e-GRO Edible Alert

Jonathan Karall
jaa337@cornell.edu

Neil Mattson
nsm47@cornell.edu

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Do Microgreens Respond to Daily Light Integral and Carbon Dioxide Enrichment?

Microgreens are defined as a wide range of vegetable and herb seedlings that are harvested shortly after the emergence of the first true leaf and prior to leaf expansion/senescence of cotyledons. Microgreens represent a quick turn, potentially high value crop for greenhouses and indoor production. Because there are a wide diversity of species used, recommendations for cultural practices are lacking for many. Relatively little information is available on microgreens responses to light and carbon dioxide.

Figure 1. Microgreens have gained popularity as a tasty salad ingredient and garnish.

Because many microgreens start with a relatively large seed that can provide initial nutrition to the developing seedling it is thought they are relatively less responsive to light and CO_2 than their full-size counterparts (ex. baby greens or head lettuce). However, experimental data is needed to evaluate these claims. <u>The objective of this study</u> was to determine how three species of microgreens would respond to daily light integral (DLI) varying from 3 to 12 $mol \cdot m^{-2} \cdot d^{-1}$ and carbon dioxide enrichment from 400 ppm (ambient) to 1,000 ppm.

Figure 2. Images of microgreen species used in the experiment where A, B and C represent arugula, mizuna and mustard. Images © by Jonathan Karall, Cornell University.

Experimental methods

Three microgreen species; arugula (*Eruca sativa* L.), mizuna (*Brassica rapa* L. var. japonica) and mustard (*Brassica juncea* 'Garnet Giant') were chosen for this study. The seeds were purchased from Johnny's Seed and were selected to represent a diversity in sensory attributes for both vision and taste. We also choose these three as their share similarities in seed size and number of days from seeding to harvest.

Previous experiments were conducted to determine cultural parameters such as seed density, fertilizer, and substrate (see GPN article). We used flats with 2401 (24-cell) inserts with a peat-based potting mix (Lambert LM-111) pre watered to a moisture content ratio of 1:1 (peat-lite mix:fertilizer solution) by weight with Jack's 21-5-20 Liquid Feed at 150 ppm nitrogen. Seeds were sown on the top of the substrate at a rate of 125 seeds per cell (equivalent to 3,000 seeds per 20"x10" flat). Seeds were then misted with the same fertilizer solution. For germination, the trays were covered with a propagation dome that was then covered with a standard black flat to restrict light. Seeds were then germinated in darkness at 73 °F until 95% of the seedlings were 1 cm in height. Germination times were 42 hours for arugula, 46 hours for mizuna, and 48 hours for mustard. After germination, microgreens were placed into the respective treatments (described below) with 12 cells per species per treatment.

The experiment used two adjacent controlled environment chambers at 73 °F, each with their own mini acrylic chambers which allowed for control of CO_2, temperature, and relative humidity. For each experimental run, one DLI (from 3, 6, 9, and 12 $mol{\cdot}m^{-2}{\cdot}d^{-1}$) was selected. The growth chambers had T5 cool white fluorescent lights. Light was supplied over a 14 hour photoperiod. Shade cloth (50%) was used over afor the lowest DLI. Each of the four acrylic mini chambers was randomly assigned one of the CO_2 concentrations (400, 600, 800, 1000 ppm). Flats were watered as needed (roughly every 3-days) via subirrigation with Jack's 21-5-20 at 150 ppm N. The experiment was repeated for each DLI and then replicated over time for a total of three times.

Microgreens were harvested when 50% of seedlings had a first true leaf measuring 1 cm in length. Measured parameters included average plant height (from substrate to the tallest part of representative plants), days to harvest, and fresh weight per cell.

