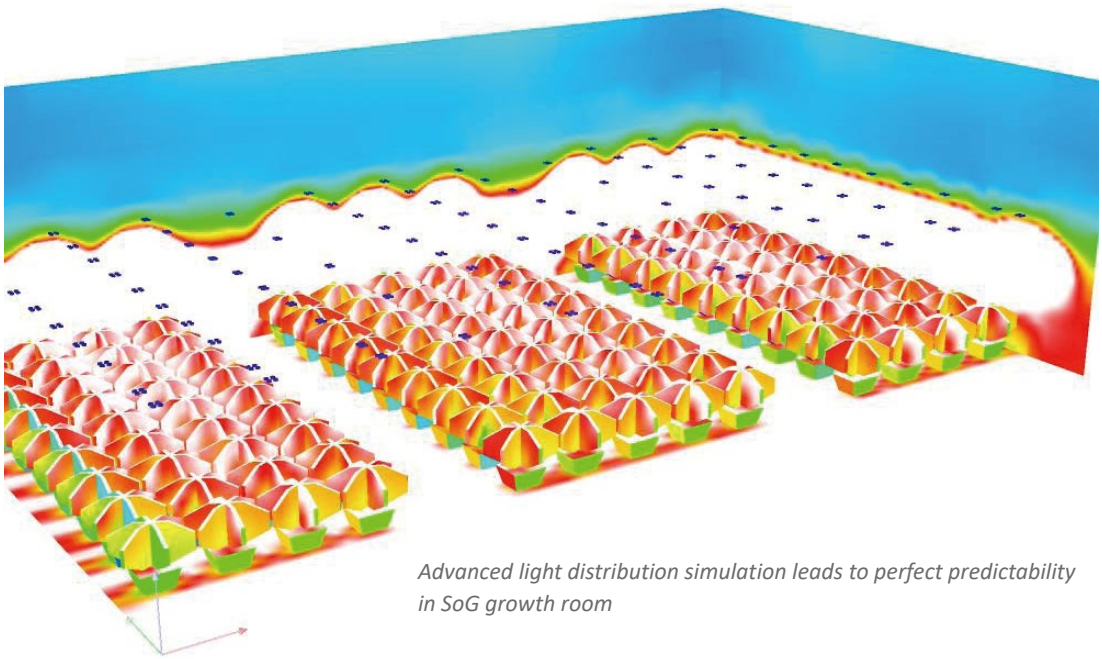
We see even in many cases that the foreseen construction bars tend not to deliver enough fixation points for some grow lights leading to extra construction profiles in the project and related extra costs.

The CoolFin® delivers a stunning PPF of 1.500µmol/s out of a single LED grow light.
And that's all full passive cooled thanks to the advancd heat pipe technology we use.

In this way the cost of cabling, smart controls costs and expensive circuit breakers can be strongly reduced.

Never the less a perfect light distribution over the plant canopy is achieved through the TIR lens technology.

With 6 off-the-shelf available TIR lenses in combination with 11 proven growth spectra, a perfect combination of light controls can be achieved adapted to your crops and practical situation.



*Advanced light distribution simulation leads to perfect predictability in SoG growth room*

# Technology – Growth Spectra for Yield and advanced Morphology

To understand how your crops are going to react on different wavelengths and colors, you have to keep in mind that every crop and every growth stage requires an individual approach.

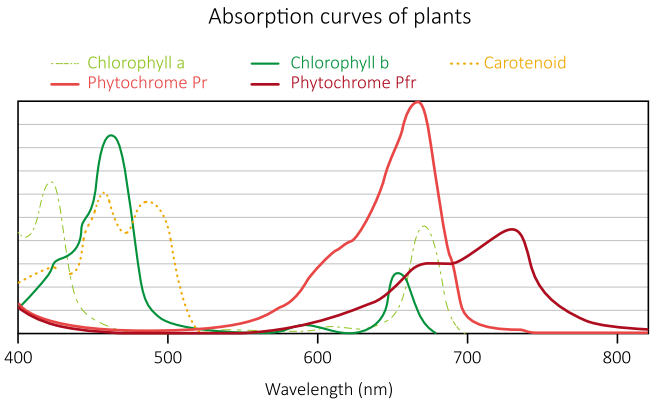
The amount of light affects the photosynthesis process in the plant.

