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Evaluating the performance of small-scale indoor vertical hydroponics systems for lettuce production

Abiodun Adelowokan[1], Elham Fathidarehnijeh[1], Kamsika Jeyarasa[1], Oludoyin Adigun[1], Raymond Thomas[1], Lakshman Galagedara[1] and Mumtaz Cheema[1]

[1]School of Science and Environment, Grenfell campus, Memorial University of Newfoundland, Corner Brook, A2H 5G4, Canada

*aaadelowokan@grenfell.mun.ca

Introduction

- Food security is a significant concern across the globe due to climate change and ever increasing world's population.
- Newfoundland and Labrador (NL), faces challenges of field crop production due to extreme weather conditions, short growing season, stony and low fertile soils.
- Current food production in NL is only 10% of its total population's requirement.
- To enhance local food production and reduce carbon foot prints, there is a need to introduce some innovative approaches or techniques to produce homegrown fresh vegetables.
- One option is growing vegetables under household conditions, such as small-scale indoor vertical hydroponics to grow vegetables without additional resources.

Objectives

- To evaluate the performance of small-scale vertical hydroponic systems designed specifically for indoor vegetable production
- To assess the effects of light emitting diodes (LED) and fluorescent light on the growth and yield of lettuce.

Materials and methods

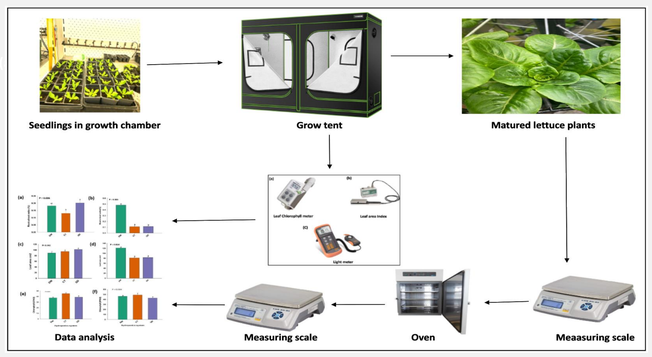

Fig. 1. Flow chart showing the step-by-step processes of lettuce production in grow tent.

- The experimental treatments consist of two vertical hydroponic systems: Christmas Tree (CT), Green DNA (GD), and a commercially available deep-water system (DW) (control).
- The experimental design was completely randomized with three replications, while the experiment was repeated twice.
- Pelleted lettuce seeds were sown in pre-soaked nursery trays containing coco coir.
- Seedlings were raised in a walk in growth chamber located at the RECPLEX building, a Boreal Ecosystem Research Facility, Grenfell Campus Memorial University of Newfoundland.
- Three-week-old lettuce nursery plants were transplanted in CT, GD and DW systems in the grow tent.
- During the growth cycles, photoperiod, temperature, and relative humidity were maintained at 16/8 h day/night, 25/17 °C, and 75-80%, respectively.
- EC and pH were monitored 2-3 times daily, and pH was maintained 5.8–6.2.
- A ready-to-mix commercially available nutrient solution was prepared following the product guide from the manufacturer.
- Two experiments were performed at different times with two different light sources: (1) LED and (2) fluorescent lights.
- Lettuce crop was harvested 45 days after seeding .
- The agronomic performance was measured based on the number of leaves, total fresh biomass, leaf area, shoot, and root dry weight, root-shoot ratio,

