

# Growth and development of cereals in a controlled environment with sole source LED lighting

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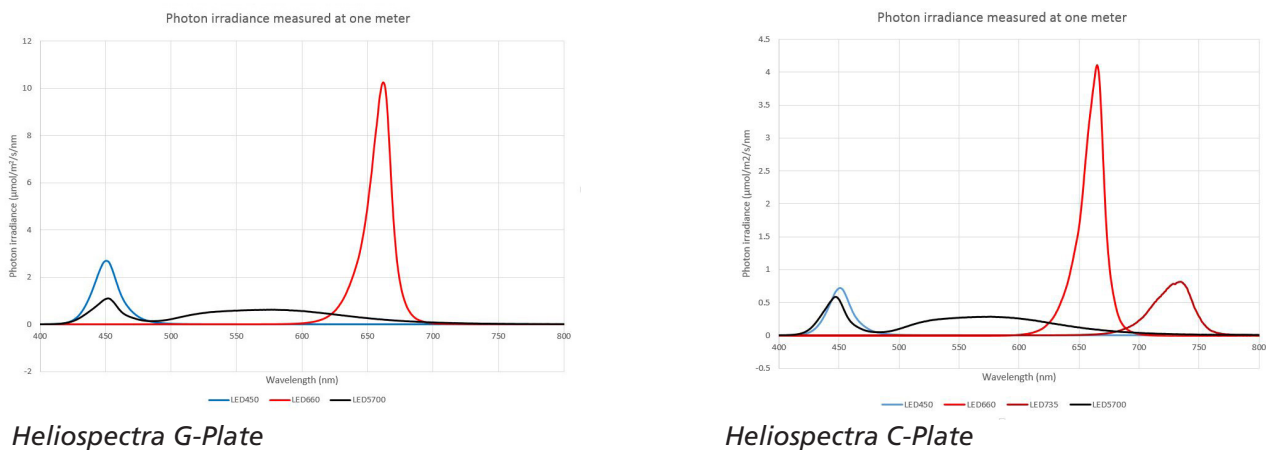
## Overview

University of Gothenburg, together with the biotech companies CropTailor and OlsAro as well as Heliospectra, have conducted a trial on growing cereals in a controlled environment under sole source LED lighting. The purpose was to study growth and development under two different LED light treatments, and also compare the results with experiences from growing under the traditional HID lamps. Growth parameters that are important to cereals and that were evaluated are plant architecture, developing time, flowering time, grain quality and yield.

## Method/Setup

Two different cereals were studied: oat (Belinda) and barley (Bonus). Eighteen seeds of oat and 4 seeds of barley were planted in pots (14 cm in diameter) with soil, 3 and 1 seed per pot, respectively. The plants were grown in a temperature-controlled Conviron growth cabinet, which was divided into two units by a reflective shade. Each unit was equipped with a LED lamp from Heliospectra, mounted 1.3 m above the floor. The lamp models LX602G and LX601C from the LX-series were used in this study. LX602G has three different LED diodes – blue (LED450), red (LED660) and white (5700K) – whereas LX601C also has far-red diodes (LED735). The photoperiod was 16 hours and the temperature was held constant at 22°C. The plants were watered twice a week, and extra water was applied on dry pots during the initial germination. No extra fertilizer was applied.

Figure 1. Light spectrum of the light treatments using the Heliospectra G- and C-Plate



## Purpose

The purpose of the light treatments was to study the effect of far-red light. The lamps were set to give the same PAR intensity, but with or without far-red light. Light intensities, measured 20 cm above the floor with LiCor PAR meter, are shown in Table 1.

## Results

After about 5 weeks, oat and barley in the far-red unit started to flower, and after 6 weeks, the plants in the non far-red unit started to flower as well. No other clear differences were observed by visual inspection, e.g. the leaves had similar color. After 9 weeks the differences were more distinct between treatments. Plants under far-red treatment were on average 10 cm taller (up to 110 cm tall), and they had better grain quality.

Absolute PFD ( $\mu\text{mol}/\text{m}^2/\text{s}$ )		
	FR	No FR
PAR	259	258
PAR + FR	301	260

Table 1. Light intensities of the light treatments.

Figure 2. Growth comparison of light treatments Far-red vs. No Far-red



Left: Oat comparison

Right: Barley comparison

After 13 weeks the grain quality was evaluated more thoroughly, every grain on each panicle (oat) and on each ear (barley) was counted and inspected. Oat treated with far-red had large panicles with 55-60 grains in each and a majority of the mini ears had two grains, whereas the oat not treated with far-red had 30-35 grains per panicle and one grain per mini ear. Size and weight of the grains did not differ significantly. As a comparison, oat grown under HID light (mixture of HPS and metal halide lamps, 124-203  $\mu\text{mol}/\text{m}^2/\text{s}$  in PAR 20 cm above the bench) in a growth room reached only about 60 cm in height, had approximately 25 grains per panicle and most mini ears contained one grain. The differences between LED light treatments were smaller for barley, it had 20-25 grains per ear in both units. However, the plants in the far-red unit were on average 10 cm taller.

Table 2. Light intensities of the light treatments.

Oat	Grain Count	Grain per Mini Ear	Weeks to Flower	Length (cm)
FR	55-60	2	5	110
No FR	30-35	1	6	100
HID*	25	1	5	60

\*PAR in HID units; 124-203  $\mu\text{mol}/\text{m}^2/\text{s}$  in PAR 20 cm above the bench

Barley	Grain Count	Grain per Ear	Weeks to Flower	Length (cm)
FR	20-25	2	5	100
No FR	20-25	1	6	87

## Results

In summary, both oat and barley grow well under sole source LED lighting. Ongoing studies on wheat show good promise as well (not published here). Far-red light seem to be beneficial, primarily for oat. The numbers obtained for oat in the far-red unit – 110 cm tall, 55-60 grains per panicle and two grains per mini ear – are strikingly good and highlights the potential of this technology for e.g. seed production in a controlled environment.



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