

**HYDROPONICALLY-GROWN LETTUCE (*Lactuca sativa*) USING DIFFERENT
IRRIGATION REGIMES**

**College of Agriculture and Natural Resources
BOHOL ISLAND STATE UNIVERSITY
Zamora, Bilar, Bohol**

ANALYN M. LLOREN

June 2022

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A Thesis
Presented to the Faculty of the
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APPROVAL SHEET

This thesis entitled "HYDROPONICALLY-GROWN LETTUCE (*Lactuca sativa*) USING DIFFERENT IRRIGATION REGIMES", prepared and submitted by **Analyn M. Lloren**, in partial fulfillment of the requirements for the degree of Bachelor of Science in Agricultural and Biosystems Engineering (BSABE) has been examined and recommended for acceptance and approval for implementation.

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THE RESEARCHER

ABSTRACT

The study was conducted from May 2022 to June 2022 at Maitum, Catigbian, Bohol. The general objective of this study was to assess and evaluate the growth of hydroponically-grown lettuce using different irrigation regimes namely: continuous flooding, intermittent irrigation at 1-day interval, intermittent irrigation at 3-day interval, and intermittent irrigation at 5-day interval. The parameters gathered include root depth, plant height, plant weight, area of leaves, and the number of leaves of the hydroponically-grown lettuce. The study used Complete Randomized Design (CRD) using different irrigation regimes as treatments with three (3) replications in a Nutrient Film Technique (NFT) system where water or nutrient solution circulates throughout the entire system with the use of water pump and the system is slightly slanted so that the nutrient solution runs through roots and down back the reservoir. The findings of this study show that among the four treatments, Treatment 2 which is the intermittent irrigation at 1-day interval has the higher average means of measurement compared to the rest of the treatments. Furthermore, results show that there is significant difference on the application of different irrigation regimes as treatments on hydroponically-grown lettuce in terms of root depth, plant weight, area of leaves and number of leaves at 0.50 level of significance except on plant height. It is concluded that hydroponically-grown lettuce plants best grow at 1-day interval of irrigation regime. It is recommended that hydroponically-grown lettuce or any plants must be monitored every day from pest that can ruin the quality of plants, facilitate irrigation and maintenance, and must have a thorough and intensive plan from cost analysis and design for efficient, effective and successful farming.

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Chapter 1

THE PROBLEM AND ITS SCOPE

Rationale

Over the last decade, people's interest in how their food is produced has increased greatly. More consumers want safe food that have been produced with sustainable, mindful growing practices and is free from pesticide residues. As a result, many people explore different techniques, practices, and methods on how to grow plants and/or crops for food production. One of these commonly known practice or technique worldwide is the so-called hydroponics system.

Currently hydroponic cultivation is gaining popularity all over the world because of efficient resources management and quality food production. Hydroponics is a technology for growing plants in nutrient solutions (water and fertilizers) with or without the use of artificial medium (e.g., sand, gravel, vermiculate, rockwool, peat, coir, sawdust) to provide mechanical support. It is further categorized as open, where after the nutrient solution has been delivered to the plant roots, it is not reused; or closed where surplus solution is recovered, replenished, and recycled. Most hydroponic systems operate automatically to control the amount of water, nutrients and photoperiod based on the requirements of different plants (Resh, 2013).

Due to rapid urbanization and industrialization, not only the cultivable land is decreasing but also conventional agricultural practices causing a wide range of negative impacts on the environment. Moreover, with rapid population growth and

consequently more food demand, water scarcity is becoming a prime issue for many countries. Among the users of water, agriculture is one of the highest consumers.

To sustainably feed the world's growing population, methods for growing sufficient food have to evolve. Modification in growth medium is an alternative for sustainable production and to conserve fast depleting land and available water resources for crop or plant irrigation. In the present scenario, soil less cultivation might be commenced successfully and considered as alternative option for growing healthy food plants, crops or vegetables (Butler and Oebker, 2006). Agriculture without soil includes hydro agriculture (Hydroponics), aqua agriculture (Aquaponics) and aerobic agriculture (Aeroponics) as well as substrate culture. Among these hydroponics techniques is gaining popularity because of its efficient management of resources and food production. Various commercial and specialty crops can be grown using hydroponics including leafy vegetables, tomatoes, cucumbers, peppers, strawberries, and many more.

In this regard, experiment using hydroponics system on leafy vegetable lettuce or hydroponically-grown lettuce under different irrigation regimes, which uses and utilizes water in irrigation, were focused in this study with the objectives of assessing or evaluating the growth of the lettuce plant particularly getting the plant height, leaf area and the root deep. The findings of this study will be beneficial to the community particularly in promoting hydroponically-grown plants and crops while conserving land and water resources.

