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Enhanced Productivity of Lettuce (*Lactuca sativa* L.) by Fermented Cardaba Banana in a Hydroponic Cultivation System

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Abstract. The study entitled "Enhanced Productivity of Lettuce (*Lactuca sativa* L.) by Fermented Cardaba Banana in a Hydroponic Cultivation System." The study aimed to determine the productivity and financial feasibility of cultivating lettuce using soilless agricultural methods with the supplemental foliar application from the fermented cardaba banana (FCB). The study was analyzed using a Randomized Complete Block Design (RCBD) consisting of three (3) blocks and four (4) treatments - FCB - 0, 30, 45, 60. Lettuce seeds were sown in a seedling tray and hardened until it was transplanted (21DAS) in the Nutrient Film Technique (NFT). Seven-day interval application of FCB was applied until it was harvested (26 DAT). The data collected the following data - weight at harvest, marketable and non-marketable, yield per cycle, and net income. The results show that FCB-45 ($p<0.05$) has the highest non-marketable lettuce. On the other hand, FCB-60 ($p<0.05$) has the highest yield and marketable. Moreover, the FCB-60 shows the highest net income of Php 42,038.51.

Keywords: NFT Hydroponics, Income, yield, foliar, protected farming

1. Introduction

Lettuce (Lactuca sativa L.) is native to Southern Europe and Western Asia and is the most commercially significant green vegetable crop worldwide. According to PSA (2020), the Philippines' production of 7,061.60MT was gathered from a survey on crop output for the 2020 growing season based on the volume of lettuce produced in each region. Growing one's food enhances food security and assurance of healthy living. One effective way of cultivating plants is through hydroponic farming (Sharma et al., 2019). In contrast to the soil-based system, the hydroponic system provides plants with a consistently balanced nutritional medium. It reduces the risk of soil-borne disease transmission (Nguyen et al. 2016). For the commercial operation of hydroponic farms, it is necessary to develop cost-effective hydroponic technologies that effectively minimize human labor requirements and cut initial investment and operational expenses (Sharma et al., 2018).

On the other hand, with ample supply and demand, cardaba bananas "saba" are often not adequately disposed of (Samonte, 2018). Espiritu (2021) further stated that foliar feeding from FCB is high in macro and micro concentrations. Thus, this provides nutrient-rich for crops. Hence, the study aimed to determine the effect of supplemental foliar spray from fermented cardaba in growing lettuce using a hydroponics system in a protected greenhouse structure at Gabaldon, Nueva Ecija climatic condition.

2. Methodology

2.1. Description of the Experimental Area, Protected Structure, and NFT Hydroponics System

The study was conducted at the NEUST-CEA experimental area, where the greenhouse is a semi-controlled structure with a plastic cover and a 50% shaded net to protect crops from rain and control the sun's heat, respectively. NFT hydroponics uses an A-frame with PVC pipe painted with white-colored paint using a recirculating pump to supply nutrient solution continuously.

2.2. Research Design and Data Analysis

The study was analyzed using the Randomized Complete Block Design (RCBD), which consists of four (4) treatments with three (3) replications with a 0.4m long and 0.7m vast distance between the blocks and 0.7m between plant holes provided and maintained. The total population crops consisted of 216 experimental plants, and each experiment was labeled correctly, indicating their assigned treatments. The treatments used are FCB-30, 45, 60, and 0, varying ratios from 1000 ml of water (adopted by Cosico et al. 2011) with some modification.