Results and Discussion

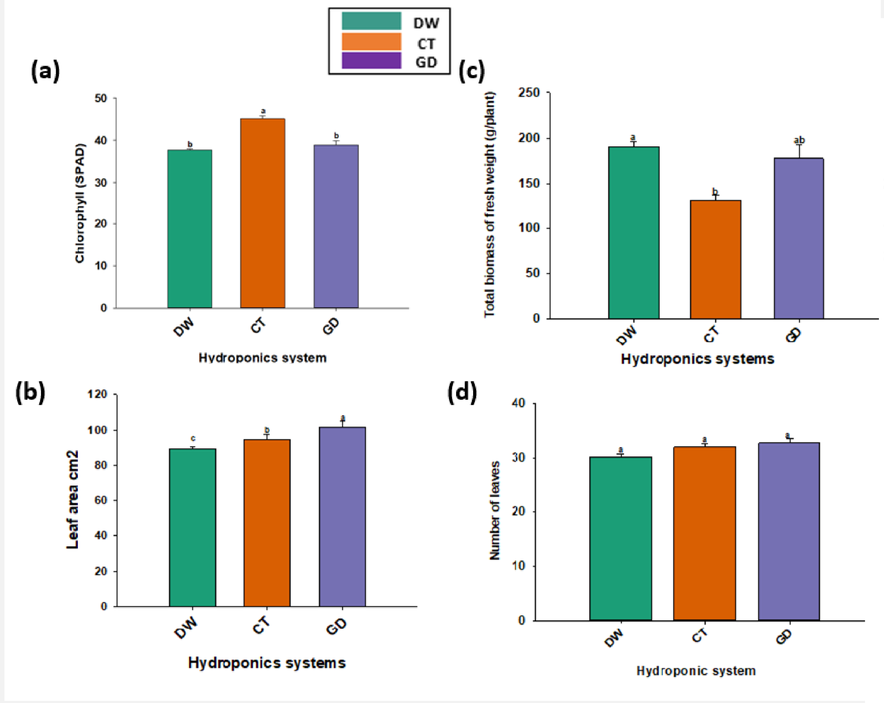

Fig. 2. Comparative performance of small scale vertical hydroponic systems with Christmas tree (CT), Green DNA (GD) and Deep-water culture system as control

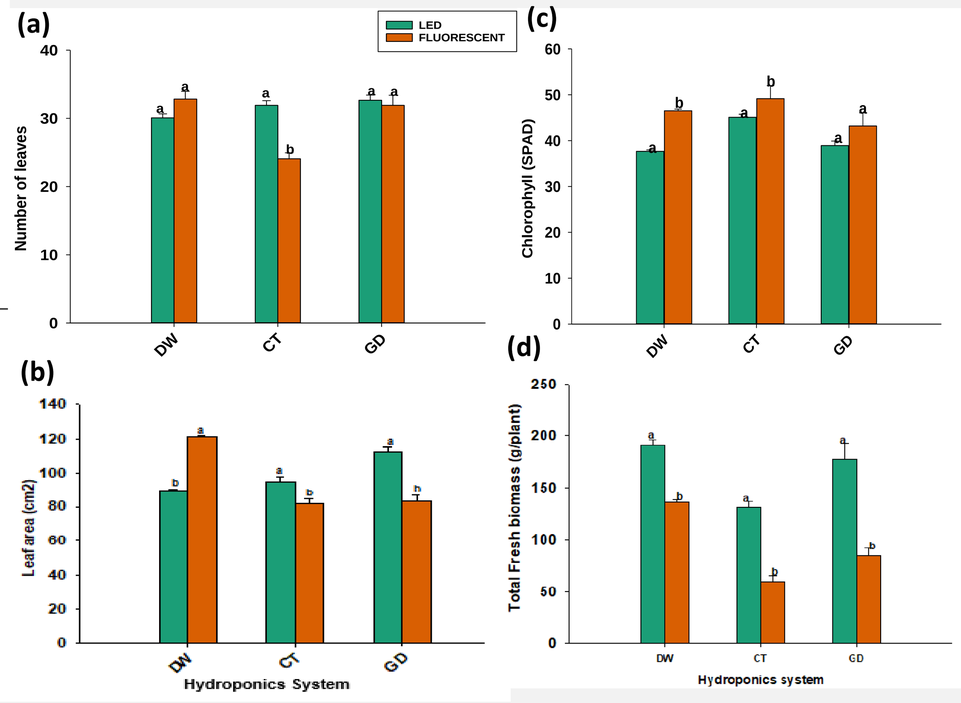

Fig. 3. Effect of light sources on the agronomic performance of lettuce: (a) number of leaves (b) Leaf area (c) Chlorophyll content (d) Total fresh biomass

- All three hydroponic systems have a significant effect on the tested agronomic parameters;
- Total fresh biomass was significantly higher in DW, though statistically at par with GD. Lowest total fresh biomass was recorded in CT system.
- The chlorophyll content were significantly higher in CT compared to GD and DW, but there was no statistical difference between GD and DW.
- GD produced higher root fresh weight and root dry weight.
- Leaf area was significantly higher in GD, followed by CT whereas, lowest was observed in DW system.
- Light sources had significant effects on agronomic performances parameters of the lettuce crop. Total fresh biomass, LA, root fresh and dry weight was significantly higher in LED compared to fluorescent light.
- However, fluorescent light produced significantly higher chlorophyll content, but there was no significant difference in the number of leaves produced under both light

Conclusions

- Based on two crop growth cycle results, DW system produced higher total fresh biomass; however vertical hydroponic systems (CT and GD) produced higher chlorophyll content, LA, root fresh and dry weight.
- LED showed superior agronomic performance than fluorescent light.
- Further studies are ongoing to measure the phytochemical profile of the lettuce grown in three systems and two lights (LED and fluorescent lights).
- To authenticate feasibility of small-scale indoor vertical hydroponics systems, further growing of crop cycles with close monitoring is needed. in a home environment.

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