This process is a photochemical reaction within the chloroplasts of the plant cells in which $CO^2$ is converted into carbohydrate under the influence of the light energy.

The spectral composition of the different wavelength regions (blue, green, yellow, red, far red or invisible e.g. UV or IR) is important for the growth, shape, development and flowering (photomorphogenesis) of the plant.

For the photosynthesis, the blue and red regions are most important.

The timing / light duration which is also called photoperiod is mainly affecting the flowering of the plants. The flowering time can be influenced by controlling the photoperiod.




Photosynthetic efficiency is mainly driven by chlorophyll a and b.

Chlorophyll a and b are mainly responsible for the photosynthesis and responsible for the definition of the area for the photosynthetically active radiation PAR.

The Photosynthetically Active Radiation (PAR) shows further photosynthetic pigments also known as antenna pigments like carotenoids - carotene, zeaxanthin, lycopene and lutein etc.

The Phytochromes Pr (red) and Pfr (far red) are mainly influencing the germination, plant growth, leave building and flowering.

The phytomorphogenic effects are controlled by applying a spectrum with a certain mix of 660nm and 730nm in order to stimulate the Pr and Pfr phytochromes.

## Different regions of the wavelength in the illuminaton spectrum have different effects on the plants

| Wavelength range [nm] | Photosyntesis | Further Effects | Further Effects | Further Effects |
|---|---|---|---|---|
| 200 – 280 | | Harmful | | |
| 280 – 315 | | Harmful | | |
| 315 – 380 | | | | |
| 380 – 400 | Yes | | | |
| 400 – 520 | Yes | Vegetative growth | | |
| 520 – 610 | Some | Vegetative growth | | |
| 610 – 720 | Yes | Vegetative growth | Flowering | Budding |
| 720 – 1000 | | Germination | Leaf building and growth | Flowering |
| > 1000 | | Converted to heat | | |

## A typical application example for the use of 730nm: The shade escape reaction

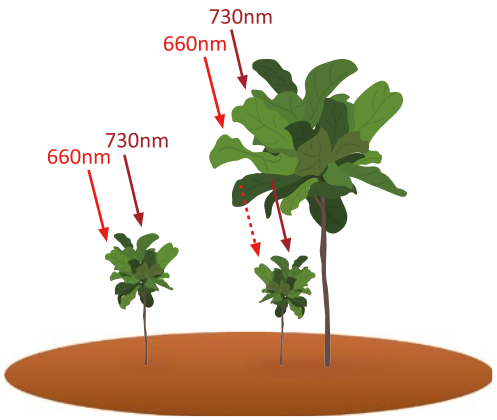
One of the most obvious influence of far red light on a plant is the shade escape reaction.

### Illumination with 660nm:

If the plant is illuminated mainly with 660nm it feels like illuminated in the direct sun and grows normally.

### Illumination with 730nm:

If the plant is illuminated mainly with 730nm it feels like growing in the shadow of another plant that shades the sun light.
Therefore the plant is reacting with an increased length growth to escape the shadow. This leads to taller plants but not necessarily to more bio mass.



## CoolGrow® Growth Spectra

With 4 individual CoolGrow® LED engines, each with its individual TIR lens, the CoolFin® produces an absolute market leading PPF of 1.500µmol/s.

Each individual CoolGrow® module can be foreseen from one of the below growth spectra, allowing a multitude of combinations to finetune the growth recipe exactly to what your crops need at each stage of cultivation.

The CoolFin® also allows “dual drive”, what implements that you can individually control each of both drivers and in this way use various spectra for various stages of growth – this method is ideally for cannabis SoG (Sea of Green) cultivation which has found its strive at commercial growers aiming at the highest yield per square meter.

