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Agronomic Characteristics, Production, and Economics of Hydroponic Lettuce Using Different Culture Pots

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Abstract

The study was conducted from November 2022 to January 2023 at TESDA Lasam, Institute of Technology to evaluate which of the agronomic characteristics, yield, and economics of hydroponic lettuce using different culture pot has the most suitable for Lettuce (*Lactuca sativa*) production. Specifically, the study aimed to find out what growing pots will be the best for growing lettuce in terms of the following parameters. Average height per plant (cm), average number of leaves per plant, average length of roots (cm) per plant, average fresh weight per sample plant (g), and Return on Investment Analysis. The Complete Randomized Design (CRD) was used in the study with four (4) treatments and three (3) replication. The treatments were as follows: T1- PVC Pipe, T2- Styrofoam fruit crate, T3- Bamboo poles, T4- Plastic bottle. The result revealed that the highest average height (cm) per plant and the most number of leaves was obtained on Treatment 2. The average length of roots (cm) per plant was obtained in Treatment 1. Return on Investment was obtained in Treatment 4. Analysis of variance shows a highly significant difference among the average height (cm) per plant. Likewise, analysis of variance shows a significant difference among the average length of roots (cm) per plant. However, it did not show any significant difference between the average number of leaves and the average fresh weight per sample (g).

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Introduction

Continuous agricultural innovations are crucial to meet the increasing food demand of exploding global population. According to the Philippine Statistics Authority, the country's population is pegged at 109, 035, 343 as of May 20, 2021, and an annual growth rate of 1.9% is observed. It is one of the greatest challenges of the agricultural sector, as the increase in the human populace implies an increase in food consumption. The problem also on urbanization is very alarming because of the conversion of agricultural land areas to commercial sites, which has a high impact on the reduction of total production. Thus, to address the pressing problem, strategies to double global food production while reducing greenhouse gas emissions and protecting valuable ecosystems are needed to secure food availability and affordability is a must (Sahara, 2009).

With the advancement of technology, crops can now be grown in any container, provided nutrient solutions must be present for plants for them to draw the necessary nutrients needed for growth and development. The approach is the birth of hydroponics production of crops. Hydroponics is regarded as the agriculture of the future since the cultivation does not require a vast land area. In addition, the technology can still be adopted to solve the area of production, especially on the problem of urbanization, where the conversion of agricultural areas into commercial sites is a threat. However, in the setup of the said technology, there is a high production cost due to the materials used. This is why the use of locally available as a potential substitute to the existing commercial materials.

Undeniably, the major crops grown in hydroponic gardening are mostly green leafy vegetables due to their growth duration and habit. According to the National Grocery Association, nearly 87% of consumers indicated that the availability of locally grown foods could be a major influence on grocery shopping decisions (Han *et al.,* 2016). The increasing demand for locally grown fresh leafy greens such as lettuce is no longer new due to its benefits specifically for health-conscious individuals.

Lettuce is among the most popular leafy greens due to its high dietary fiber, vitamins A and C, and antioxidant content. Lettuce contains moisture, energy, protein, fat, carbohydrates, dietary fiber, and sugars. The minerals and vitamins found in lettuce include calcium, iron, magnesium, phosphorous, potassium, sodium, and zinc, along with vitamins like thiamin, riboflavin, niacin, folate, vitamins B-6, C, A, E, and vitamin K. For thousands of years, lettuce has been cultivated as more than a vegetable. It was also thought to possess medicinal properties by ancient people. Some of the health benefits that have been confirmed by modern scientific research include the following: it has anti-inflammatory, protects neuronal cells, lowers cholesterol levels, induces sleep, and is antioxidant.

Considering the readily available materials within the locality, the researcher has sought to use these resources to assess the response of lettuce, specifically on its growth and yield parameters. Results of this study will serve as benchmark information for plant enthusiasts to adopt other materials as potential containers in hydroponic production, hence this study.

The study aimed to evaluate which of the different growing pots is the most suitable for lettuce production under hydroponics technology.

