# Influence of different lighting cycles in the vegetation phase on Cannabis sativa L.

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## 1 Introduction

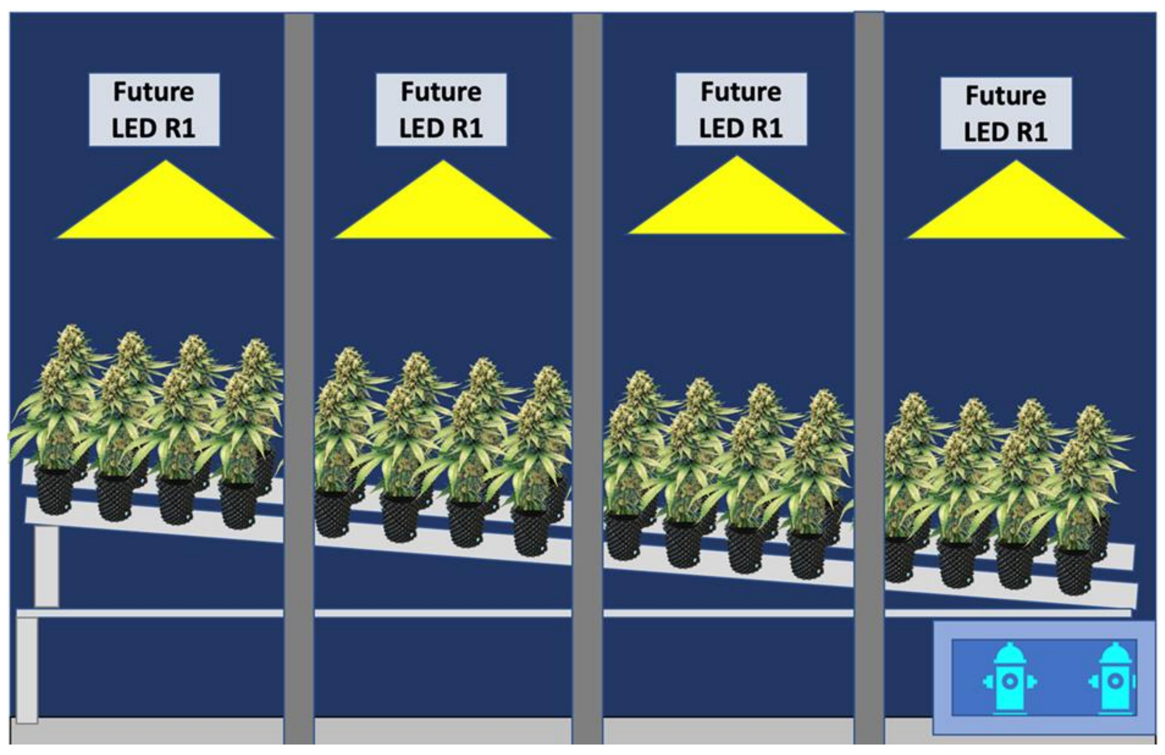
An important abiotic stressor is excess light. One possible reaction of plants to extreme radiation intensity is the synthesis of secondary metabolites with photoprotective properties.
Some cannabinoids and terpenes have these protective properties (Yang et al., 2018). In our experiment we wanted to examine whether permanent lighting in the vegetation phase would influence plant growth and secondary metabolites. In addition, the lock-in effect was investigated. For this purpose, the red spectrum was limited in the last days, to reduce terpene release.

## 2 Methods

Facilities:
The experiment was carried out in an air-conditioned chamber which was divided into 4 by 1 square meter compartments.

Plant material and substrate:
Self-cut cuttings of the EU-certified female Cannabis sativa L. variety "Fedora 17" were used for the experiment and potted in 5L airpods filled with a substrate mixture of 2 parts coconut and 1 part perlite.

Light sources and lighting variants:
4 lighting variants were tested on 9 plants each. Each compartment was equipped with a FUTURE LED R1. The differences in the lighting were the exposure time in the vegetation phase (18- and 24-hours) and the spectral lighting in the last 3 days before harvest (full spectrum and reduced red components).

