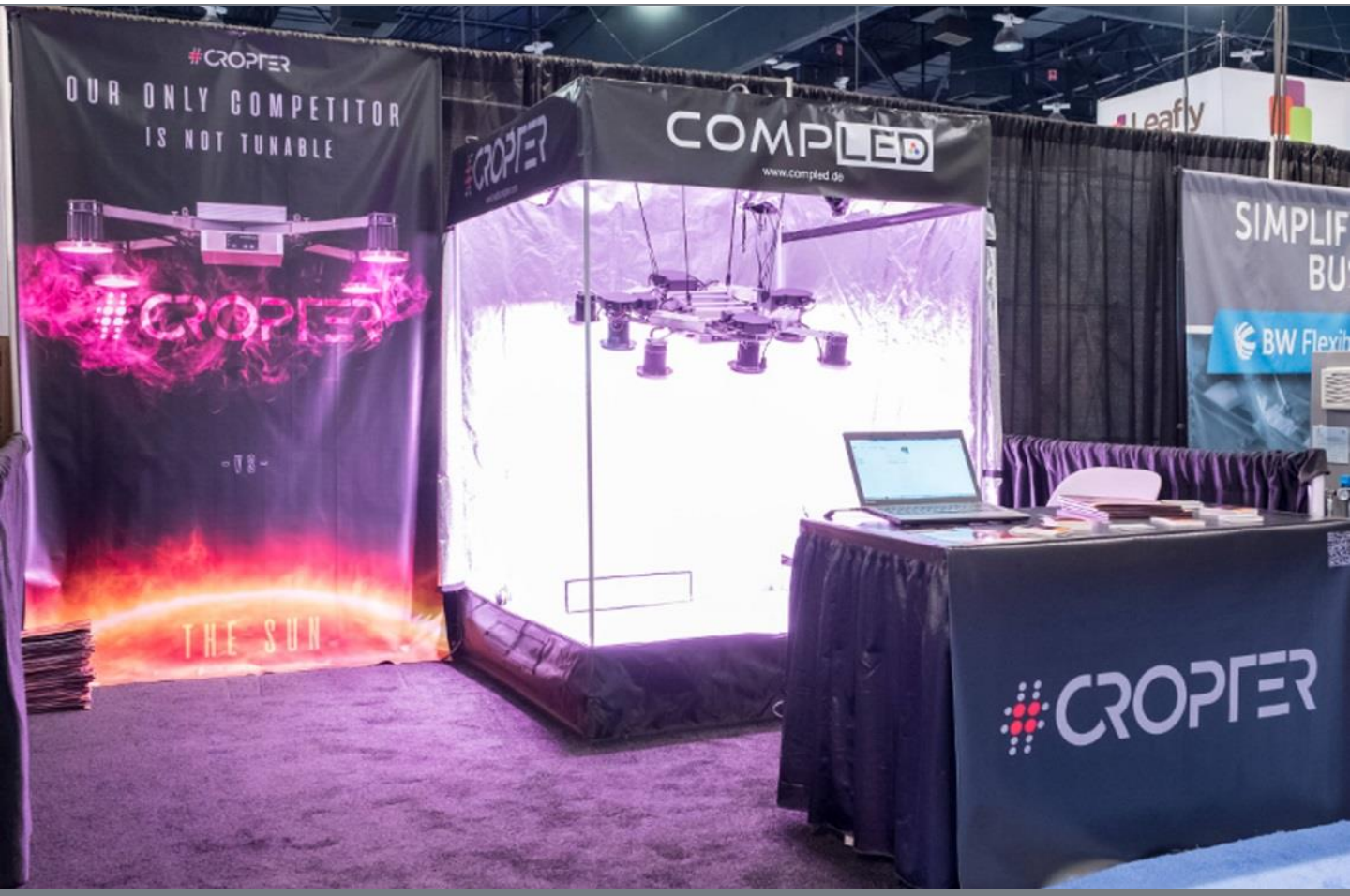

figure 1: COMPLED booth at MJBizCon 2018 in Las Vegas

LED lighting in state-of-the-art cannabis cultivation

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1.1 What is the optimal max. photosynthetic photon flux density (PPFD)?