Materials and methods

The following materials were used in the experiment: are the following: seeds, seedling tray, styrofoam fruit crate, bamboo poles, PVC pipes, coco coir, plastic bottle, seedling plug, culture pots, plastic cover, snap solution, water, mixer, nursery, tape, foam cutter, record book, pencil. The Complete Randomized Design with three (3) replications was used to test the following treatments:

Treatment 1- PVC Pipe
Treatment 2- Styrofoam fruit crate
Treatment 3- Bamboo poles
Treatment 4- Plastic bottle

Securing the seeds

Seeds of lettuce (Dabi variety) were procured from a reliable agriculture supply at Tuguegarao City.

Preparation of growing media

Coco coir was used as growing media for growing lettuce. The material was sterilized with boiling water before placing them into individual seedling plugs. The amount of growing media per seedlings plug was equal to avoid bias results.

Preparation of different potting culture

The PVC pipes were used as the culture pots with a size of 110 mm. The PVC Pipes were cut at 1.5 m length with eight (8) holes. Using disposable cups, marks are made in the PVC pipes, and we guide in cutting and marking holes. Drilled and cut that circle out and ensured there was enough distance between the disposable cups. After that, cover the PVC pipe on both sides with cleanout number six (#6), and seal with silicone gel to avoid leaking and draining of nutrient solution. Likewise, paint the PVC pipe with white color to avoid absorbed of heat from the sunlight on the PVC pipe. Every PVC pipe was sterilized with a 10% solution of sodium hypochlorite and sundried the whole day.

Preparation of Styrofoam fruit crates

Styrofoam fruit crates were used as the culture pots. The bottom part of the box was lined with a polyethylene sheet to prevent the solution from leaking. On the lid or box cover, eight (8) holes equidistant from one another were cut off. Every Styrofoam fruit crate was sterilized by a 10% solution of sodium hypochlorite and sundried the whole day.

Preparation of Bamboo poles

For the treatments using, bamboo poles as growing pots were cut at 2 m length with eight (8) holes. Using disposable cups, marks were made on the bamboo poles. Drilled and cut that circle out and ensured that maintained enough distance between the disposable cups. After which, the bamboo poles were covered on both sides with aluminum foil tape and sealed with silicone gel to avoid leaks and possible draining of nutrient solution. Every bamboo pole was sterilized with a 10% solution of sodium hypochlorite and sundried for the whole day.

Preparation of lettuce seedlings

Lettuce seeds were sown in a seedlings tray using coco coir as growing media. In order to hasten the seed germination, water was sprinkled on the seed sown and continued to maintain its moisture state until it reached 21 days old. During this time, lettuce seedlings were already mature enough for transplanting.

Transplanting

Lettuce seedlings were transplanted early in the morning at one (1) seedling per seedling plug to have a uniform number of plants per treatment.

Application of nutrient solution

The preparation of the snap solution was based on the procedure given by UPLB. The non-circulating method of the hydroponic system was used in the experiment wherein the roots of the plants were dipped in the nutrient solution. An equal amount of prepared solution was provided per treatment.

The amount of nutrient solution left in the container per day was also measured to assess the rate of absorption. In addition, the pH of the solution ranging from 5.8 to 6.5, was also maintained throughout the growing period to ensure efficient absorption of nutrients.

Pest control

Pests such as vinegar flies were controlled with the use of physical methods. This was done by picking the pest with the use of bare hands and pinching them to death.

Harvesting

Lettuce was harvested 42 days after transplanting. This was done by uprooting the entire plant in the styro cup. During this time, agronomic attributes such as root length, root weight and herbage yield were accounted.

Statistical analysis

All data were analyzed using the Statistical Tool for Agricultural Research (STAR). Analysis of Variance (ANOVA) and the least significant difference at 5% and 1% levels were used to determine the significance of the treatments used in the experiment.

Data gathered

Ten (10) sample plants were randomly selected from each treatment for data collection. The selected sample plants were marked with a tape for identification. The following data gathered from the study was the following:

Average height per plant (cm) – This data was gathered from the average plant height in centimeters one week after sowing and every week measuring the sample plants from the base to the tip most part of the longest leaf.

