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# Chlorophyll fluorescence emission of tomato plants as a response to pulsed light based LEDs

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**Abstract** The effects of pulsed light based-LEDs at eleven frequencies (0.1, 1, 10, 50, 100, 500 Hz, 1, 5, 10, 50 and 100 kHz) programmed at 50 % duty cycle were analyzed, obtaining important parameters of the fluorescence emission of chlorophyll such as: maximum fluorescence (Fm′), minimum fluorescence, the fluorescence emission in steady state, maximum efficiency of PSII (Fv′/Fm′), the fraction of PSII centers that are open, photochemical quenching, nonphotochemical quenching (NPQ), quantum efficiency of photosystem II (ΦPSII), electron transport rate (ETR) and quantum yield of $CO_2$ assimilation ($\phi CO_2$). For the study and validation of the results obtained in the experiments, the analysis of variance (ANOVA) was applied 0for each parameter with confidence intervals of 95 %. The results show that the frequencies of pulsed light had positive and negative effects on the fluorescence parameters with respect to the control treatment (continuous light). The frequencies that generated the best performance of Fv′/Fm′, NPQ, ΦPSII, ETR, $\phi CO_2$ in tomato plants were 0.1, 1, 100 Hz, and 1 kHz. The increase obtained in these parameters can represent an optimal growth and productivity conditions for optimal energy consumption.

**Keywords** Chlorophyll fluorescence · Pulsed light · LEDs · Growth plants

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## Introduction

Light is a source of information affecting germination, phototropism, flowering time, development of chloroplasts movements in leaves and stomata with which plants control photosynthesis (Goto 2003; Spalding and Folta 2005). Light also provides energy for plants to synthesize organic compounds. There are several factors related to light that are involved in growth and development of plants like quality and quantity of the light, and photoperiod (Goto 2003). These factors can be easily manipulated in growth chambers, growth rooms and partially controlled in greenhouses.

There exist a wide variety of artificial light sources for plant growth: metal halide (MH), fluorescent lamps, high pressure sodium lamps and solid state lighting (LEDs). To evaluate the effects of light on the plant growth (quality and quantity), different light sources were applied during the growth of lettuce, tomato, spinach, and cucumber (Bula