Would you require a growth recipe just that bit different than what we have off the shelf available, just let us know and we will produce it for you.
As long as it fits on the CoolGrow®, it’s just a matter of combining various leds to a final result.

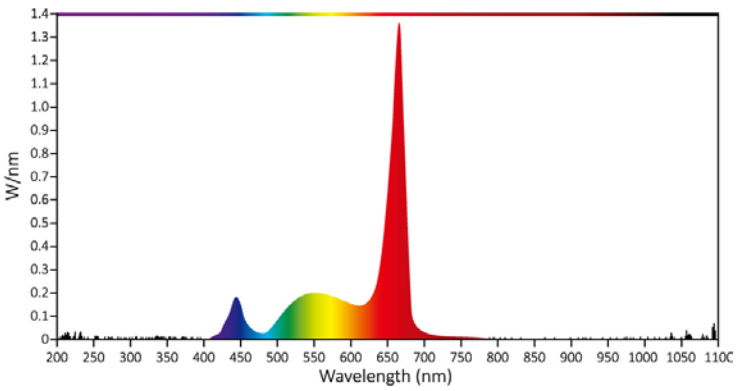
### CoolGrow® 3R2EQW

This is the most frequent used spectrum in a variety of mature crops promoting flowering, budding, leaf building and a good biomass production.

Ideal for cannabis flowering stage and multiple leafy greens.

Very strong results with high crop cultivation like tomatoes, cucumbers, bell peppers and egg plants as well with a wide variety of berries.

This spectrum is interpreted by the human eyes as clear white and creates an ideal light atmosphere for visual inspection.




| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 12% |
| Green<br>500 - 600 nm | 28% |
| Red<br>600 - 700 nm | 60% |
| Far Red<br>700 - 780 nm | 0% |

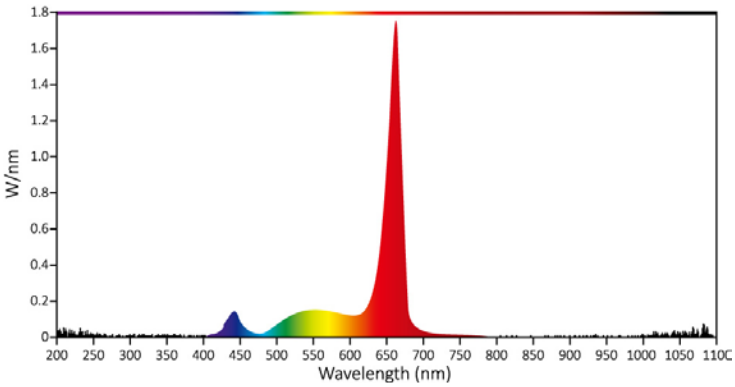
## CoolGrow® RREQW

With a slightly higher focus on hyper red 660nm and limited photons in the blue and green to yellow spectrum, this growth recipe goes ideal for plants which you want to elongate during maturing.

The recipe promotes longer stems and internodes, leading to an open plant structure and a higher ratio of photosynthesis.

Most potted plants give a great result under this spectrum.

This spectrum is interpreted by the human eyes as warm white and creates a good light atmosphere for visual inspection - human eye response similar to SON-T.




| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 9% |
| Green<br>500 - 600 nm | 20% |
| Red<br>600 - 700 nm | 71% |
| Far Red<br>700 - 780 nm | 0% |

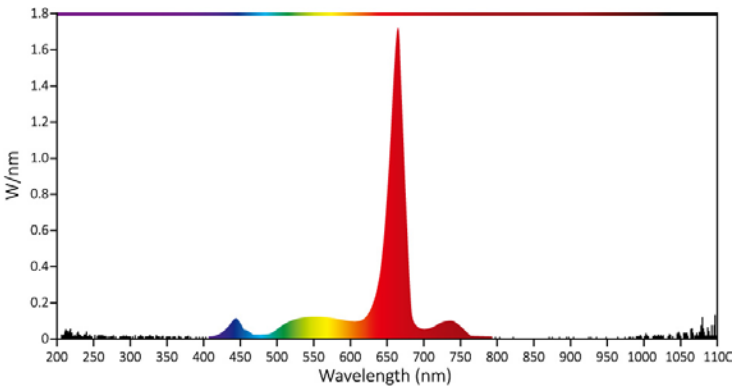
## CoolGrow® 3REQWFR

With additional photons in the far red spectrum 730nm and a clear focus on the 660nm bandwidth this spectrum is ideal for ornamentals, soft fruits and a wide variety of floriculture supplemental lighting.