Average numbers of leaves per plant – This data was collected every after 7 days by counting the leaves that emerged from the sample plants.

Average length of roots per plant (cm) – This was obtained by measuring the length of the roots after harvesting.

Average fresh weight of leaves per sample (g) - This was taken by weighing all sample plants in each treatment. This total weight was determined by the number of samples to get the average weight sample in each treatment.

Return on Investment Analysis – the cost of the materials and labor from the establishment to harvesting were recorded. Return on Investment was determined using the formula: Net Income = Gross Income- Total cost of production.

Results and discussion

Average plant height (cm)

The average plant height (cm) of lettuce as affected by the use of different culture pots is presented in Fig. 1. Analysis of variance reveals that there exists a highly significant difference at a 1% level among the different treatments tested. In the comparison of treatments, plants planted in fruit crates (Treatment 2) recorded the tallest plant height with a mean of 24.33 cm; however, when compared to Treatment 1 (PVC Pipe) and Treatment 4 (Plastic bottles) as pot culture no significant result was observed. All these treatments are significantly different from treatment 3 (bamboo poles), with a mean of 19.83 cm.

The result is due to the fact that PVC pipe, styrofoam fruit crates, and plastic bottles do not absorb solution as compared to bamboo poles which may have observed some amount of water with nutrients and have a higher capacity of nutrient solution to accommodate compared to bamboo poles, this condition greatly affected the overall growth of plants.

Table 1. Summary of the cost and return analysis of hydroponic lettuce using different culture pots.

Treatment	Yield (kg) per treatment	Gross sales per treatment (Php)	Total cost of production (Php)	Net income per treatment (Php)	ROI %
T1 (PVC pipe)	48 plant/cups @ ₱35	1680	681.52	998.48	146.50
T2 (Styrofoam fruit crates)	48 plant/cups @ ₱35	1680	531.52	1148.48	216.07
T3 (Bamboo poles)	40 plant/cups @ ₱35	1400	561.52	838.48	149.32
T4 (Plastic bottle)	48 plant/cups @ ₱35	1680	477.52	1202.48	251.71

This research contradicts the findings of (Pattung *et al.*, 2017); at 35 days after transplanting, plants grown in bamboo poles (T2) are the tallest among the treatments with a mean of 27.89 cm, followed by plants grown in PVC pipes (T1) and bamboo poles (T3), with a mean of 27.82 cm and 27.51 cm. (Pattung *et al.,* 2017).