LITERATURE BACKGROUND

Legal Basis

Section 2 of Republic Act No. 10068 known as the Organic Agriculture Act of 2010 an act providing the development and promotion of organic agriculture in the Philippine and for other purposes. It is declared to promote, propagate, develop, further and implement the practice of organic agriculture that will cumulatively condition and enrich the fertility of the soil, prevent depletion of natural resources and promote the healthy use of soil, water and air as well as minimize all forms of pollution thereto that may result from agricultural practices.

Moreover, the emphasis of hydroponics was reiterated in Memorandum Circular No.42 Series 2020- Section 3-3. A memorandum subjected in implementing guidelines for urban agriculture program under Republic Act No. 11494 or the 'Bayanihan to Recover as One Act'. It emphasized hydroponics as a technology to be used in growing leafy vegetables, tomatoes, gravel, perlite, or other material can be used to provide more physical support for the plants. Since water in hydroponics systems is recycled and reused, it can save on water usage for growing crops.

Hydroponics

Hydroponics is a technology for growing plants in nutrient solutions (water and fertilizers) with or without the use of artificial medium (e.g., sand, gravel, vermiculate, rockwool, peat, coir, sawdust) to provide mechanical support. The term Hydroponics was derived from the Greek words' *hydro*' means water and

ponos' means labour and literally means water work. The word hydroponics was coined by Professor William Gericke in the early 1930s; describe the growing of plants with their roots suspended in water containing mineral nutrients. Researchers at Purdue University developed the nutriculture system in 1940.

Hydroponics has been around thousand years. The ancient Romans used it and even Babylonians used it in their 'Hanging Gardens of Babylon'. Additionally, ancient Egyptian hieroglyphics, dated several hundred years B.C. describe how they grown plants in water. During 1960s and 70s, commercial hydroponics farms were developed in Arizona, Abu Dhabi, Belgium, California, Denmark, German, Holland, Iran, Italy, Japan, Russian Federation and other countries.

The main objective of hydroponics is to supply the ideal nutritional environment for optimum plant performance while conserving land and water resources (Johnson, 2001).

Benefits and Limitations of Hydroponics

Recently, hydroponic technique is becoming popular because this is clean and relatively easy method and there is no chance of soil-borne disease, insect or pest infection to the crops thereby reducing or eliminating use of pesticides and their resulting toxicity. Besides, plants require less growing time as compared to crop grown in field and growth of plant is faster as there is no mechanical hindrance to the roots and the entire nutrient are readily available for plants. This technique is very useful for the area where environmental stress (cold, heat, dessert etc.) is a major problem (Polycarpou et al., 2005). Crops in hydroponic system are not

influenced by climate change therefore, can be cultivated year-round and considered as off season (Manzocco et al., 2011). Further, commercial hydroponic systems are automatically operated and expected to reduce labour and several traditional agricultural practices can be eliminated, such as weeding, spraying, watering and tilling (Jovicich et al., 2003). Hydroponics saves large amount of water as irrigation and other kind of sprays is not needed and water logging never occurs. The problem of pest and disease can be controlled easily while weed is practically non-existent. Higher yields can be obtained since the number of plants per unit is higher compared to conventional agriculture. Although soil-less cultivation is an advantageous technique but some limitations are significant. Technical knowledge and higher initial cost are fundamental requirement for commercial scale cultivation (Resh, 2013). Plant in a hydroponics system is sharing the exact same nutrient, and water borne diseases can easily spread from one plant to another (Ikeda et al., 2002). Hot weather and limited oxygenation may limit production and can result in loss of crops. Maintenance of pH, EC and proper concentration of the nutrient solution is of prime importance. Finally, light and energy supply are required to run the system under protected structure.

Water Conservation in Hydroponics

As water becomes scarce and important as a resource, the use of hydroponics and other water saving technologies for crop production is needed now and is poised to popularize in time. Hydroponics uses substantially less water as compared to the soil farming. In soil farming, most of the water that we supply to the plants gets leached deep into the soil and is unavailable to the plant's roots,

whereas in hydroponics, plant roots are either submerged in water or a film of nutrients mixed in water is constantly encompassing the root zone, keeping it hydrated and nourished. Water is not wasted in this process, as it gets recovered, filtered, replenished and recycled. Waste nutrient solution can be used as an alternate water resource for crop cultivation under hydroponic system (Choi et al., 2012). Savings in irrigation water, fertilizer and increase in vegetable and water productivity under hydroponic system as compared to conventional agriculture. NFT based hydroponics can reduce irrigation water usage by 70% to 90% by recycling the run-off water. It is possible to effectively grow high value, good quality vegetables under controlled hydroponic conditions using 85 to 90% less water than traditional soil-based production. Water sources from groundwater or dam/river water commonly contain factors that can influence plant yield and affect plant condition, including salinity, dissolved solids and pathogens. While some of these factors can be beneficial to crops, others need to be minimized.

