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Efficiency of photosynthesis comparing light emitting diodes and fluorescent tube irradiation

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Abstract

Light emitting diodes are known as a high efficiency and energy saving light source. But there are some disadvantages to be considered. LED's have low power per unit and only a static wavelength. Beside the technical problems there are plant physiological questions referring to their photosynthetic. To figure out the efficiency and usability of emitting diodes, this experiment compares LED to common fluorescent lamps by measuring and evaluating the CO^2 gas exchange response of a living control plant.

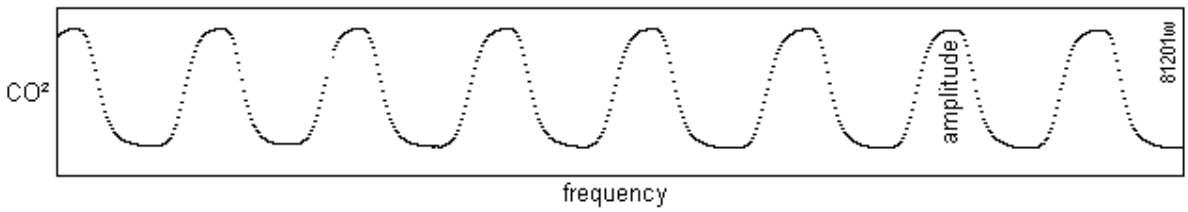
Material and Methods

Plant material, growth conditions and technical

Tabak (Nicotinia) were grown in growth chamber (model Chopper Light, Germany) under a 1 and 2 hour photoperiod, 60% relative humidity, and day/night temperatures of 25°/25°. As light source for this experiment, four 20w fluorescent tubes by the brand *OSRAM white cool* using a *Chopper Light adapting equipment for fast switching* and a combination of *98 blue and red LED's* were used to compare the value of the CO2 assimilation. The light intensities of both artificial illuminating trials were 80 µmol m^{-2} s^{-1} at a distance of 80mm.

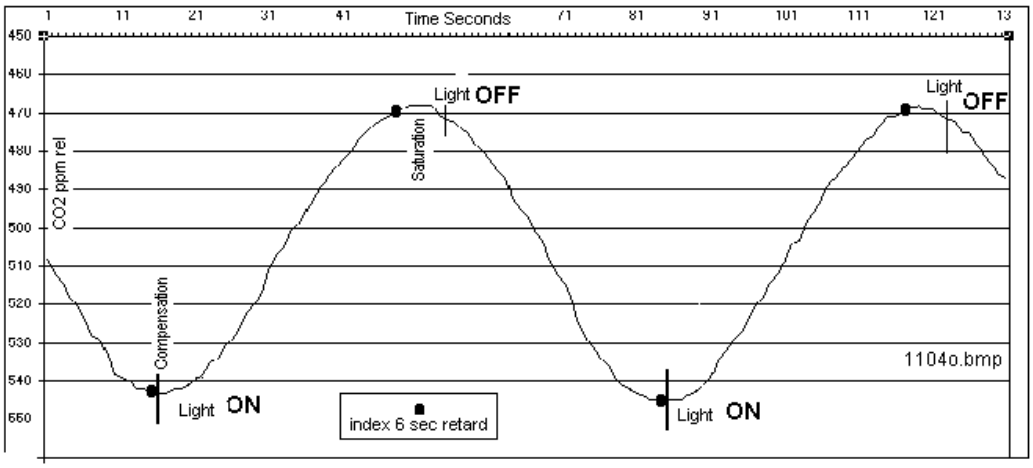
Exchange measurements and calculations

The interplay between the CO2 assimilation and light can be used as a control factor. The light is a main driving force for the CO2 assimilation, as a short statement: "no light - no assimilation - no photosynthesis". To measure the assimilation, a modified Chopper Light lamp and CO2 logger (ADC 225-MK3) were connected by a cuvette to the plant, a common method for CO2 investigation. The uniqueness for this way of CO2 recording, using the name PCL for plant controlled light, is that the CO2 assimilation controls the light when the light is switched between ON and OFF. This application gives a unique result. It generates a harmonic oscillation.