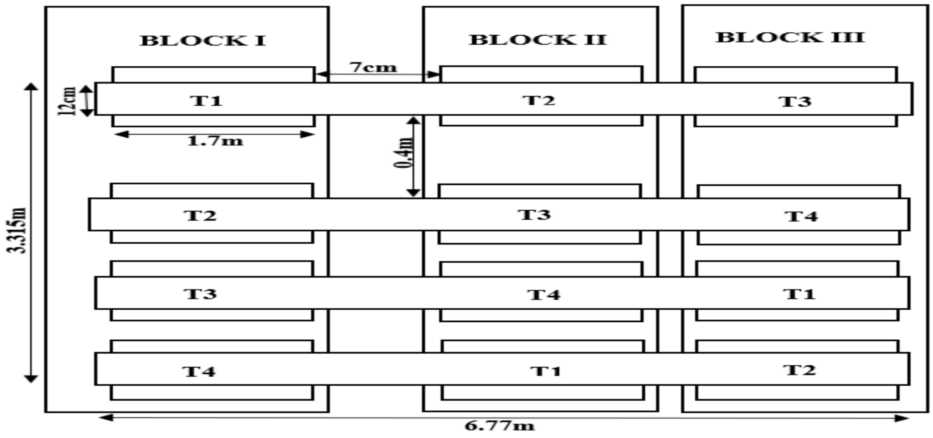

Figure 1. Experimental Layout of the study

Statistical techniques were applied to all observations about growth and yield parameters. The treatment means for growth and yield characteristics were obtained from the collected raw data. The study employed the Statistical Tool for Agricultural Research (STAR). The data set underwent statistical analysis using Analysis of Variance (ANOVA) for Randomized Complete Block Design (RCBD) to assess the treatments' statistical significance. The Least Significant Difference (LSD) Test was employed at a significance level 0.05 to determine statistically significant differences among the means.

2.3 Experimental Materials, Treatment Preparation, Nutrient Solution and Application

The study used 216 lettuce seedlings of the grand rapids type. The hydroponics system utilized for the experiment was the Nutrient Film Technique (NFT). Snap solution served as the source of nutrients. The FCB was prepared before the sowing stage.

The procedures for preparing FCB were adopted from Sulok et al. (2021) with few modifications. The researchers gathered overripe saba fruits that exhibited no signs of insect or disease infestation. Subsequently, the fruits were carefully washed, cleaned, and finely sliced into little pieces. Then, 1 kilogram of molasses was mixed with chopped banana fruits within a sterile receptacle. Subsequently, the object was securely covered, sealed, and allowed to undergo fermentation at ambient room temperature. After seven days of fermentation, the combination underwent filtration using a cloth to separate the sludge from the juice. The juice was transferred into plastic bottles and stored in a refrigerator for 21 days.

The application of fertilizer was carried out by the precise treatments outlined in this study. Fermented cardaba banana juice was applied after the transplanting process by integrating it as a foliar nutrient for the plant. The treatment ratios of 30ml conducted the application of fertilizer: 1000ml of water, 45ml: 1000ml of water, and 60ml: 1000ml of water. The application uses a handheld sprayer to spray the leaves of plants. FCB was applied between 3:00 p.m. and 5:00 p.m. every week. The SNAP nutrition solution is applied at a ratio of 250ml per 50L of water in the reservoir.

2.4 Sowing, Hardening, Transplanting and Harvesting

The seedling trays were partially filled with cocopeat and adequately moistened to maintain a suitable moisture level without excessive saturation. Three seeds were evenly distributed and buried under a quarter of an inch thick layer afterward. In order to maintain adequate moisture levels in the growing medium, it is common practice to spray the developing seeds (Gallagher, 2022) regularly.

During the 3DAS, the seedlings were subjected to a spray application of distilled water. Furthermore, the water was applied to the lower portion of the plant on the 4DAS and 5DAS. Subsequently, an additional nutrient solution of 1.25ml was administered to the lower region of the plant on the 6DAS and 10DAS to ensure optimal concentration. The lettuce seedlings were transplanted into plastic cups on the 10DAS. The task was carried out throughout the late afternoon to mitigate any damage to the seedlings caused by a mild frost.

When transferring seedlings from plug trays to the NFT Hydroponics system, careful handling of the stems to not damage their root system to facilitate rapid root penetration. Refusing to fill the cup with cocopeat when transitioning to fortify is advisable. A bottom watering technique was employed to ensure optimal growth, wherein a SNAP nutrient solution (NutSol) of 1.25ml:1000ml of water was administered from the 11DAS – 15DAS. Subsequently, from the 16DAS – 20DAS SNAP, NutSol was increased to 2.5ml:1000ml of water to promote the plant's attainment of its maximum vigor on the 21DAS, which shows three (3) to four (4)

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fully developed leaves. Lettuce was transplanted into the Nutrient Film Technique (NFT) system.

The harvesting process was conducted on the 26DAT. All sample plants were collected, carefully managed, and appropriately identified based on their respective blocks and treatments. The signs of lettuce reaching maturity include a pale tint, glossy appearance, firm texture, and attainment of its maximum size. The experiment was carried out during the early morning hours to preserve the freshness and vitality of the plant.