The extra far red photons simplify controlled timing on flowering.

Ideal for plants who don’t like too much blue spectrum like Phalaenopsis.

This spectrum is interpreted by the human eyes as warm white and creates a good light atmosphere for visual inspection - human eye response similar to SON-T.



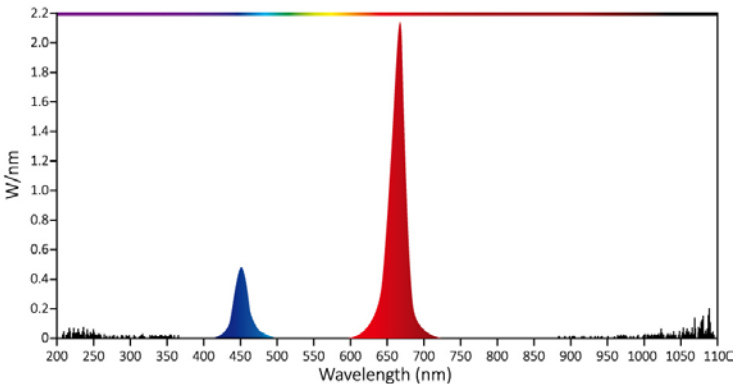

| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 7% |
| Green<br>500 - 600 nm | 16% |
| Red<br>600 - 700 nm | 72% |
| Far Red<br>700 - 780 nm | 5% |

## CoolGrow® 5RB

An energy wise very effective spectrum with only focus on deep blue 450nm and hyper red 660nm (12% to 88% ratio).

This is a typical general purpose spectrum, which works ideal with a wide score of crops and particular with leafy greens.

Althought frequently promoted for greenhouse cultivation, keep in mind that for the human eye response this spectrum is interpreted as red-purple and may complicate visual plant inspection.



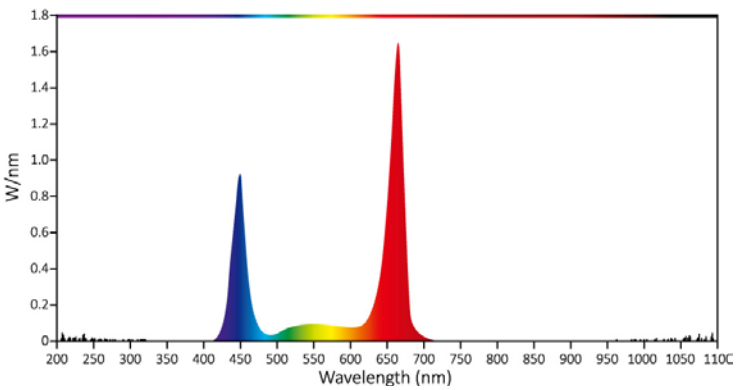

| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 12% |
| Green<br>500 - 600 nm | 0% |
| Red<br>600 - 700 nm | 88% |
| Far Red<br>700 - 780 nm | 0% |

## CoolGrow® 3RBEQW

With a clear focus on the deep blue 450nm and hyper red 660nm spectrum, this recipe focusses on vegetative growth phases and propagation.

The recipe delivers shorter, compact plants with a good biomass ratio – the extra energy in the blue 450nm bandwidth also promotes stomata opening.

All together a good balance between both photon levels guarantees a good mix between vegetative growth and biomass production.



