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Short Communication

# Effect of Partial Replacement of Albert's Solution with Compost Tea on Growth and Yield of Hydroponic Lettuce

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## Abstract

Compost tea, a nutrient and microbe-rich organic solution, is used for improving crop growth, yet its application in hydroponic systems remains underexplored. This study evaluated the effectiveness of using compost tea as an organic liquid fertilizer for hydroponic lettuce (*Lactuca sativa* L.) cultivation at Uva Wellassa University of Sri Lanka. Compost tea was prepared by steeping 1 kg of compost in 10 L of water for 10 days with continuous aeration, and its nutrient composition was analyzed. Six treatments: T1 (water control), T2 (100% Albert's solution (AS)), T3 (100% compost tea (CT)), T4 (75% CT + 25% AS), T5 (50% CT + 50% AS), and T6 (25% CT + 75% AS) were evaluated. The experiment was arranged in a Completely Randomized Design (CRD) with four replicates. The pH remained stable across treatments, while electrical conductivity gradually decreased in all fertilizer solutions, except the control. After 60 days, T5 and T6 recorded significantly higher ($p < 0.05$) leaf number (14.33, 16.33), leaf area (743, 846.33 $cm^2$), shoot fresh weight (43.44, 42.15 g) and dry weights (7.04, 8.06 g) and leaf greenness (17.37, 19.23) compared to other treatments. Among the treatments, T5 and T6 showed the best overall growth and yield performance. The results suggest that partial substitution of Albert's solution with compost tea can improve the growth and yield of hydroponically grown lettuce while supporting more sustainable nutrient management practices.

**Keywords:** Albert's solution, Compost tea, Hydroponics, Lettuce, Organic

## 1. Introduction

Hydroponics is a soilless cultivation method where the plants are grown in a nutrient rich aqueous solution rather than in soil. The root system may be either directly submerged in the nutrient solution or anchored in an inert aggregate medium such as coir, peat, perlite, rock wool, which provides physical support while permitting water and nutrient uptake (Resh, 2022). Conventional hydroponic systems typically rely on highly soluble inorganic nutrient formulations, such as Albert solution, which ensure precise nutrient delivery but may involve high costs and potential environmental concerns related to nutrient discharge.

In recent years, the use of organic nutrient sources in hydroponics has gained attention as an alternative approach. Organic based nutrient solutions are used to partially or fully replace synthetic fertilizers in organic hydroponics (Torres and Somera, 2023). Compost tea, a liquid extract obtained by steeping compost in water, represents one such organic input. It is increasingly recognized as a valuable organic input due to its ability to supply readily available nutrients and beneficial microorganisms to plants. Studies have shown that compost tea can enhance plant growth and nutrient uptake by improving microbial activity and nutrient mineralization processes (Scheuerell and Mahaffee, 2002; Szekely and Jijakli, 2022; Pilla *et al*., 2023).

Previous studies have suggested that compost tea can improve plant growth and nutrient availability in soil-based systems. However, its performance in hydroponic environments remains less clearly understood. While some reports indicate potential benefits such as improved root development and microbial activity, evidence regarding its consistency and effectiveness in soilless systems is still limited. Additionally, challenges such as nutrient variability, imbalance, and microbial management have been reported when organic solutions are used in hydroponics (Szekely and Jijakli, 2022).

Despite increasing interest, there is a lack of well-defined studies evaluating the suitability and performance of compost tea as a nutrient source under controlled hydroponic conditions. In particular, information on its effects on plant growth, nutrient uptake, and yield performance in comparison to conventional systems is insufficient.

Therefore, the objective of the present study is to evaluate the effectiveness of partial incorporation of compost tea as an organic liquid fertilizer in hydroponic cultivation, with specific emphasis on its impact on plant growth and yield performance of lettuce.

