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Lettuce has a retail value of nearly \$2 billion and is one of the most widely consumed fresh crops. Growing lettuce in indoor vertical farms has gained popularity due to greater annual productivity, shorter production cycles, and consistent, year-round quality attributes.

We investigated how light intensity (or the photosynthetic photon flux density; PPFD), photoperiod, and their product, the daily light integral (DLI), affect lettuce growth and quality attributes. We wanted to determine whether lettuce growth would increase linearly with DLI, and whether growth was similar under the same DLI achieved by different PPFDs and photoperiods.

We grew red-leaf lettuce 'Rouxai' and green-leaf lettuce 'Rex' in the Controlled Environment Lighting Laboratory at Michigan State University using a deep flow hydroponics system at an air temperature of 72 °F (22 °C). The lighting treatments consisted of different combinations of PPFDs and photoperiods to achieve DLIs of 6.9 to 15.6 mol·m⁻²·d⁻¹. PPFDs ranged from 120 to 270 μmol·m⁻²·s⁻¹ and photoperiods were between 16 and 24 hours.

26 days after seed sow, we quantified plant growth by measuring fresh weight, dry weight, leaf width, leaf length, leaf number, and plant diameter, as well as quality metrics such as leaf color and relative chlorophyll concentration (SPAD index).

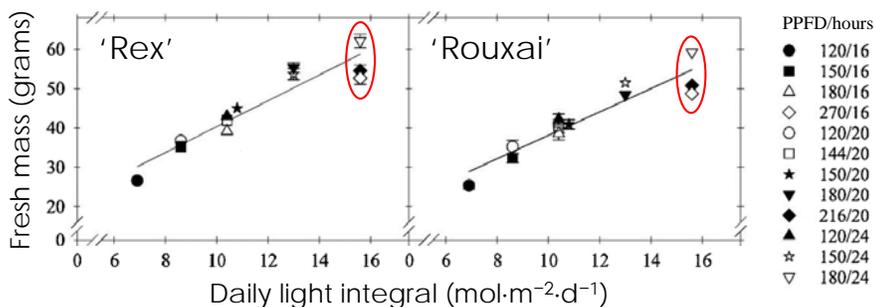


Figure 1. The effect of PPFD, photoperiod, and their product (daily light integral) on fresh shoot mass of two lettuce cultivars 26 days after seed sow.

Summary of Findings

As the DLI increased:

- Fresh weight (Figure 1), dry weight, leaf width, leaf number, and SPAD index increased for both cultivars.
- Plant diameter and leaf length decreased for the cultivar 'Rex' but there was no change for 'Rouxai'.
- 'Rouxai' leaves became redder, bluer, and darker.

At the highest DLI of 15.6 mol·m⁻²·d⁻¹ (red circles):

- A lower PPFD with a longer photoperiod led to greater yields for both cultivars, compared to a higher PPFD paired with a shorter photoperiod.

At a lower DLI of 10.4 mol·m⁻²·d⁻¹:

- The combination of PPFD and photoperiod did not affect plant growth

Take-Home Message

- As expected, increasing the DLI increased quality attributes and linearly increased growth.
- At a high DLI, a lower PPFD and long photoperiod increased yields more than a higher PPFD and a shorter photoperiod.