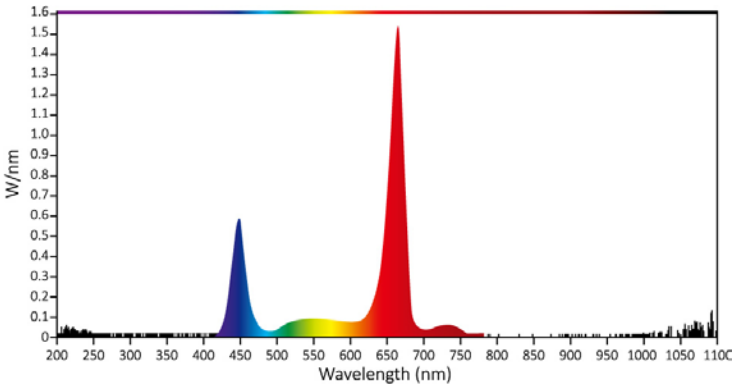

| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 23% |
| Green<br>500 - 600 nm | 14% |
| Red<br>600 - 700 nm | 63% |
| Far Red<br>700 - 780 nm | 0% |

## CoolGrow® 3RBEQWFR

Again a clear target on the deep blue 450nm and hyper red 660nm spectrum, this recipe focusses on vegetative growth phases and propagation.

The extra photons in the far red 730nm spectrum enhance the transition period from vegetative growth to flowering.

Ideal for cannabis vegetative growth and a wide score of ornamentals.



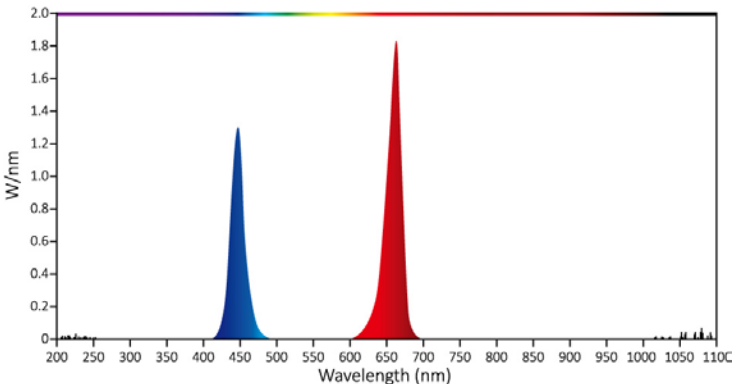

| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 18% |
| Green<br>500 - 600 nm | 14% |
| Red<br>600 - 700 nm | 65% |
| Far Red<br>700 - 780 nm | 3% |

## CoolGrow® RRB

A clear high efficacy spectrum with balance between deep blue 450nm and hyper red 660nm (30% to 70% ratio).

Focus on vegetative growth for plants which you don't want to elongate too much.

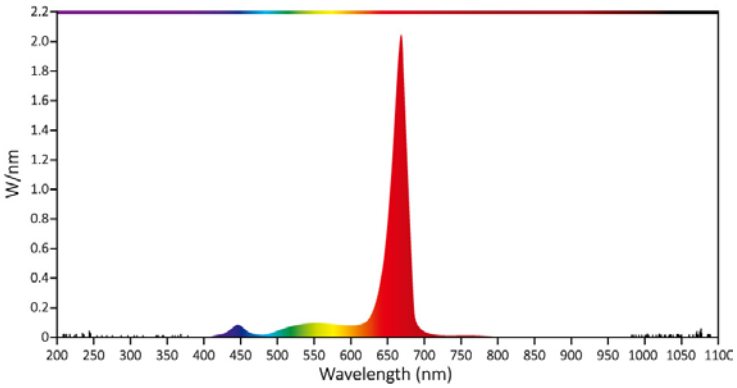
Very good results with a variety of algae like Spirulina and Arthrospira.




| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 30% |
| Green<br>500 - 600 nm | 0% |
| Red<br>600 - 700 nm | 70% |
| Far Red<br>700 - 780 nm | 0% |