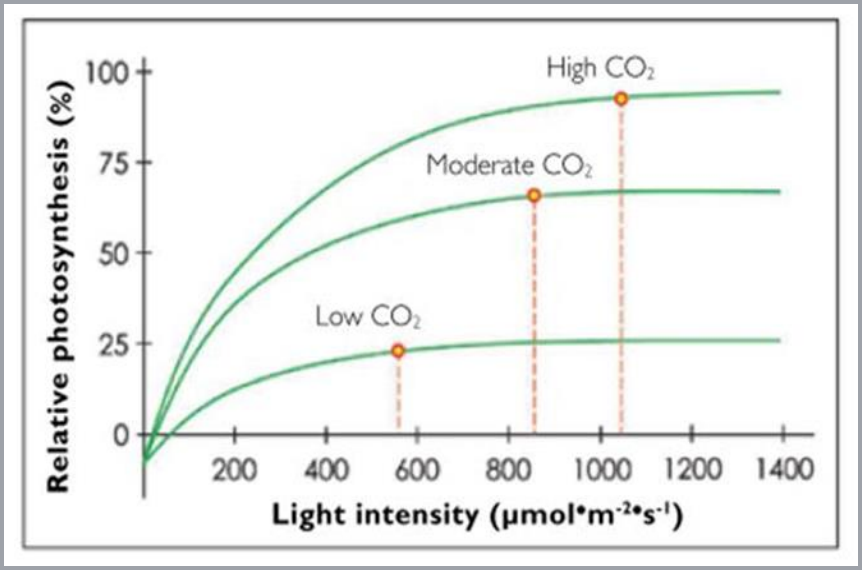

figure 2: recommended max. intensity in relation to CO2 level for cannabis cultivation

In general a max. PPFD of **800 – 1,000 µmol/m²/s (75 – 93.5 µmol/sf/s)** should be available especially if CO2 will be supplemented.

In order to cope with aging-induced losses, a lighting system should always be dimmable and designed with at least 10 percent reserve. That will ensure the same max. intensity for 5 – 6 years.

1.2 Efficiency of lighting technologies

A state of the art GAVITA 1,000 Watt DE fixture provides 1.7 µmol/J (aka 1.7 µmol/W/s)

State-of-the-art LED fixtures provide 2.0 - 2.5 µmol/J

All manufacturers that claim to have a higher efficiency are ‘cheating’ in some way, normally they do not refer to the overall system efficiency.

The efficiency of LED tech will highly depend on the spectrum. Blue-Red-Light solutions are typically more efficient…

1.3 Efficiency vs. effectivity

Efficiency is important but useless if the plants cannot use the light properly. Imagine a grow room using only red light (660nm). The efficiency of such a lighting system could be above 3.0 µmol/J but your plants will definitely die because they cannot cope with this light.

What does this means for professional cultivators?

An optimized spectrum can improve effectivity and also help to save energy. But strains/varieties have different needs. **Therefore the spectrum should always be tunable to provide the possibility of fine-tuning.**