Fresh weight

For mizuna and mustard there was a linear increase in fresh weight as DLI increased from 3 to 12 mol·m^{-2}·d^{-1} (Figure 3) Fresh weight increased by 22-25% from the lowest to the highest DLI treatment. Arugula was more responsive to DLI, fresh weight increased by 51% from 3 to 9 mol·m^{-2}·d^{-1} and then exhibited little further gains from 9 to 12 mol·m^{-2}·d^{-1}. All species responded to carbon dioxide enrichment in a linear fashion showing about an 11% yield increase from 400 to 1,000 ppm CO_2. Put another way, CO2 enrichment could be used to reduce the amount of lighting needed. For example, fresh weight of mizuna at a DLI of 9 mol·m^{-2}·d^{-1} with 1,000 ppm CO_2 was greater than a DLI of 12 mol·m^{-2}·d^{-1} with ambient CO_2 (400 ppm).

Height

Average plant height for mizuna and mustard decreased linearly as DLI increased from 3 to 12 mol·m^{-2}·d^{-1} (Figure 4). Decreases amounted to reductions in plant height of 0.9 cm for mizuna and 1.3 cm for mustard as DLI increased from 3 to 12 mol·m^{-2}·d^{-1} at 400 ppm CO_2.

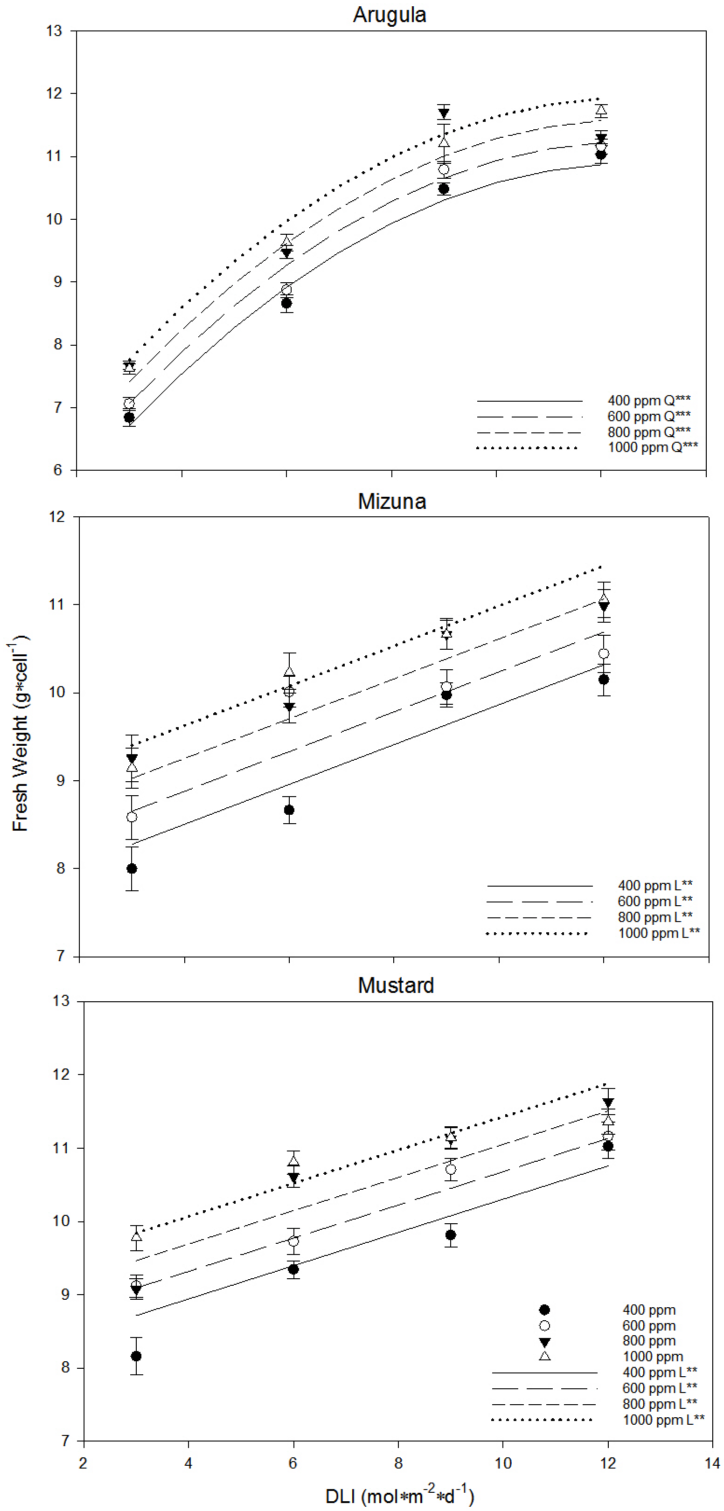

Figure 3. Fresh weight (grams per cell) of arugula, mizuna, and mustard microgreens in response to daily light integral and CO_2 (Note 1 20”x10” tray = 24 cells)