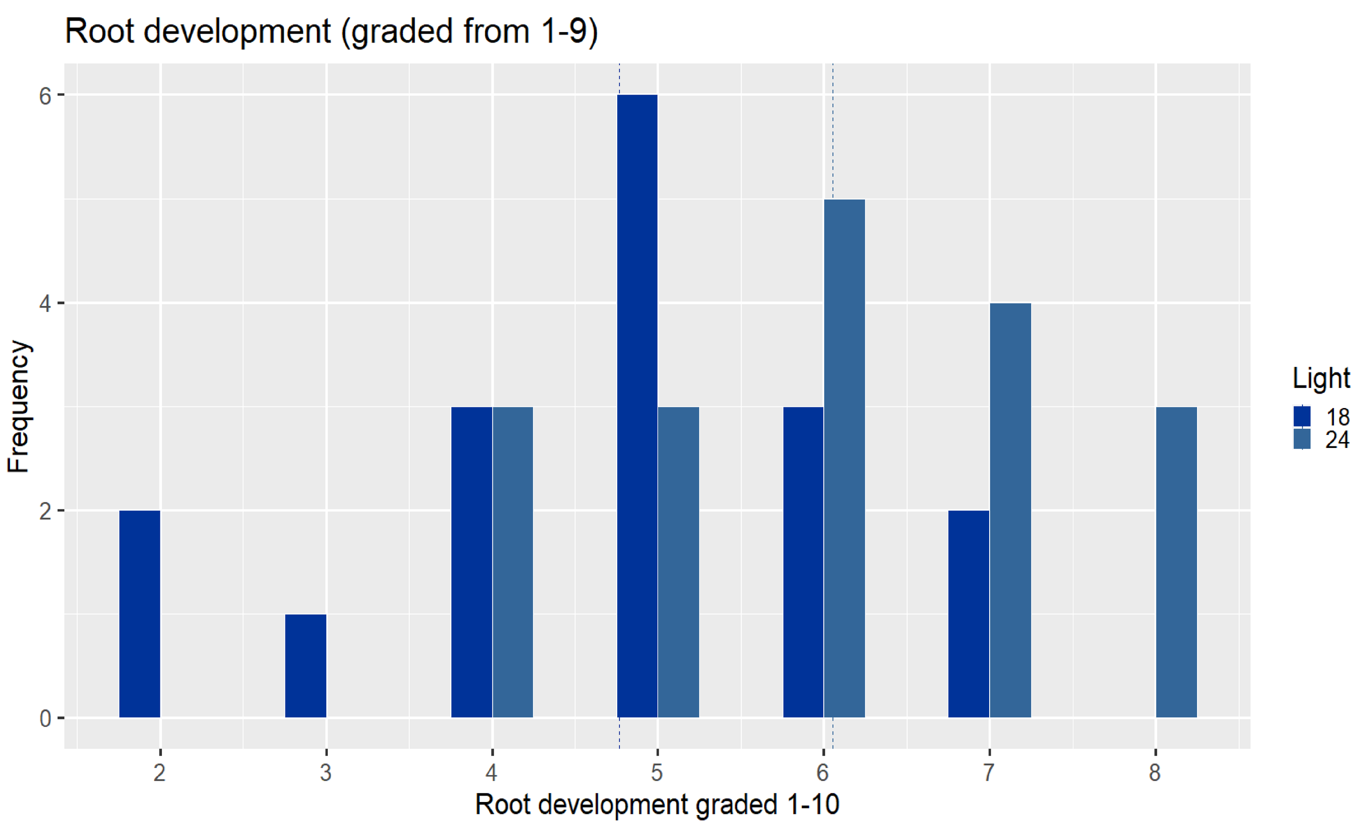



Irrigation:
The plants were watered automatically with two submersible pumps and a hose system.
Two different fertilizers were used for the experiment: A fertilizer especially for the requirements of the vegetation phase and a fertilizer especially for the bloom phase.

Climate control:
The climate in the cultivation chamber was controlled by an AIR BLUE air conditioning system. Settings could be made for room temperature and humidity.
During the vegetative phase, the chamber temperatures were set to 26 °C and the relative humidity (RH) to 60%. For the flowering phase, the temperature was set to 25 °C. and 51.5% relative humidity.

## 3 Results

The permanent lighting in the vegetation phase had a positive influence on various plant properties, including better root growth and increased yields of various secondary metabolites. The Lock-in effect could not be confirmed.

