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EXTENDED ABSTRACT
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Optimizing Lettuce (*Lactuca sativa*) Growth in Hydroponic Systems: Varietal and Container Insights

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Lettuce (*Lactuca sativa*) is a favored component of salads, and its suitability for hydroponic cultivation is well-established. However, debates persist regarding the optimal hydroponic techniques and suitability of lettuce varieties. To address this, a study was conducted with the following objectives: (i) to determine the preferred lettuce varieties for a hydroponic system, and (ii) to compare the growth of lettuce varieties in pots and tanks. This experiment was conducted in a greenhouse in Hilo, Hawaii, USA. Lettuce varieties were grown in a commercial hydroponic tank and hydroponic pots using a non-circulating hydroponic system. In this method, plants grow above the nutrient solution, absorbing nutrients through capillary action in the early stages up to the later root development stage. As the plant matures, the lower roots take in nutrients, while the upper roots absorb air. This system eliminates the need for pumps. Additionally, this system requires low maintenance and is easily adopted by small-scale farmers.

The water-holding capacity of each lettuce-growing pot and tank was 11.4 L and 378.5 L, respectively. Nutrient solutions were formulated using 11.34 kg of commercial hydroponic fertilizer with a 5:11:26 NPK ratio and 6.8 kg of magnesium sulphate in 94.64 L of water for Stock Solution A. The Stock Solution B consisted of 11.34 kg of calcium nitrate with a 15.5:0:0 NPK ratio. Each litre of hydroponic water was enriched with 4 mL of both stock solutions. Lettuce seeds were sown in grow cubes, placed in 5.08-cm net pots, and kept in a humid room for two weeks. After two weeks, the lettuce seedlings were transplanted into the hydroponic systems and grown for an additional 6 weeks (total of 2 months from seeding). The electrical conductivity (EC) of the nutrient solution was 1.8.

A total of 13 lettuce varieties were cultivated in hydroponic pots, and 12 of these varieties were grown in a commercial hydroponic tank. The 12 varieties included were Anuenue, BIBB, Black Seeded Simpson, Buttercrunch, Green Ice, Little Gem, Lolla Rossa, New Red Fire, Parris Island Cos, Rouge d'Hiver, Tom Thumb, and U.H. Manoa. The variety 'Simpson Elite' was cultivated exclusively in pots due to limited seedling availability at transplanting (two weeks after seed sowing). Leaf types of these varieties included loose-leaf (Black Seeded Simpson, Green Ice, Lolla Rossa, New Red Fire, Simpson Elite), butterhead (BIBB, Buttercrunch, Tom Thumb), romaine (Little Gem, Parris Island Cos, Rouge d'Hiver), and semi-head (U.H. Manoa). Photographs of the lettuce varieties used in the preference test are as shown in Figure 1. Lettuce varieties were arranged in separate randomized complete blocks with four blocks used in the tank and two in the pots. The reason for using only two blocks in pots was to ensure that visitors (community members and students) could easily walk around, observe the experimental units from all sides, compare all lettuce varieties, and freely participate in the performance test. Lettuce plants were harvested two months after seeding (6 weeks after transplanting). For the consumer preference test, pot-grown lettuce varieties were used. Community members and students at the University of Hawaii at Hilo rated their preferences on a 1-13 scale (1 = most preferred, 13 = least preferred). Thirty participants evaluated the varieties, and their performance was expressed as average ratings with standard errors (SEMs). The analysis of variance for foliage height, root length, and biomass was separately calculated and compared for pot-grown and tank-grown lettuce. Additionally, cumulative biomass for pot-grown and tank-grown plants was compared.

The preference test results (mean ratings ± SEMs) showed that consumers favored Anuenue (4.72 ± 0.66), BIBB (5.07 ± 0.53), Buttercrunch (6.31 ± 0.49), Green Ice (5.07 ± 0.61), New Red Fire (6.24 ± 0.75), Parris Island Cos (4.52 ± 0.73), and Rouge d'Hiver (6.31 ± 0.68) varieties over the other varieties. The results (mean values ± SEMs) for biological parameters revealed distinct trends: the Black Seeded Simpson variety displayed the tallest foliage (30 ± 2.51 cm), while the Tom Thumb (10.66 ± 0.33 cm) was the shortest. The BIBB (370 ± 80 g) and Green Ice (313.33 ± 46.3 g) varieties produced the highest biomass in pots and tanks, respectively. Conversely, Lolla Rossa variety consistently exhibited the lowest biomass in both growing environments: pots (115 ± 25 g) and tanks (130 ± 6.87 g) ($p \leq 0.05$).

In conclusion, all tested lettuce varieties thrived in non-circulating hydroponic systems. Notably, 75% of pot-grown lettuce varieties exhibited greater biomass compared to those cultivated in tanks. This higher biomass in pot-grown conditions might be attributed to increased spacing on one side of the replication due to having only two replications. However, further experimentation is necessary to validate this hypothesis. Results of the preference test showed that 53.84% of the tested lettuce varieties were "preferred." Varietal characteristics and container type are crucial in non-circulating hydroponics.

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Figure 1. Hydroponic lettuce: Varietal growth at 30, 40, 50 days after sowing (DAS), March 20-April 9, 2019, Hilo, Hawaii, USA.

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