For arugula, plant height was essentially unaffected by DLI but did decrease at the highest treatment 9 mol·m^{-2}·d^{-1}. CO2 also had a subtle effect where plant height increased slightly (0.4 cm averaged across species and light levels) as CO_2 increased from 400 to 1000 ppm.

Days to Harvest

The days to harvest varied by species and was about 12 days for arugula and mustard and 10.5 days for mizuna at the lowest DLI (Figure 5). Days to harvest decreased for all species by about two days as DLI increased to 12 mol·m^{-2}·d^{-1}. The CO_2 concentration did not influence plant developmental stage (i.e. days from seeding to harvest).

Bottom Line

While microgreens do not appear to require DLIs as high as mature leafy greens crops (ex. 17 mol·m^{-2}·d^{-1} for head lettuce) or fruiting crops (ex. 25+ mol·m^{-2}·d^{-1} for tomatoes), microgreens may benefit from increasing DLI up to 9 mol·m^{-2}·d^{-1} for arugula and 12 mol·m^{-2}·d^{-1} (and potentially beyond) for mizuna and mustard. Growers should understand their ambient DLI (such as by purchasing a quantum sensor connected to a datalogger) to then assess if supplemental light makes sense (or during which months it makes sense). Besides increasing fresh weight, increased DLI reduced days to harvest by about two days resulting in quicker crop turns. CO_2 enrichment from ambient to 1,000 ppm increased harvested fresh weight by 11%. Thus, growers should