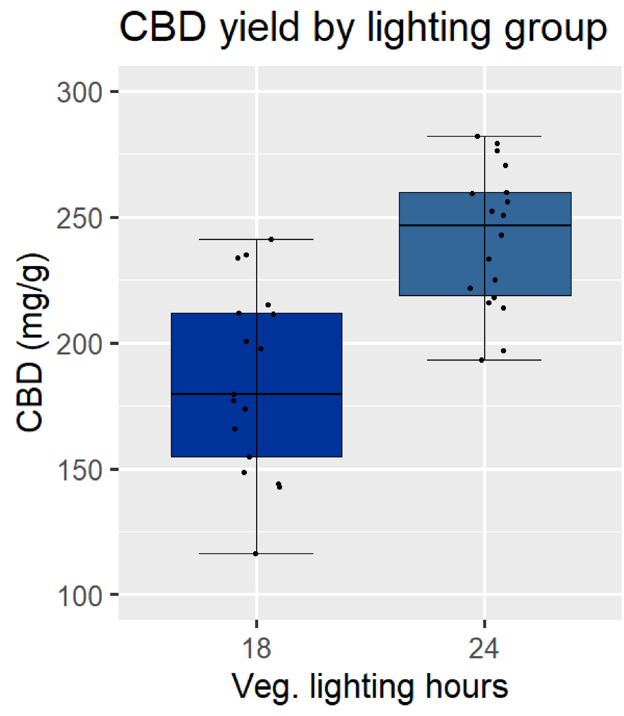



Morphological differences – root development:
Cannabis plants grown with 24-hours lighting in the vegetation phase had significantly better developed roots than plants with 18-hours lighting. *(p-value 0.01088 < alpha 0.05)*

### Cannabinoids:

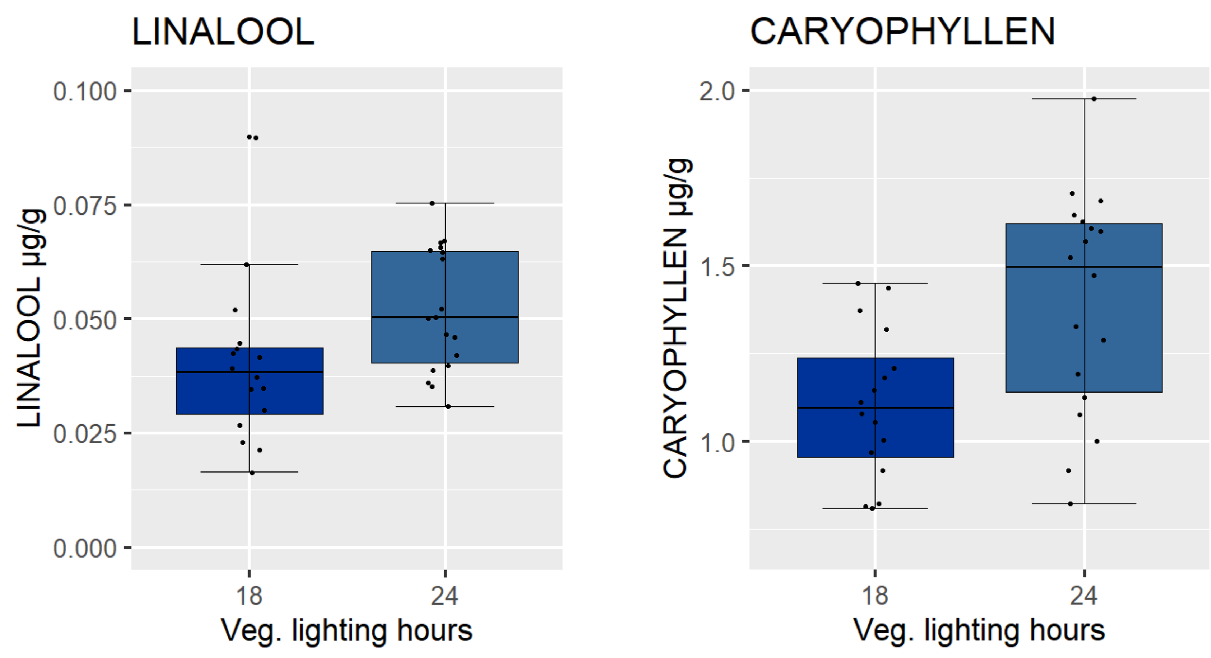
Yield of selected cannabinoids:
The European Parliament raised the limit from 0.2% to 0.3% in October 2020. Despite the increase in the threshold, 11 out of 18 samples for the 24-hour variant and 7 of 17 samples for the 18-hour variant are above this value. There were no significant differences between the groups in terms of THC yield, although a tendency towards higher values was observed in the 24-hour group.