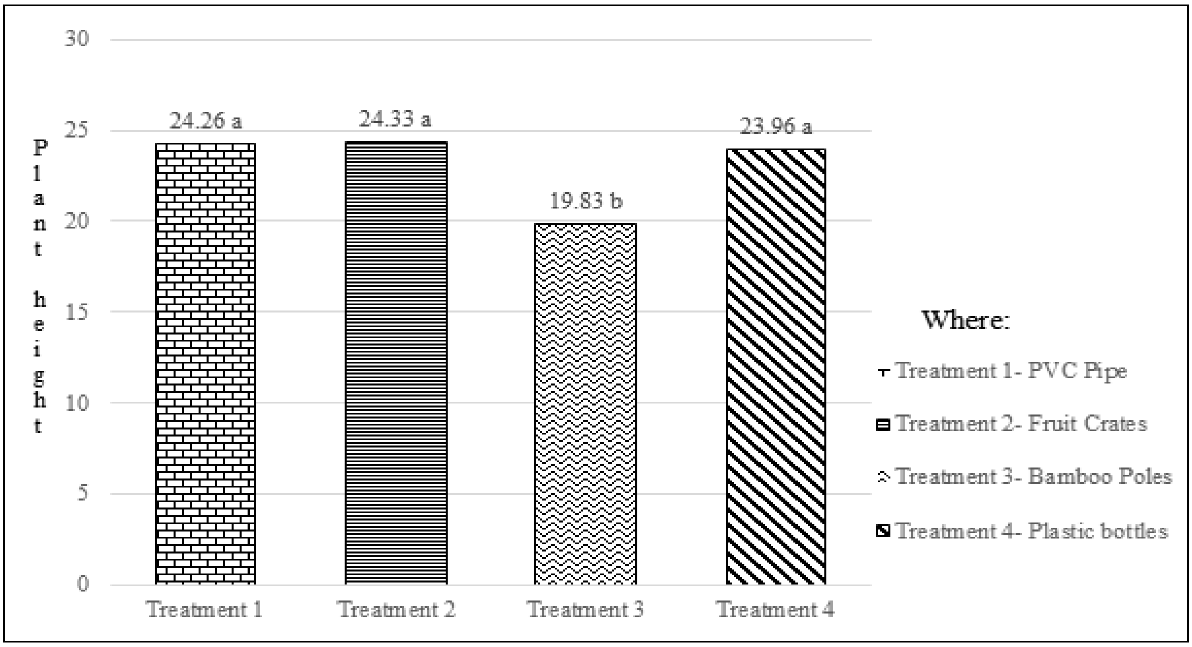

Fig. 1. Average plant height (cm) of lettuce as affected by different culture pots. TESDA-Lasam Institute of Technology, January 2023.

Average number of leaves

Fig. 2 shows the average number of lettuce leaves as affected by the use of different culture pots. Lettuce grown in PVC pipe (Treatment 1) produced the greatest number of leaves with a mean of 15 leaves per plant was closely followed by Treatment 2 (fruit crates) and Treatment 4 (plastic bottle) with an equal number of leaves of 14 per plant. The lowest number of leaves produced per plant was observed in Treatment 3 (bamboo pole), with a mean of 11. However, despite the numerical discrepancies, no significant difference among treatments was observed in the analysis of variance (ANOVA).

This simply means that the use of different culture pots did not affect the production of leaves per plant.

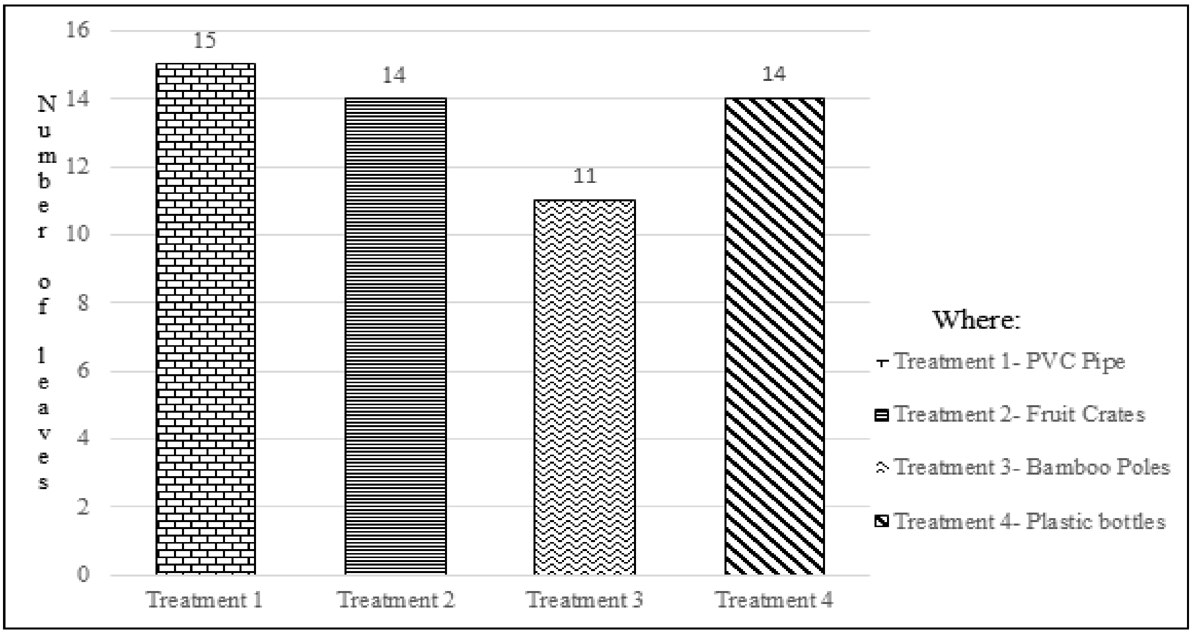

Fig. 2. Average number of lettuce leaves as affected by the use of different culture pots. TESDA-Lasam Institute of Technology, January 2023.