## 2. Materials and Methods

### 2.1 Preparation of Compost Tea

Compost tea was prepared following standard aerated compost tea preparation protocols (Scheuerell and Mahaffee, 2002; Moț *et al*., 2024). Certified, commercially available compost (1 kg) was wrapped in a cotton cloth bag and was immersed in 10 L of distilled water containing 100 g of dissolved sugar, serving as a readily available carbon and energy source to stimulate microbial activity. The solution was continuously aerated 10 days using an air pump to promote aerobic microbial proliferation and prevent anaerobic conditions. Physicochemical parameters, including pH and electrical conductivity (EC), were measured daily throughout the brewing period.

### 2.2 Nutrient Composition Analysis of the Prepared Compost Tea

The nitrogen (N) content of the prepared compost tea was determined using the Kjeldahl method (Bremner, 1960) in the Livestock Production Laboratory at Sabaragamuwa University of Sri Lanka. Total phosphorus (P) was quantified using Olson's colorimetric method, and exchangeable potassium (K) was measured with a soil meter (Model: JBS-3001-SCY-PT, v1.0). The analyses for total P and exchangeable K were conducted at the National Institute of Fundamental Studies (NIFS), Kandy, ensuring accurate and standardized nutrient assessment. These measurements provided critical information on the macronutrient composition of the compost tea prior to application in hydroponic systems.

### 2.3 Preparation of Albert's Solution

For the conventional inorganic nutrient treatment, Oasis Albert Solution Liquid (OASL) was used. The nutrient solution was prepared by diluting 5 mL of OASL in 1 L of distilled water. This formulation provides essential macronutrients, including N (11.40%), $P_2O_5$ (10.68%), and $K_2O$ (24.68%), along with important micronutrients. The solution was freshly prepared prior to each experimental run to ensure nutrient stability and consistency across treatments.

### 2.4 Plant Material and Nursery Management

Lettuce (*Lactuca sativa* L.) was chosen as the experimental crop due to its short growth cycle, uniformity, and high responsiveness to nutrient management in hydroponic systems (Resh, 2022; Brechner *et al.*, 1996). Seeds were sown in nursery trays filled with a 1:1 (v/v) ratio mixture of coir dust and compost, which provided sufficient aeration and moisture for germination. Seedlings were maintained under controlled conditions for three weeks, after which uniform and healthy seedlings were selected for transplantation into the hydroponic units.

### 2.5 Hydroponic System Setup and Experimental Treatments

This research was conducted inside a protected house at Uva Wellassa University of Sri Lanka. Average temperature inside the protected house ranged from 30–34°C during the study period. Hydroponic units were constructed using 4 L plastic containers, with inner and outer surfaces lined with black and white polyethylene film, respectively, to minimize algal growth and prevent light penetration. The root-dipping technique was used for transplanting lettuce seedlings into nutrient solutions.


**Figure 1.** Hydroponic unit used for the experiment

Different fertilizer combinations were established as treatments (Table 1), including compost tea-based organic solution and conventional Albert's solution, to evaluate their effects on plant growth, nutrient uptake, and yield performance. Each treatment was replicated to ensure statistical reliability and reproducibility.

**Table 1**: Fertilizer combinations used as treatments

| Treatment No. | Fertilizer combinations |
|---|---|
| Treatment 1 (T1) | Water (control test) |
| Treatment 2 (T2) | 100% Albert's solution (AS) |
| Treatment 3 (T3) | 100% Compost tea (CT) |
| Treatment 4 (T4) | 75% Compost tea + 25% Albert's solution |
| Treatment 5 (T5) | 50% Compost tea + 50% Albert's solution |
| Treatment 6 (T6) | 25% Compost tea + 75% Albert's solution |

## 2.6 Experimental Design and Data Analysis

The experiment was arranged in a Completely Randomized Design (CRD) with four replicates per treatment. Each replicate consisted of one hydroponic unit containing a single lettuce plant. Fertilizer treatments included compost tea–based organic nutrient solutions and conventional inorganic nutrient formulations, applied in different proportions as shown in Table 1.

