# Effects of Light Intensity on the Photosynthetic system Response in vegetables

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Light is one of the most important environmental factors that regulates plant photosynthetic system growth and development [1]. At high and low light intensities, photosynthetic carbon fixation increases, but the excess light is a stressor and therefore causes depression of photosynthetic efficiency [2]. Photosynthetic systems are also exposed by the spectrum of light. The effects of blue radiation on photosynthesis are the consequences of the specific absorption spectrum of photosynthetic pigments (chlorophylls, carotenoids) [3].

Photosynthetic rate is one of non-intrusive tools for rapidly inferring several functionally important leaf and plant properties. Photochemical reflectance index (PRI) is related with photosystem II (PSII) via the xanthophyll cycle and could be used as a proxy for light use efficiency (LUE). PRI can track minor LUE changes in an environment with changing light, or it can serve as a proxy for physiological variables of light-dependent photosynthetic reactions. Long-term research showed that the main source of variation in the PRI–LUE relationship is changes of chlorophylls and carotenoids ratio under changing temperature [4]. However, it is not yet well known, how different combinations of light intensity affects vegetables photosynthetic systems response.

In this study we present how different light intensity produced by light emitting diodes (LEDs) influence the response of photosynthetic system in different vegetables, cultivated in the closed environment. Red leaf lettuces (*Lactuca sativa* L., 'Lobjoits Red Cos') and radish (*Raphanus sativus* L., 'Cherry Belle') were cultivated under combinations of red (660nm) and blue (445 nm) LED lighting under different photosynthetic photon flux density (PPFD) of 150 and 250 µmol $m^{-2}s^{-1}$ for three weeks. Before the technical maturity stage, plants were treated as follows: (1) 150 µmol $m^{-2}s^{-1}$ (2) 150 µmol $m^{-2}s^{-1}$ to 250 µmol $m^{-2}s^{-1}$ (3) 250 µmol $m^{-2}s^{-1}$ and (4) 250 µmol $m^{-2}s^{-1}$ to 150 µmol $m^{-2}s^{-1}$. At the technical maturity stage, photosynthesis rate, PRI, LUE, chlorophyll a and b and xanthophyll's (zexanthin+lutein) contents were evaluated.

Results has shown that light intensity differently affects photosynthetic response of different growth strategy vegetables (Table 1). In contrast to radish, red leaf lettuce was less sensitive to changes of PPFD during vegetation period. The common tendency for both plants was found only for LUE – significantly lower values were found under 250 µmol $m^{-2}s^{-1}$ , whereas significant increase was observed when seedlings of both plants were treated with 250 µmol $m^{-2}s^{-1}$ and during maturity stage were treated with 150 µmol $m^{-2}s^{-1}$. In contrast to radish, grown only under 250 µmol $m^{-2}s^{-1}$ PPFD and illuminated by lower PPFD during maturity stage, the significant increase of photosynthetic rate followed by significant decrease of chlorophyll's and xanthophylls accumulation was observed in radish grown only under 250 µmol $m^{-2}s^{-1}$ PPFD.

Table 1. Influence of PPFD on photosynthesis rate, PRI, LUE, chlorophyll a, b and xanthophyll's contents

| Light intensity µmol $m^{-2}s^{-1}$ | PRI | | Photosynthetic rate | | Light usage efficiency | | Chl-b µg/$g^{-1}$ | | Chl-a µg/$g^{-1}$ | | Zexsanthin + Lutein µg/$g^{-1}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Red leaf lettuce | Radich | Red leaf lettuce | Radich | Red leaf lettuce | Radich | Red leaf lettuce | Radich | Red leaf lettuce | Radich | Red leaf lettuce | Radich |
| 150 | -0,075 | **0,090**** | 8,715* | 20,831 | 0,058 | **0,139** | 118,644 | 94,211 | 455,208 | 319,783 | 1,974 | 2,204 |
| 150→250 | -0,085 | 0,069 | 13,097 | 18,408* | 0,052 | 0,074* | 111,937 | 84,717 | 416,909 | 321,882 | 1,936 | 2,031* |
| 250 | -0,086 | 0,054* | 11,253 | **25,013**** | 0,045* | 0,100* | 114,804 | 54,160* | 393,281 | 199,549* | 2,084 | 1,361* |
| 250→150 | -0,069* | 0,073 | 13,037 | 17,177* | **0,087**** | 0,115* | 130,307 | **176,521**** | 428,769 | **657,410**** | 2,183 | **5,115**** |
| $LSD_{0,05}$ | 0,008 | 0,007 | 1,616 | 1,156 | 0,010 | 0,006 | 25,695 | 39,108 | 87,680 | 138,924 | 0,366 | 0,594 |
| $LSD_{0,01}$ | 0,012 | 0,011 | 2,448 | 1,752 | 0,016 | 0,009 | 38,932 | 59,254 | 132,848 | 210,490 | 0,554 | 0,900 |

* Significant at P <0.05; ** Significant at P <0.01, according to Fisher's criteria

Concluding remark. The photosynthetic behaviour of different life strategies vegetables varies depending on solid-state lighting intensity. The most favorable conditions for red leaf lettuce photosynthetic system is cultivation only under 250 µmol m-2s-1 PPFD and illumination by lower PPFD during maturity stage. Whereas, the significantly lower amount of photosynthetic pigments resulted in increase of photosynthetic rate in radish cultivated only under 250 µmol $m^{-2}s^{-1}$ PPFD.

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