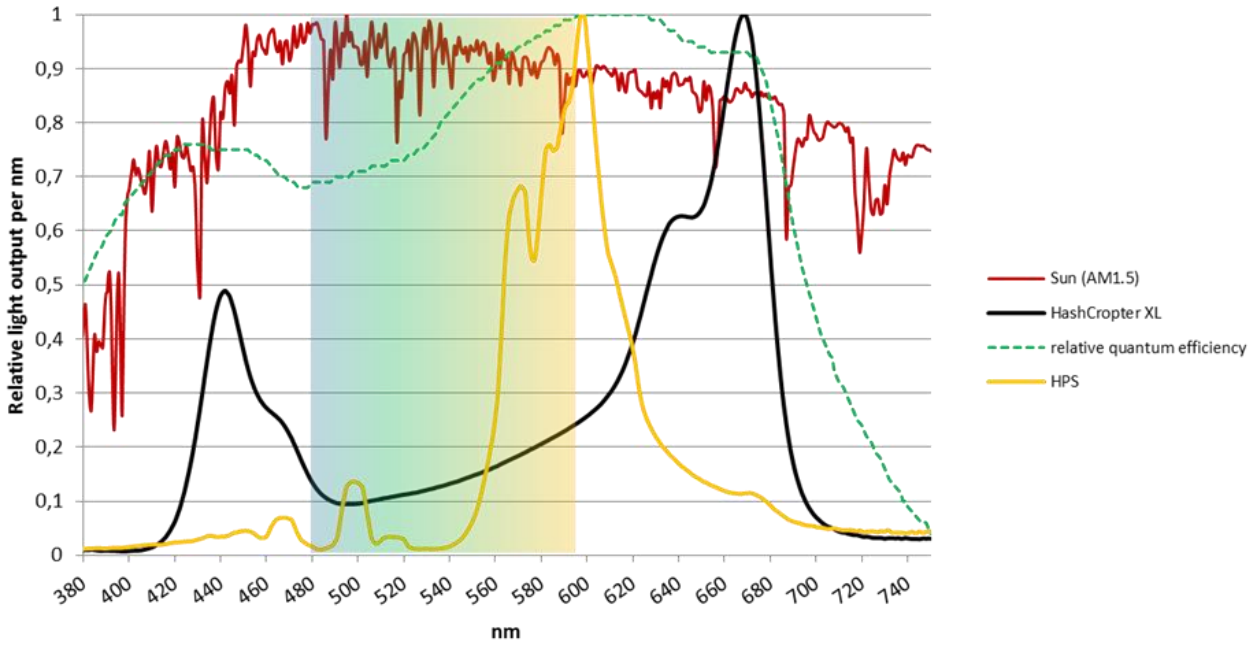

figure 3: HashCropter spectrum compared to SUN and HPS and in relation to the relative quantum efficiency

Efficiency is about saving costs, effectivity is about maximizing yields and quality!

Plants are using green and yellow light at almost the same efficiency level as they use blue light (see figure 3).

Green and yellow light can penetrate the leafs and also the canopy much deeper.

Especially at high intensity levels green and yellow light will avoid over-stressing photo receptors.

HPS provides a lot of yellow light. That cannot be bad since HPS has been performing quite well ;)

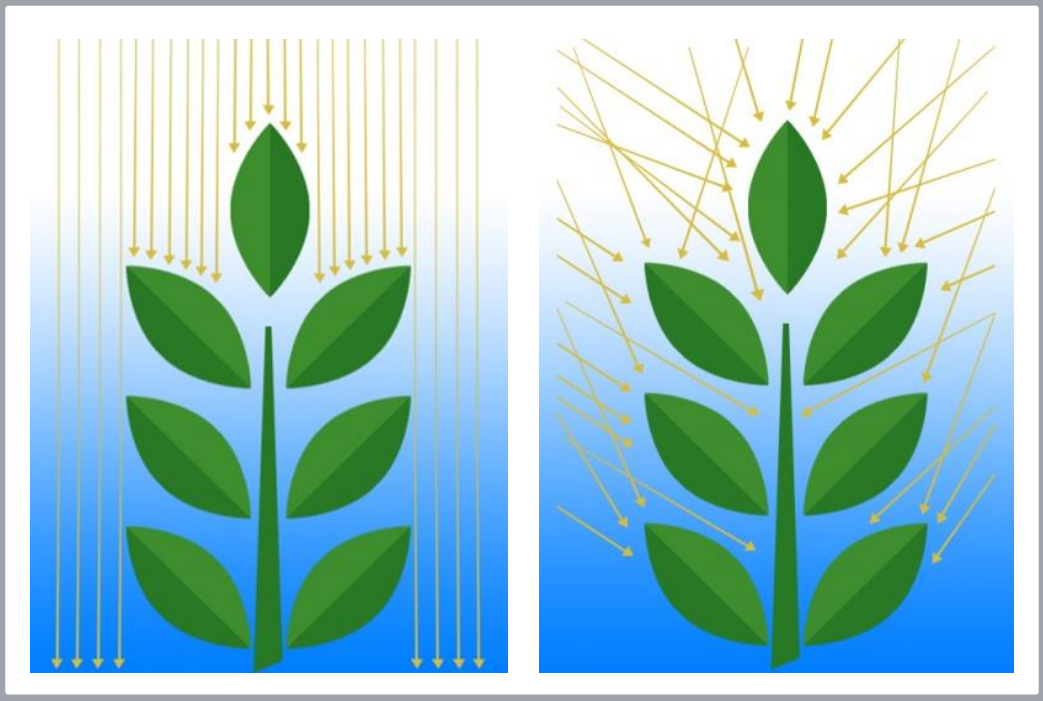

figure 4: What happens when you try to focus light by using lenses

Plants are 3D ‘objects’ and therefore it is also crucial to make sure that lower layers of the canopy will get enough light…

If you focus light (by using lenses) it will help to avoid losses but it will also prevent the light to penetrate the canopy properly…

Light should always be as diffuse as possible (like in nature or provided by HPS – That’s actually one of the biggest advantages of HPS beside the higher amount of green and yellow light.