Throughout the experiment, the pH and electrical conductivity (EC) of the nutrient solutions were monitored weekly to assess nutrient stability and availability. Plant growth parameters were recorded at two-week intervals, including number of leaves per plant, leaf greenness, and leaf area. Leaf greenness was analyzed using chlorophyll meter

(SPAD-502Plus). Yield parameters were recorded at 60 days after planting at the market maturity stage.

Data were analyzed using analysis of variance (ANOVA), and mean separation was performed using Tukey's test. Statistical analyses were conducted using Minitab 17 software.

## 3. Results and Discussion

### 3.1 Physicochemical Properties and Nutrient Analysis of Compost Tea

After 10 days, the compost tea reached a pH of 6.97 and an EC of 1.57 dS $m^{-1}$, which fall within the acceptable ranges for hydroponic nutrient solutions. The acceptable range for hydroponic lettuce cultivation is generally 5.5–6.5, with 5.8–6.2 considered ideal for maximum nutrient availability, while the recommended EC range is approximately 0.8–1.6 dS $m^{-1}$ depending on the crop growth stage. Therefore, the prepared compost tea was considered suitable for application in hydroponic systems (Moț *et al*., 2024).

The nutrient composition of the prepared compost tea is presented in Table 2. The solution contained appreciable amounts of macronutrients, including nitrogen (N), phosphorus (P), and potassium (K), which are essential for plant growth in hydroponic systems.

**Table 2**. Nutrient composition of compost tea

| Nutrient | Quantity |
| --- | --- |
| Total Nitrogen | 1.8% (Dry weight basis) |
| Total Phosphorus | 34.5 mg/100 ml |
| Exchangeable Potassium | 21.6 mg/100 ml |

### 3.2 Variation of Physicochemical Properties in Different Fertilizer Treatments

There was no any considerable variation of pH observed in all treatments throughout the experiment (Figure 2). pH value of the treatments was ranged in between 6.5 – 8.3 throughout the experiment.

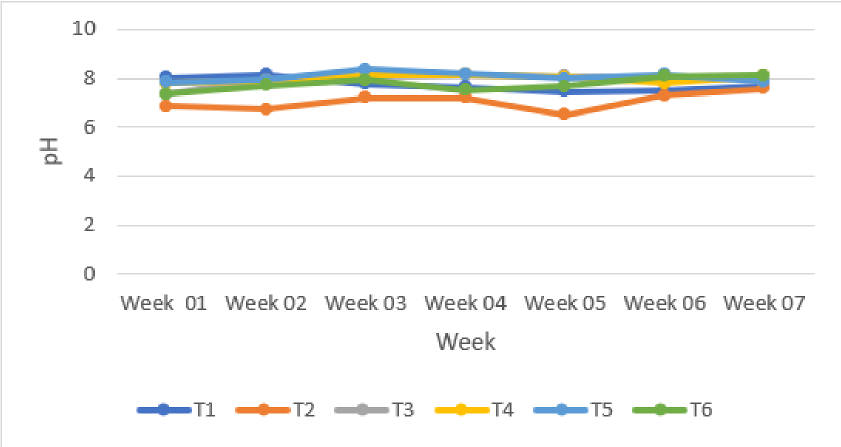


**Figure 2.** Weekly variation of pH in Fertilizer Treatments

But a considerable variation of EC levels was observed (Figure 3). There was a gradual decrease in EC values in all fertilizer treatments except T1 (Control). The EC value at T1 remained constant throughout the period