## CoolGrow® 4REQW

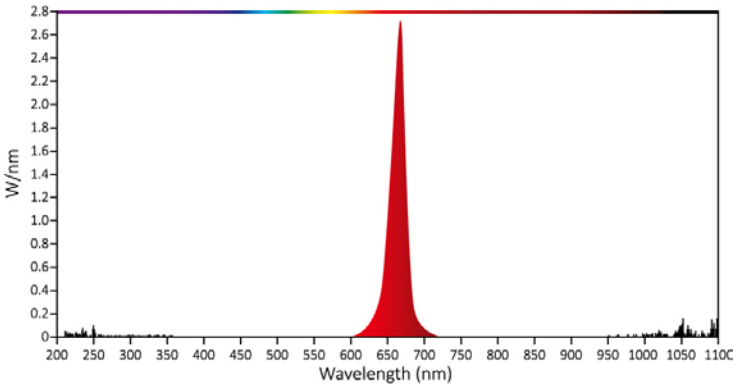
With the bulk of the photons in the hyper red 660nm bandwidth, this spectrum goes ideally together with hybrid lighting systems in combination with HPS SON-T luminaires.
While the vast majority of photons from a SON-T are produced in the 550nm to 630nm this growth recipes used as a supplement will create more elongated plants with a higher biomass, longer stems, longer internodes and an overall open morphologic structure.
We recommend this spectrum in hybrid systems with HPS lamps for floriculture products like chrysanthemum.




| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 5% |
| Green<br>500 - 600 nm | 14% |
| Red<br>600 - 700 nm | 81% |
| Far Red<br>700 - 780 nm | 0% |

## CoolGrow® RRR

With all the photons bundled on the 660nm bandwidth, this spectrum is designed either as supplemental spectrum to HPS SON-T grow lamps, as well as to be used as spectrum controls supplement for adaptive spectrum over growth stage.
Both the CoolFin®, CoolCube®, CoolStack® as CoolPack® LED horti top lights allow dual channel spectrum controls. Various CoolGrow® growth recipes can be placed together on the same grow light, and each pair can be individually addressed.
Suppose that you want to aim at various growth stages without changing the plants from location or changing the luminaires, for example the Sea of Green (SoG) cultivation method for medicinal cannabis, than this platforms let you combine 2 engines focusing on vegetative growth with 2 engines purely focusing on the flowering stage.

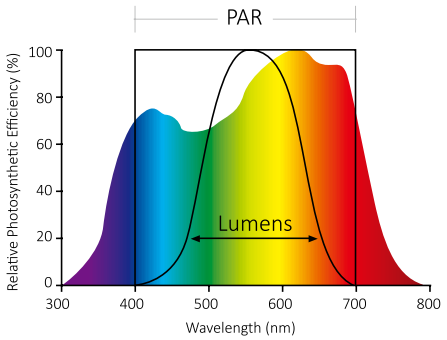



| PFD<br>380 - 780 nm | % |
|---|---|
| UV<br>380 - 400 nm | 0% |
| Blue<br>400 - 500 nm | 0% |
| Green<br>500 - 600 nm | 0% |
| Red<br>600 - 700 nm | 100% |
| Far Red<br>700 - 780 nm | 0% |

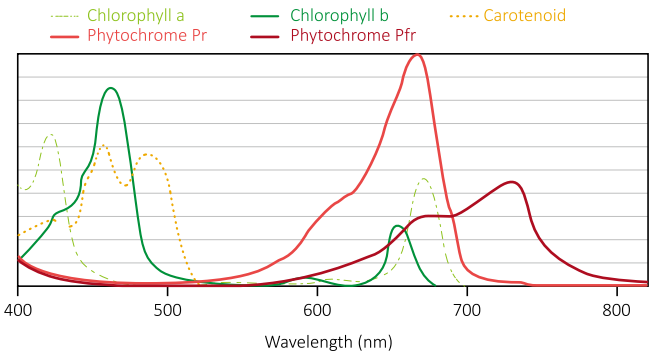
## PAR, PPF, PPFD and DLI

Plants absorb radiation mostly in the 400-700 nm visible range and convert $CO^2$ uptake and water into oxygen and glucose.

The amount of absorption in each wavelength depends on the cellular structure of the plant and may differ from species to species somewhat.