Average root length per plant (cm)

The average root length of lettuce as affected by the use of different culture pots is shown in Fig. 3. Statistical analysis revealed significant differences among the different treatments tested. The longest root was observed in Treatment 1 (PVC pipe) with a mean of 19.28 cm, but not significantly different with crops grown in fruit crates (Treatment 2) and plastic bottles (Treatment 4) with a corresponding means of 17.23 cm and 14.56 cm, respectively. Still, the shortest length of roots per plant was observed from planting in bamboo poles (Treatment 3) with a mean of 9.31 cm, which is significantly different from the other treatment.

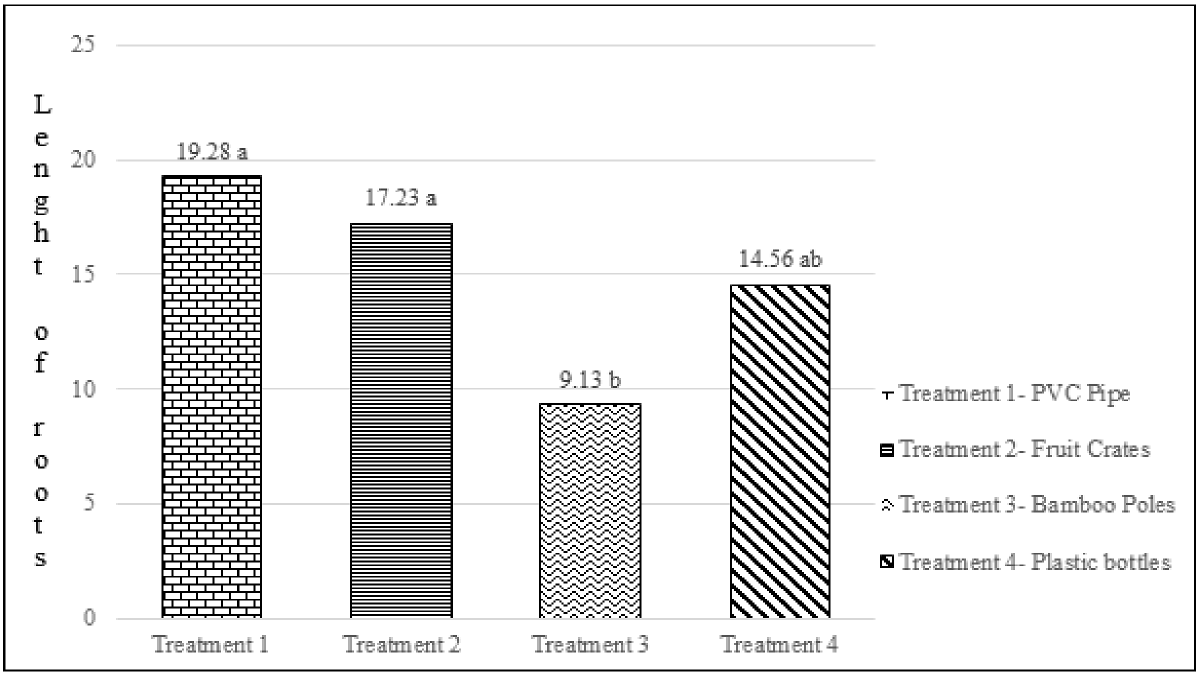

Fig. 3. Average root length of lettuce as affected by the use of different culture pots. TESDA-Lasam Institute of Technology, January 2023.

This contradicts the findings of (Pattung *et al.*; 2017). Where plants grown in styrofoam fruit crates and bamboo poles were similar results. Fruit crates (T3) produced the longest roots with a mean of 24.04 cm, followed by plants grown in bamboo poles (T3) with a mean of 23.80. The shortest length of roots was produced by plants grown in PVC pipes (T1) with a mean of 23.79 cm only.