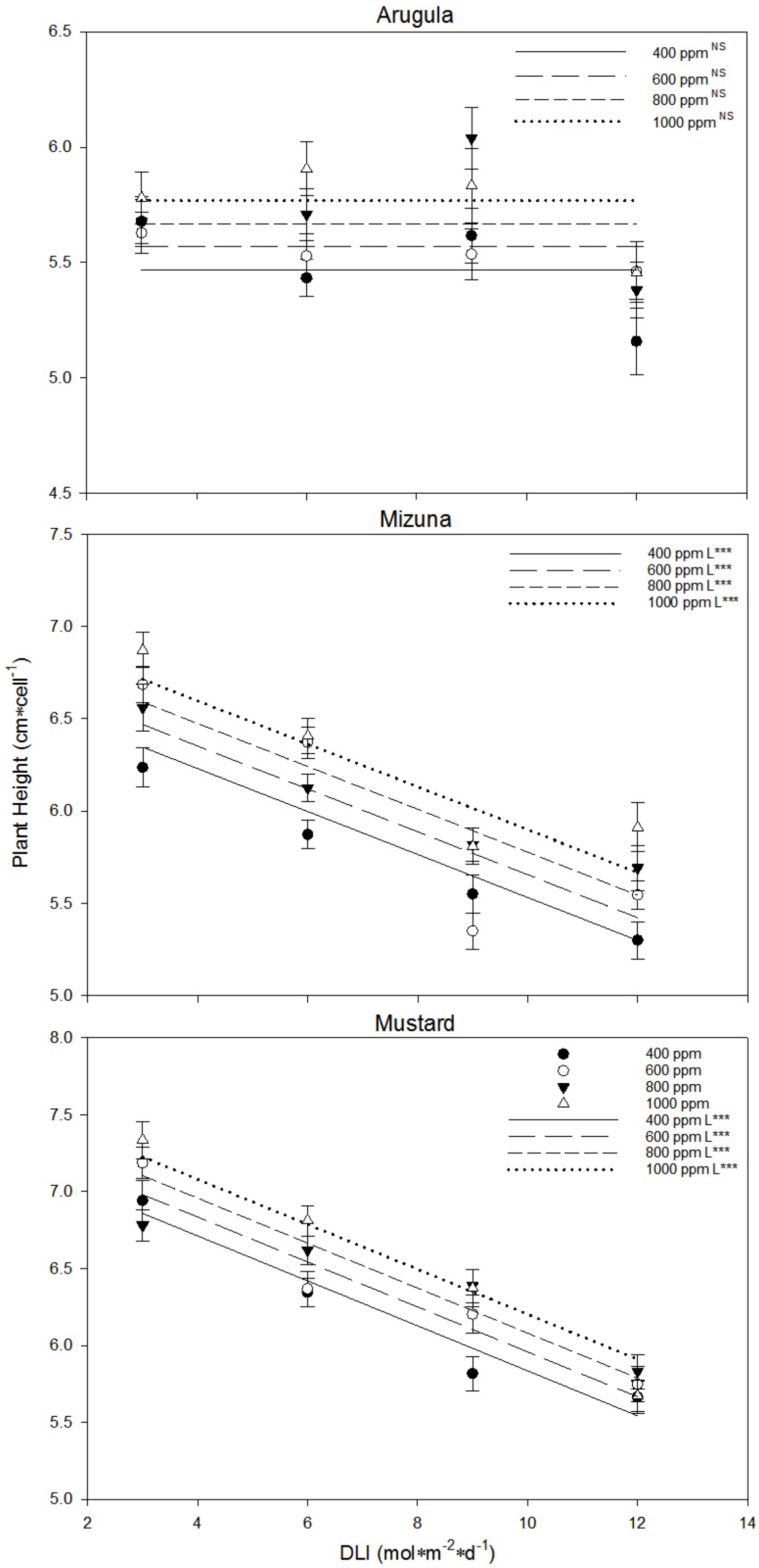

Figure 4. Height of arugula, mizuna, and mustard microgreens in response to daily light integral and CO_2.

assess the economics of CO_2 enrichment and in closed production systems (i.e. no open ventilation) there may be an economic returning of CO_2 enrichment. Plant height decreased by up to 1.3 cm with increasing DLI. For some growers, if microgreens are too compact in height they can be difficult to harvest. If these growers use higher light intensities they may want to consider measures to increase stem height such as a slightly longer germination period in the darkness. More research is needed to quantify how other microgreens species/cultivars respond to light and carbon dioxide. Commercial growers should always conduct small-scale trials to see how plants respond in their own facilities before adopting new practices.

Overall microgreens can be a profitable crop and they may be more practical (in terms of energy cost) for indoor farming without sunlight as they require lower DLI than head lettuce and fruiting crops.

Citations

Allred, J. and N. Mattson. 2018. Growing better greenhouse microgreens. Greenhouse Product News, Under Control, CEA supplement. October:10-13. Available online.

Allred, J. 2017. Environmental and cultural practices to optimize the growth and development of three microgreen species. M.S. Thesis. Cornell University. 78pp. Available online.