Since Fedora 17 is known as a CBD-rich fiber hemp variety, the high CBD values are not surprising. Our attempt resulted in a maximum CBD value of 28.2%. The mean value of the 18-hour group was 18.5%, that of the 24-hour group 24.1%. This difference is statistically significant. *(p-value 1.331e-05 < alpha 0.05)*




### Terpenoids:

Lock-In effect:
The reduction of the red spectrum in the last three days of the flowering phase did not have a significant positive effect on the terpene levels. The Lock-in effect was not statistically present within the experiment.



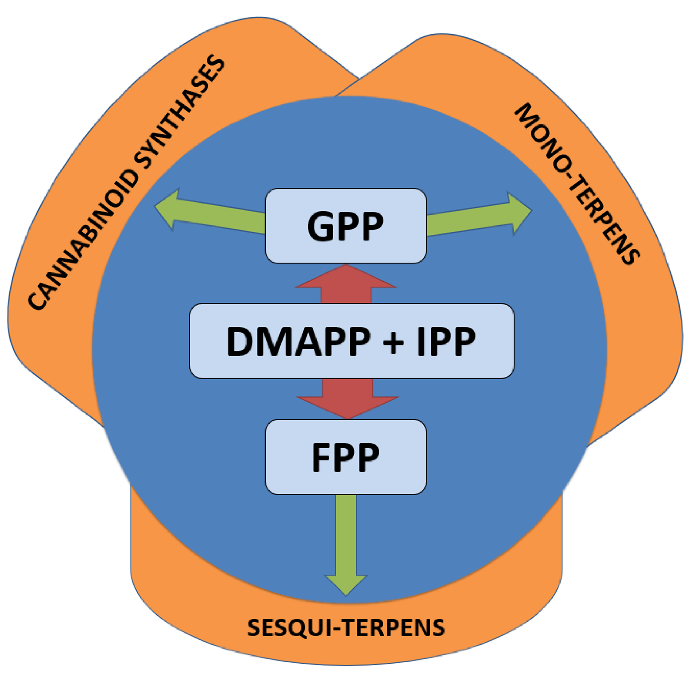

Yield of selected terpenoids:
The yields of the terpenes *LINALOOL* and *CARYOPHYLLEN* in the group that was exposed for 24-hours, increased significantly compared to the 18-hour variant. *(LINALOOL: p-value 0.032 < alpha 0.05, CARYOPHYLLEN: p-value 0.004085 < alpha 0.05)*

## 4 Conclusions

The statistical evaluation showed significantly better developed root systems in the group with the longer exposure.
Plants have a variety of photoreceptors that affect plant development. Studies have shown a link between these receptors and root development. These receptors are also present in the roots.
In the model plant *Arabidopsis thaliana*, it was demonstrated that the light is transmitted from the shoot to the roots via vascular bundles, where it activates the phytochrome B receptor. This receptor alters the gene expression of *HY5* which leads to an accumulation of linked proteins and thus enhances root growth. The results of the experiment follow these findings (Lee et al., 2016).

The differences observed between the two lighting groups with regard to cannabinoids and terpenes can be explained using different approaches. One approach is the light-protecting properties of some terpenes and cannabinoids. The lamps used are full spectrum LEDs with additional UV radiation. The aim is to use these lamps to copy the spectrum of the sun as well as possible. Some studies indicate that more cannabinoids are formed with increased UV radiation. A lamp can benefit from light-protecting properties, especially with permanent lighting (Yang et al., 2018).

Another explanation relates to the biosynthesis of cannabinoids and terpenes. Cannabinoids and monoterpenes are synthesized from geranyl pyrophosphate, sesquiterpenes from farnesyl pyrophosphate. Farnesyl pyrophosphate (FPP) is precursor, just like geranyl pyrophosphate (GPP), isopentenyl pyrophosphate (IPP) and its isomer dimethylallyl pyrophosphate (DMAPP) (Booth, 2019).
The synthesis of these precursors can be controlled by the intensity of light, which is a possible explanation for the observations made (Lichtenthaler, 1998).




Biosynthesis of secondary metabolites adapted from Yang et al., 2018