2.5 Data Collection

In the data collection, for the growth parameters of lettuce, the following parameters were collected - average plant height at harvest, average number of leaves, width of leaves at harvest, and average number of days to mature. Additionally, the data in yield performance were as follows - average lettuce weight, average non-marketable and marketable, and average yield per cycle.

3. Results and Discussion

3.1 Growth Performance of Lettuce Applied with Varying Ratio of FCB

Table 1 presents the growth parameters, indicating that FCB-60 exhibited the highest average plant height of 22.55 cm ($p<0.05$). This finding supports the research conducted by Talaat et al. (2015) and Yadav et al. (2012), which indicates that fermented juices include bacteria capable of solubilizing phosphate (P) and potassium (K) for agricultural purposes. The advantageous microorganisms facilitate the conversion of solubilized nutrients into readily absorbable forms by plants, promoting their growth and development. Similarly, the statistical analysis reveals that FCB-60 ($p<0.05$) exhibits the earliest maturation compared to the other treatment means.

Table 1 Growth Parameters Applied with Varying FCB

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Treatments	Ave. Plant Height at Harvest (cm)	Ave. No. of Leaves at Harvest	Ave. Width. of Leaves at Harvest (cm)	Ave. Days to Maturity
FCB-30	*186.67[c]*	*176.00[c]*	*9.63*	*44.76[b]*
FCB-45	*271.67[b]*	*236.67[b]*	*9.83*	*42.76[c]*
FCB-60	*323.33[a]*	*303.33[a]*	*10.59*	*40.65[d]*
FCB-0	*165.00[d]*	*160.67[d]*	*8.72*	*46.67[a]*

Means with the same letter are not significantly different at 0.05, LSD.

3.2 Yield Performance of Lettuce Applied with Varying Ratio of FCB

Table 2 presents the yield parameters, indicating that FCB-60 exhibited the highest average plant height of 22.55 cm *($p<0.05$).* This finding supports the research conducted by Talaat et al. (2015) and Yadav et al. (2012), which indicates that fermented juices include bacteria capable of solubilizing phosphate (P) and potassium (K) for agricultural purposes. The advantageous microorganisms facilitate the conversion of solubilized nutrients into readily absorbable forms by plants, promoting their growth and development. Similarly, the statistical analysis reveals that FCB-60 *($p<0.05$)* exhibits the earliest maturation compared to the other treatment means.

Table 2 Yield Parameters Applied with Varying FCB

Treatments	Ave. Lettuce Weight at Harvest (g)	Average Weight of Marketable Lettuce (g)	Average Weight of Non-Marketable Lettuce (g)	Average Yield per Year (kg/200 m^2)
FCB-30	*186.67[c]*	*176.00[c]*	*10.67[c]*	*8,928.00[c]*
FCB-45	*271.67[b]*	*236.67[b]*	*35.00[a]*	*13,440.00[b]*
FCB-60	*323.33[a]*	*303.33[a]*	*20.00[b]*	*15,936.00[a]*
FCB-0	*165.00[d]*	*160.67[d]*	*4.33[d]*	*7,824.00[d]*

Means with the same letter are not significantly different at 0.05 level, LSD

3.3 Simple Cost and Return Analysis

Table 3 shows the result of the investment in lettuce. Regarding net income per cycle, FCB-60 registered the highest at Php 42,038.51, followed by FCB-40

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with Php 32,129.08. This is expected, given that FCB-60 led to high weight and growth parameters.

Table 3 Simple Cost and Return Analysis

Treatments	Marketable(kg)	Production Costs	Gross Sales	Net-income
FCB-30	*176.00*	*3,268.98*	*26,400.00*	32,131.02
FCB-45	*236.70*	*3,371.42*	*35,500.00*	32,129.08
FCB-60	*303.33*	*3,460.99*	*45,499.50*	42,038.51
FCB-0	*160.67*	*3,076.84*	*24,100.00*	21,023.66

4. Conclusions

The research revealed that FCB-60 exhibited the most significant growth response, largest leaf count, and fastest time to maturity. Additionally, it resulted in the highest lettuce weight, the most significant proportion of marketable lettuce, and the best average yield in each growth cycle. The results indicate that FCB-60 had the highest net income.

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