Comparison of Two Hydroponic Tower Systems for Lettuce Production

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Introduction
Hydroponic vegetable production is increasing at a rate of 5.3% each year. Vertical farming has proven to use less land and water than traditional farming while reducing fossil-fuel emissions and fertilizer waste. This study evaluated the production of Black Seeded Simpson lettuce, Lactuca sativa, to test the performance of two hydroponic tower systems (Fig. 1), a commercially available tower (Tower A) and a student-designed tower (Tower B) in an indoor farming system in Richmond, KY.

Objectives
• Evaluate weekly growth of Lactuca sativa from Tower A and from Tower B.
• Evaluate total yield harvested of Lactuca sativa from Tower A and from Tower B after 50 days of treatment (DOT).

Materials and Methods
• The study was conducted twice, once in the spring and again in the fall of 2016.
• Lettuce seed was germinated in 2.5 cm rockwool cubes under mist in a greenhouse for ten days prior to being transferred to each tower in an indoor setting.
• Each tower contained 24 plant compartments. The compartments on Tower A were evenly spaced on a 20 cm diameter pipe, and the compartments on Tower B were dispersed on two 10 cm diameter pipes. All pipes on the towers were 1.2 meters tall.
• FloraSeries was used to provide nutrients for the lettuce in each tower (Fig. 2).
• Treatments were arranged in a randomized complete block design with eight replications and four treatments per block.
• Each week, leaf area index (LAI) (Fig. 3) and leaf weight were measured of an average-sized leaf harvested from each compartment. Photographs were also taken of each compartment (Fig. 4).
• Lettuce was destructively harvested at the conclusion of the studies (DOT 50) and total LAI and leaf weight recorded for each tower.

Results
• Both towers had similar leaf area and leaf weight throughout each of the spring and fall studies with differences noted in LAI and leaf weight on DOT 16, 23 (spring and fall), and 37 (fall only) (Fig. 5 & 6A & B).
• At the conclusion of each study (DOT 50), LAI and leaf weight was greater for Tower A (Fig. 7 & 8) with the exception of no differences being observed for LAI between the two towers at the end of the fall study (Fig. 7).
• Overall, both towers produced higher yields in the fall study compared to the spring study (Fig. 7 & 8). Tower A yielded 50% (LAI) and 42% (leaf weight) more lettuce in fall than spring; and Tower B yielded 58% (LAI) and 27% (leaf weight) more lettuce in fall than spring.

Conclusions
• Weekly growth data indicates there are no differences between the effectiveness of the two towers to grow Lactuca sativa, although results are inconclusive because only one leaf was measured on DOT 9, 16, 23, 30, 37, and 44.
• Total yield data collected at the conclusion of each study (DOT 50) indicates Tower A performs better than Tower B when growing Lactuca sativa.
• Lower yields from Tower B may have been caused by poor light distribution resulting in light not reaching the lettuce located in the area between the two pipes.
• An increase in yield from spring to fall by both towers may have been caused by room temperature and light distribution.