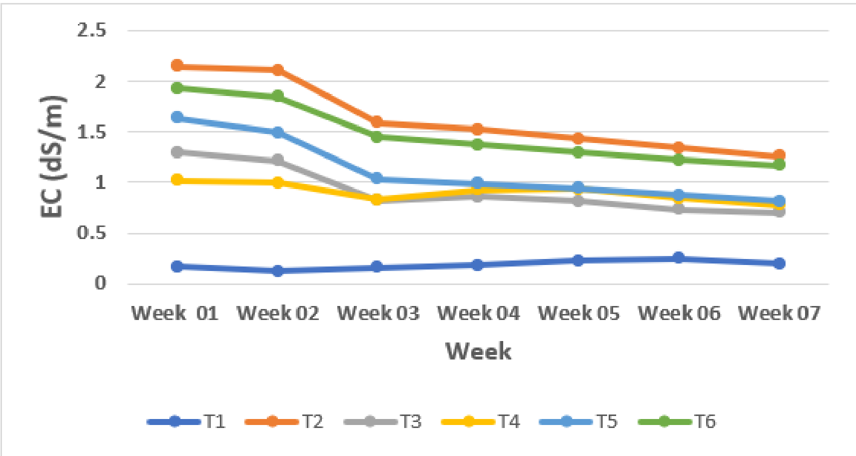


**Figure 3.** Weekly EC variation in Fertilizer Treatments

### 3.3 Effect of Different Fertilizer Solutions on Growth and Yield Performances of Lettuce

Leaf related traits showed a clear response to fertilizer treatments, with integrated nutrient combinations outperforming both the control and sole organic treatments. The summarized results of growth and yield parameters of lettuce grown in different fertilizer solutions are presented in Table 3.

**Table 3**. Results of growth and yield parameters of lettuce respected for different fertilizer treatments

| Treatments | No. of Leaves | Leaf area ($cm^2$) | Greenness (SPAD value) | Root Length (cm) | Shoot Fresh Weight (g) | Shoot Dry Weight (g) |
|---|---|---|---|---|---|---|
| T1 | 4.00±0.1$^{c}$ | 123.3±25.2$^{d}$ | 7.30±2.76$^{b}$ | 12.33±1.53$^{b}$ | 2.66±0.41$^{c}$ | 0.28±0.11$^{b}$ |
| T2 | 13.67±2.52$^{a}$ | 505.33±136.18$^{bc}$ | 14.27±2.40$^{a}$ | 21.67±3.06$^{ab}$ | 28.08±9.56$^{ab}$ | 5.47±2.49$^{ab}$ |
| T3 | 7.00±1.00$^{bc}$ | 340.33±93.25$^{cd}$ | 15.23±2.95$^{a}$ | 22.33±7.57$^{a}$ | 19.51±4.45$^{bc}$ | 3.61±1.76$^{ab}$ |
| T4 | 11.66±2.89$^{ab}$ | 509.33±47.27$^{bc}$ | 14.47±0.80$^{a}$ | 23.33±4.51$^{a}$ | 25.97±0.44$^{ab}$ | 4.37±0.89$^{ab}$ |
| T5 | 14.33±2.52$^{a}$ | 743.00±124.01$^{ab}$ | 17.37±1.00$^{a}$ | 23.67±1.15$^{a}$ | 43.44±12.99$^{a}$ | 7.04±3.34$^{a}$ |
| T6 | 16.33±1.15$^{a}$ | 846.33±43.82$^{a}$ | 19.23±1.88$^{a}$ | 28.33±2.08$^{a}$ | 42.15±2.69$^{a}$ | 8.06±0.89$^{a}$ |

Leaf related parameters showed a clear positive response to integrated nutrient treatments. Combined applications of compost tea and inorganic nutrients resulted in enhanced leaf number, expansion, and greenness compared to individual applications. This improvement reflects better nutrient availability, particularly nitrogen, which is essential for chlorophyll synthesis and leaf development. The higher leaf greenness observed in fertilized treatments suggests improved photosynthetic capacity and overall plant vigor. The coir dust and compost mixture used as the nursery medium may have enhanced early seedling vigor due to its favorable properties. However, since all seedlings were raised under identical conditions for the same duration, its effect was uniform across treatments and unlikely to introduce variability.