Absorption curves of plants




Another important parameter is Daily Light Integral which is defined as the total number of photons impringing per square meter in one day.

DLI is measured in units of mol/$m^2$.d and each plant has a specific requirement of DLI for its growth.

There is a relationship between PPFD and DLI which is given by:

DLI=PPFD x light hours per day x (3600/1000,000).

You can see from this formula that there is a trade-off between PPFD and number of light hours required to achieve a certain DLI value.

If there is a certain amount of natural lighting available for a green-house, it has to be subtracted from the original DLI value for proper artificial lighting fixture calculations.

Taking into account the DLI, PPFD and number of light hours per day, you can calculate the total number of fixtures required in a green-house to illuminate the crops.

## Calculation from DLI to PPFD and needed number of grow lights

12 moles / 16 hr photoperiod / 60 minutes / 60 seconds = 0.000208 moles

(This gives us the amount of moles delivered per second per square meter)

0.000208 moles x 1,000,000 = 208 µmols per second per meter squared (µmol/$sm^2$)

So in this case with a CoolFin® producing a PPF of 1.500µmol/s you can roughly cover 7 square meter of canopy.

With the height of the luminaire in mind the beam angle can be calculated leading to the ideal TIR lens for your light distribution.

# What are typical µmol/s.m² values for horticulture lighting?

## What light level for what type of crop?

| Plant | Min (µmol/s.m²) | Max (µmol/s.m²) | Typical (µmol/s.m²) |
|---|---|---|---|
| Tomato | 170 | 200 | 185 |
| Pepper | 70 | 130 | 100 |
| Cucumber | 100 | 200 | 150 |
| Cannabis Vegetative growth | 280 | 400 | 350 |
| Cannabis Flowering | 650 | 1,000 | 850 |

## What light level for what potted plant?

| Plant | Min (µmol/s.m²) | Max (µmol/s.m²) | Typical (µmol/s.m²) |
|---|---|---|---|
| Orchid / Phalaenopsis | 80 | 130 | 105 |
| Dendrobium | 130 | 260 | 195 |
| Bromelia | 40 | 60 | 50 |
| Anthurium | 60 | 80 | 70 |
| Kalanchoë | 60 | 105 | 82.5 |
| Potted chrysanthemum | 40 | 60 | 50 |
| Potted rose | 40 | 60 | 50 |
| Geranium | 40 | 60 | 50 |

## What light level for what cut flower?

| Plant | Min (µmol/s.m²) | Max (µmol/s.m²) | Typical (µmol/s.m²) |
|---|---|---|---|
| Chrysanthemum | 105 | 130 | 117.5 |
| Rose | 170 | 200 | 182 |
| Lily | 80 | 100 | 90 |
| Lisianthus | 170 | 200 | 185 |
| Alstroemeria | 60 | 105 | 82.5 |
| Anthurium / Orchid - cut | 80 | 105 | 92.5 |
| Freesia | 70 | 105 | 87.5 |
| Gerbera | 80 | 105 | 92.5 |
| Tulip | 25 | 40 | 32.5 |

# CoolFin®

The Next Dimension in
LED Grow Lights

| SPECIFICATIONS | |
|---|---|
| Light Source | CoolGrow® LED |
| PPF | 1.500 µmol/s |
| Input Power | 600W - 635W spectrum depending |
| Efficacy | 2.5 µmol/J - 2.7 µmol/J |
| Input Voltage | 90 - 305 Vac or 249 - 528 Vac |
| Fixture Dimensions | W468 x L446 x H251 (mm) |
| Weight | 8.500 gr |
| Thermal Management | Advanced heat pipe - passive |
| Dimming | 0 - 10V, PWM, DALI, BLO Bluetooth, Synapse Wi-Fi or LAN |
| Light Distribution | Advanced TIR - 60°, 90°, 120° |
| Lifetime | 75.000 hrs - L70 |
| Power Factor | > 95% |
| Warranty | 5 years |

MechaTronix

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The Next Dimension in LED Grow Lights

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