1.4 Optimization of grow rooms (walls, corridors)

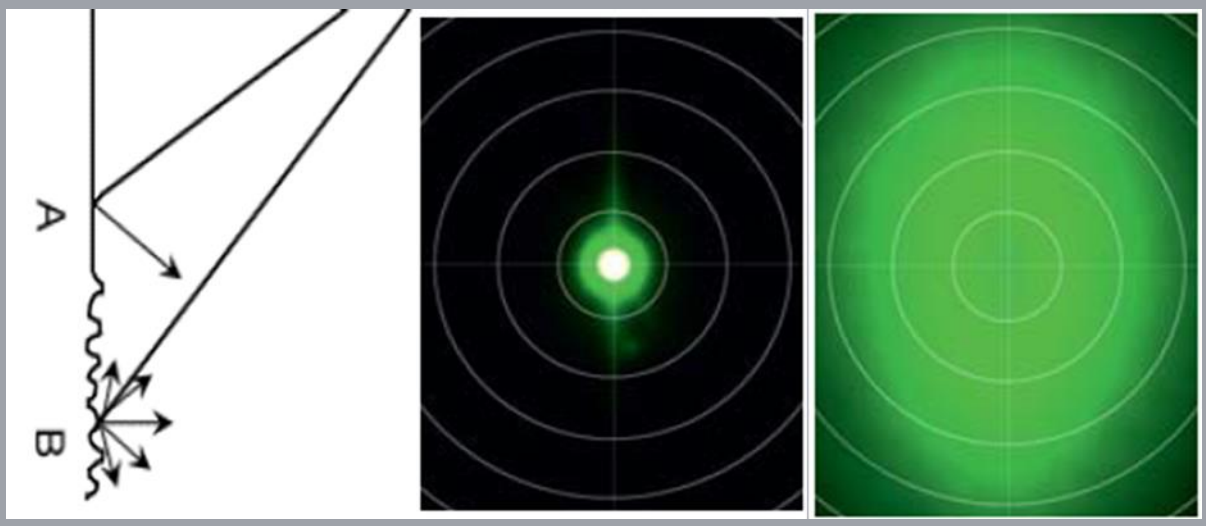

figure 5: specular (A) vs. Diffuse (B) reflection

To maximize efficiency and effectivity of the lighting system it is crucial to maximize the ratio of net growing space canopy to room size.

Furthermore the reflection of the walls should always be optimized to avoid losses and to maximize the diffusivity of the light.

Different optical-grade materials can be used to cover walls and therefore to convert a grow room into a holistic lighting device.

figure 6: picture of an optimized climate chamber at the university of Stuttgart (Germany)

1.5 Summary

I. **Effectivity is more important than efficiency especially for high-value crops, because a bigger yield or a higher quality will always outperform energy savings.**

II. **In general a max. PPFD of 800 – 1,000 µmol/m²/s (75 – 93.5 µmol/sf/s) should be available especially if CO2 will be supplemented.**

III. **State-of-the-art LED fixtures run at 2.0 - 2.5 µmol/J compared to 1.7 µmol/J of a state-of-the-art HPS.**

IV. **The spectrum as well as the intensity should always be tunable to provide the ability to fine-tune effectivity as well as efficiency.**

V. **Green and yellow light can penetrate the leafs and also the canopy much deeper and helps to avoid stressed photo receptors at high intensity lighting levels.**

VI. **Light should always be as diffuse as possible to maximize its ability to penetrate the canopy.**

VII. **An optimization of the whole grow room (reflectance of the walls, optimization of the position of the plants and of corridors in combination with a profound lighting design) is crucial and what we call holistic lighting design.**

VIII. **Last but not least: By dynamically fine-tuning the spectrum many important processes within the plant can be triggered. For a summary see: LED lighting for Urban Agriculture**

Get in touch to receive free consultation!

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