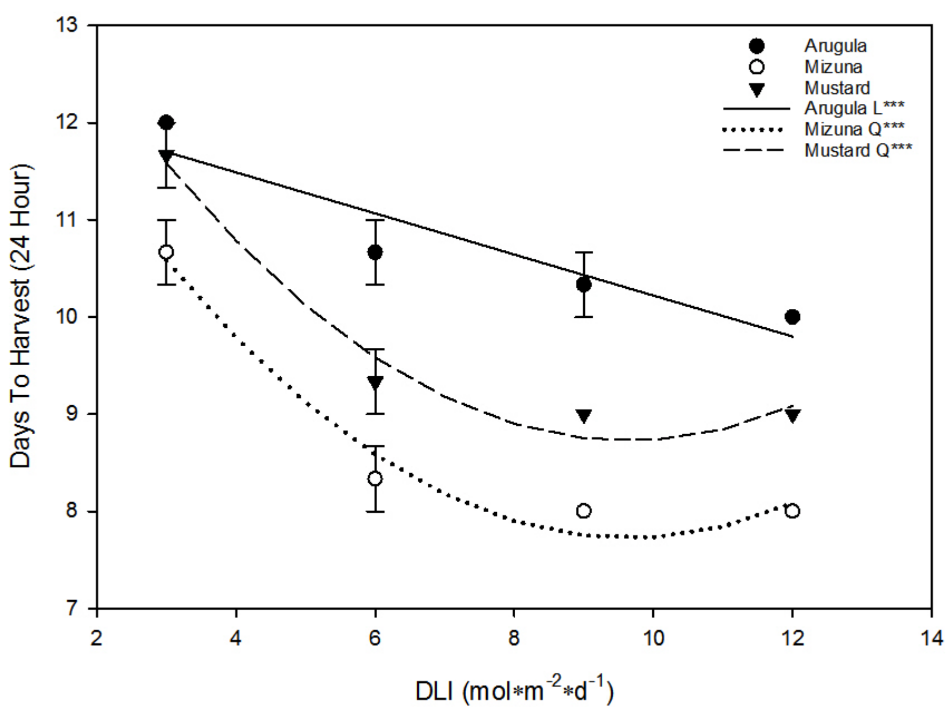

Figure 5. Days from seed to harvest of arugula, mizuna, and mustard microgreens in response to daily light integral and CO_2.

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CONTRIBUTORS

Dr. Nora Catlin
Floriculture Specialist
Cornell Cooperative Extension
Suffolk County
nora.catlin@cornell.edu

Dr. Chris Currey
Assistant Professor of Floriculture
Iowa State University
ccurrey@iastate.edu

Dr. Ryan Dickson
Greenhouse Horticulture and
Controlled-Environment Agriculture
University of Arkansas
ryand@uark.edu

Dan Gilrein
Entomology Specialist
Cornell Cooperative Extension
Suffolk County
dog1@cornell.edu

Dr. Chieri Kubota
Controlled Environments Agriculture
The Ohio State University
kubota.10@osu.edu

Heidi Lindberg
Floriculture Extension Educator
Michigan State University
wolleage@anr.msu.edu

Dr. Roberto Lopez
Floriculture Extension & Research
Michigan State University
rglopez@msu.edu

Dr. Neil Mattson
Greenhouse Research & Extension
Cornell University
neil.mattson@cornell.edu

Dr. W. Garrett Owen
Sustainable Greenhouse & Nursery
Systems Extension & Research
The Ohio State University
owen.367@osu.edu

Dr. Rosa E. Raudales
Greenhouse Extension Specialist
University of Connecticut
rosa.raudales@uconn.edu

Dr. Alicia Rihn
Agricultural & Resource Economics
University of Tennessee-Knoxville
arihn@utk.edu

Dr. Debalina Saha
Horticulture Weed Science
Michigan State University
sahadeb2@msu.edu

Dr. Beth Scheckelhoff
Extension Educator – Greenhouse Systems
The Ohio State University
scheckelhoff.11@osu.edu

Dr. Ariana Torres-Bravo
Horticulture/ Ag. Economics
Purdue University
torres2@purdue.edu

Dr. Brian Whipker
Floriculture Extension & Research
NC State University
bwhipker@ncsu.edu

Dr. Jean Williams-Woodward
Ornamental Extension Plant Pathologist
University of Georgia
jwoodwar@uga.edu

Cooperating Universities

Cornell CALS – College of Agriculture and Life Sciences

Cornell Cooperative Extension Suffolk County

UTIA Institute of Agriculture – The University of Tennessee

Iowa State University

College of Agricultural & Environmental Sciences – University of Georgia

UCONN

U of A Division of Agriculture – Research & Extension – University of Arkansas System

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