(Fig. 1)

Analyzing such an oscillation, it is possible to determine to the momentarily health condition of the living plant. By keeping the environmental conditions including stabilized, the shapes of the curves are all periodic. The height of the interval, called amplitude, is the first change that shows a reaction. Less sensitive is the wide of the frequency; a significant change was not remarkable.

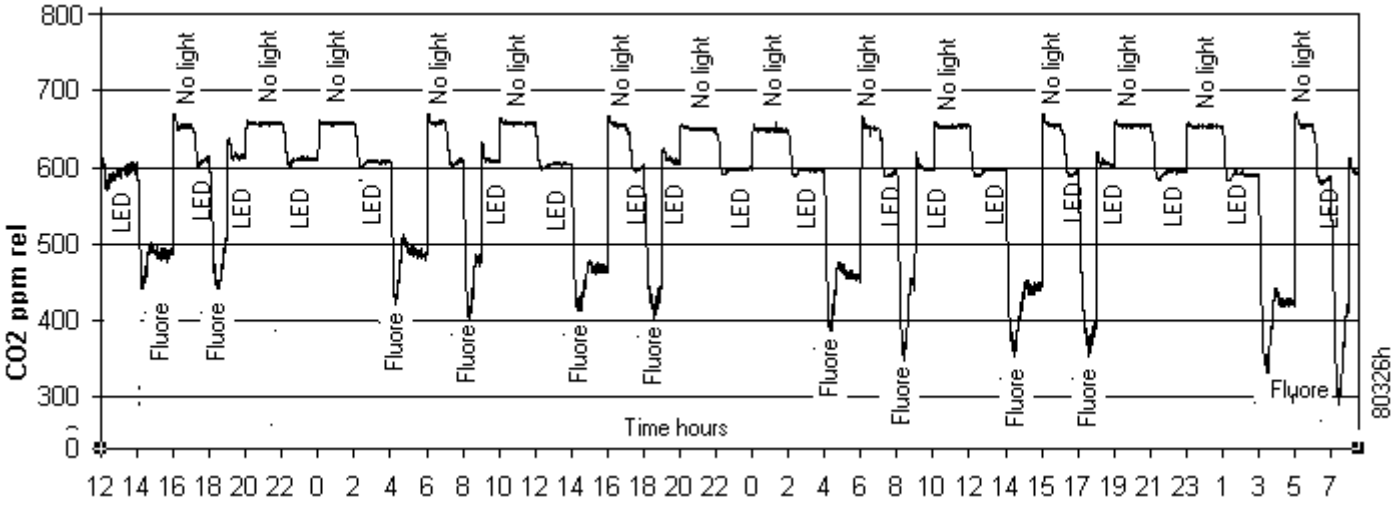


(Fig. 2)

A reaction to the intensity of light counts in seconds. A special designed software compares the actual CO2 value with the value of six second ago, and if the balance between values is equal, the light is switched. It should be noted, the light interval is generated by the plant and not from a mechanical pre adjusted switch. An additional ground light of 3 µmol is installed for technical support of light.

Results

The total length of the diagrams goes over 36 hours and runs in intervals of one or two hours. The CO^2 level was measured relative. The 650 nm CO2 level is the saturation point where the plant shows no readiness for further CO2 intake. The small peak on front of each saturation point is a characteristic reaction of the CO2 burst. Opposite when light goes on, it appears a similar effect, which is called the O2 gulp. The gulp lasts a little bit longer than the burst. Each gulp or burst is followed by normalization. A Strong light has a weighty gulp. The LED's as seen in the diagram, where the gulp is not the same significant as the gulp using the fluorescent light.



(Fig. 3)

Conclusion

This experiment showed the different CO^2 assimilation between the light source fluorescent light and Light Emitting Diodes. Concluding the result, generally fluorescent is more effective than LED illumination.