These results indicate that the combination treatments T5 (CT 50% + AS 50%) and T6 (CT 25% + AS 75%) were the most effective among the selected fertilizer regimes in enhancing leaf growth and biomass accumulation. Leaf greenness was also significantly higher in these treatments than in the control, suggesting improved chlorophyll content and nitrogen status, which are closely associated with enhanced photosynthetic activity and nutrient uptake (Pant *et al*., 2009).The superior performance of these treatments may be attributed to the complementary effects of compost tea (CT) and Albert's solution (AS), providing both readily available inorganic nutrients and organic nutrient, which together promote leaf development and physiological vigor.

Biomass production followed a similar trend, with integrated treatments producing greater shoot fresh and dry weights than sole nutrient applications. This indicates that balanced nutrient supply plays a critical role in promoting efficient biomass accumulation. The presence of both readily available inorganic nutrients and gradually released organic nutrients may have improved nutrient uptake efficiency and sustained plant growth throughout the cultivation period. Root growth was also enhanced under combined nutrient treatments, suggesting improved root system development. This may be attributed to the presence of bioactive compounds and microbial populations in compost tea, which can stimulate root elongation and function. A well-developed root system likely contributed to improved nutrient absorption and overall plant performance.

The superior performance of integrated treatments can be attributed to nutrient synergy and microbial interactions. Inorganic nutrients provide readily available elements, while compost tea contributes organic compounds and beneficial microorganisms that enhance nutrient cycling, root function, and plant growth. These combined effects improve nutrient availability and uptake efficiency, as supported by previous studies (Pant *et al*., 2009; Szekely and Jijakli, 2022; Mu *et al*., 2025).

In contrast, the lower performance of sole compost tea treatments may result from nutrient imbalance and limited availability of essential nutrients, a common limitation in organic hydroponics (Szekely and Jijakli, 2022; Moț *et al*., 2024). Overall, partial substitution of inorganic fertilizers with compost tea can improve plant growth when applied in appropriate proportions. However, variability in compost tea composition highlights the need for further research to optimize its use in hydroponic systems.

## 4. Conclusions

The present study demonstrates that compost tea can be effectively used as a supplementary nutrient source in hydroponic lettuce cultivation when combined with inorganic fertilizers. Integrated treatments showed superior performance compared to sole applications, indicating the importance of balanced nutrient supply. Among the treatments evaluated, T5 (CT 50% + AS 50%) and T6 (CT 25% + AS 75%) produced the highest growth and biomass accumulation, suggesting that partial substitution is feasible without compromising plant performance. These results highlight the potential of compost tea as a complementary input in hydroponic systems.

Although clear treatment effects were observed, the study was conducted with four replicates per treatment and a single plant per replicate. This design was adopted due to space and practical constraints associated with hydroponic systems. While controlled conditions minimized environmental variability, the limited sample size may affect the statistical robustness and generalizability of the findings. Furthermore, the experiment was conducted in a protected house where temperature exceeding the optimum range (15–25°C) for lettuce growth. Although the hydroponic system may have partially mitigated heat stress through a continuous supply of water and nutrients, the elevated temperatures could still have adversely affected plant physiological processes, growth, and yield. Therefore, future studies under optimum temperature with larger sample sizes are recommended to validate these results.

### Author Contributions

Conceptualization, U.G.A.T.P; methodology, D.M.W.G.M.J.B.D; software, D.M.W.G.M.J.B.D; validation, D.M.W.G.M.J.B.D., and G.P.A.N.W.; formal analysis, D.M.W.G.M.J.B.D; investigation, D.M.W.G.M.J.B.D; resources, U.G.A.T.P.; data curation, G.P.A.N.W.; writing—original draft preparation, D.M.W.G.M.J.B.D and G.P.A.N.W.; writing—review and editing, U.G.A.T.P.; visualization, G.P.A.N.W.; supervision, U.G.A.T.P.; project administration, U.G.A.T.P. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest**

The authors declare no conflict of interest.

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