Fresh weight per plant

Fig. 4 shows the fresh weight of lettuce per plant as affected by the different culture pots. Lettuce grown using PVC pipe (T1) recorded the heaviest mean of 69.4 grams, closely followed by plants in fruit crates (T2), plastic bottles and bamboo poles with a mean of 63.4 grams, 48.03 grams and 35.2 grams, respectively. No significant result was observed among the different treatments tested.

Cost and return analysis

The cost and return analysis of the lettuce grown under different culture pots is presented in Table 1. Plants grown in plastic bottles (T4) obtained the highest net income per treatment with an amount of Php 1202.48, followed by treatment 2 (Styrofoam fruit creates) and treatment 3 (bamboo poles) with a corresponding net income of Php.1148.48, 998.48 and Php.838.48, respectively.

However, plants grown in plastic bottles (T4) produced the highest Return on Investment (ROI) with a percentage of 251.7, with a lesser material cost of production with the amount of P 477.52, with a depreciation cost of 3-4 years followed by T2 (Styrofoam fruit creates) with a lesser material cost of production P 531.52 with a depreciation cost of 3-4 years, and T3 (Bamboo poles) with a total cost of production of P 561.52 with depreciation cost of 2 years and T 1 (PVC pipes) with the highest material cost of production due to a total amount of P 681.52, but one of the most durable and has a longer serviceability time. The return on Investment is as follows with a percentage of 216.07, 149.32, and 146,50 %.

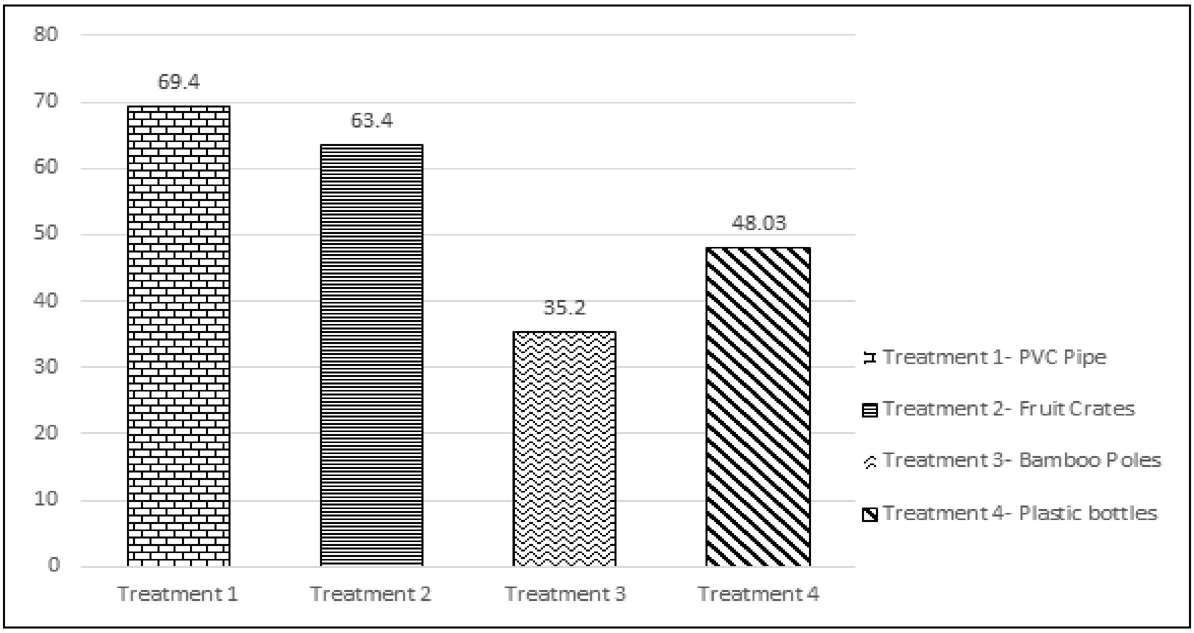

Fig. 4. Fresh weight of lettuce per plant as affected by the use of different culture pots.

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