Hydroponic Lettuce and Irrigation System

Lettuce (*Lactuca sativa*) belong to the Compositae (sunflower or daisy family). It is one of the most commonly grown hydroponic vegetables which is a method of growing plants without soil or supported by inert medium (aggregate culture) where the nutritional needs are supplied through the irrigation water. It has shallow roots that needs constant watering at least three times a week. Growth of leafy vegetables may be held in small-volume recipient, requiring special attention on irrigation and fertilization management. Due to reduced substrate volume and,

consequently, root volume, associated to low quantity of water stored, irrigation must be done carefully (Marouelli et al., 2005).

Life cycle of hydroponic lettuce is very short compared to traditionally grown lettuce. Hydroponic lettuce can be harvested after 35 to 40 days of production. Lettuce can be successfully grown in NFT system and more than 8 crops per year can be grown efficiently in this system. Horizontal and vertical hydroponic system was also evaluated with different nutrient solutions for yield optimization of lettuce (Touliatos et al., 2016). Growing of lettuce in recirculating hydroponic system at spacing of 50 plants m^{-2} significantly increased yield and yield components (Maboko and Plooy, 2009). Frezza et al. (2005) found that there is significant difference in productivity and nitrate content of lettuce in both soil less (floating system and substrate culture) and soil culture however, other traits like leaf area, dry weight and ascorbic acid content were remain unaffected. In non-circulated and non-aerated system, air space between nutrient solution and tank cover also determines optimum lettuce yield. Another study observed that marketable yield, shoot biomass and leaf area index of lettuce grown in floating system was not affected by nutrient solution composition (Falovo et al., 2009). In other experiment, it was observed that both the hydroponic and organic system perform equal in terms of lettuce yield, quality and nitrate content, whereas, delayed harvesting not only increased yield but lower down nitrate level and reduced health hazards.

THE PROBLEM

Statement of the Problem

The general objective of this study was to assess and evaluate the growth of hydroponically-grown lettuce using different irrigation regimes. Specifically, the researcher sought to provide information that would answer the following objectives:

1. What are the effects of the application of different irrigation regimes of the hydroponically-grown lettuce in terms of plant growth or the following:
 - 1.1 root depth,
 - 1.2 plant height,
 - 1.3 plant weight,
 - 1.4 leaf area, and
 - 1.5 number of leaves per plant?

2. Is there significant difference in terms of plant growth in the application of different irrigation regimes?

Null Hypothesis

There is no significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce.

Significance of the Study

The result of the study was expected to contribute to the following individual or groups:

Academe. The output of the study would be useful to the students as well as instructors who are working on the same area of research. Moreover, it would serve as basis in conducting study related on land and water management particularly on hydroponic system.

Researchers. This study would serve as basis for the formulation of data and as reference material of the researchers having similar studies or work.

Local Community. The result of this study would provide knowledge to the community and promoting in cultivating crops and plants in terms of hydroponic system (hydro agriculture) in application of different irrigation methods for production productivity, land and water management sustainability.

National Government Agencies. The output of this study would serve as basis of the government in the formulation of activities intended for agricultural modernization in food or crop production.

Scope of the Study

This research was an experimental study focused on the assessment of plant growth of hydroponically-grown lettuce using different irrigation regimes in terms of root depth, plant height, plant weight, area of leaves, and the number of leaves per plant. Different irrigation regimes used include continuous flooding (CF),

intermittent irrigation at 1-day interval, intermittent irrigation at 3-day interval and intermittent irrigation at 5-day interval. Each was treatment replicated 3 times. The growth of lettuce from seedling propagation for 7 days and from transplanting to harvesting that covered up 21 days in a Nutrient Film Technique (NFT) hydroponic system.

RESEARCH METHODOLOGY

Research Environment

The experimental study was conducted at Brgy. Maitum, Catigbian, Bohol which is geographically located at 9°50'N latitude, 124°02'E longitude. Catigbian has the tropical monsoon prevailing climate where most precipitation falls similar to that of a tropical rainforest climate. Over the course of the year, the temperature typically varies from 22.22 ° C to 31.1° C and is rarely below 21.2 °C or above 32.8° C and experience significant seasonal variation in monthly rainfall most in October and least rain on the month of April.

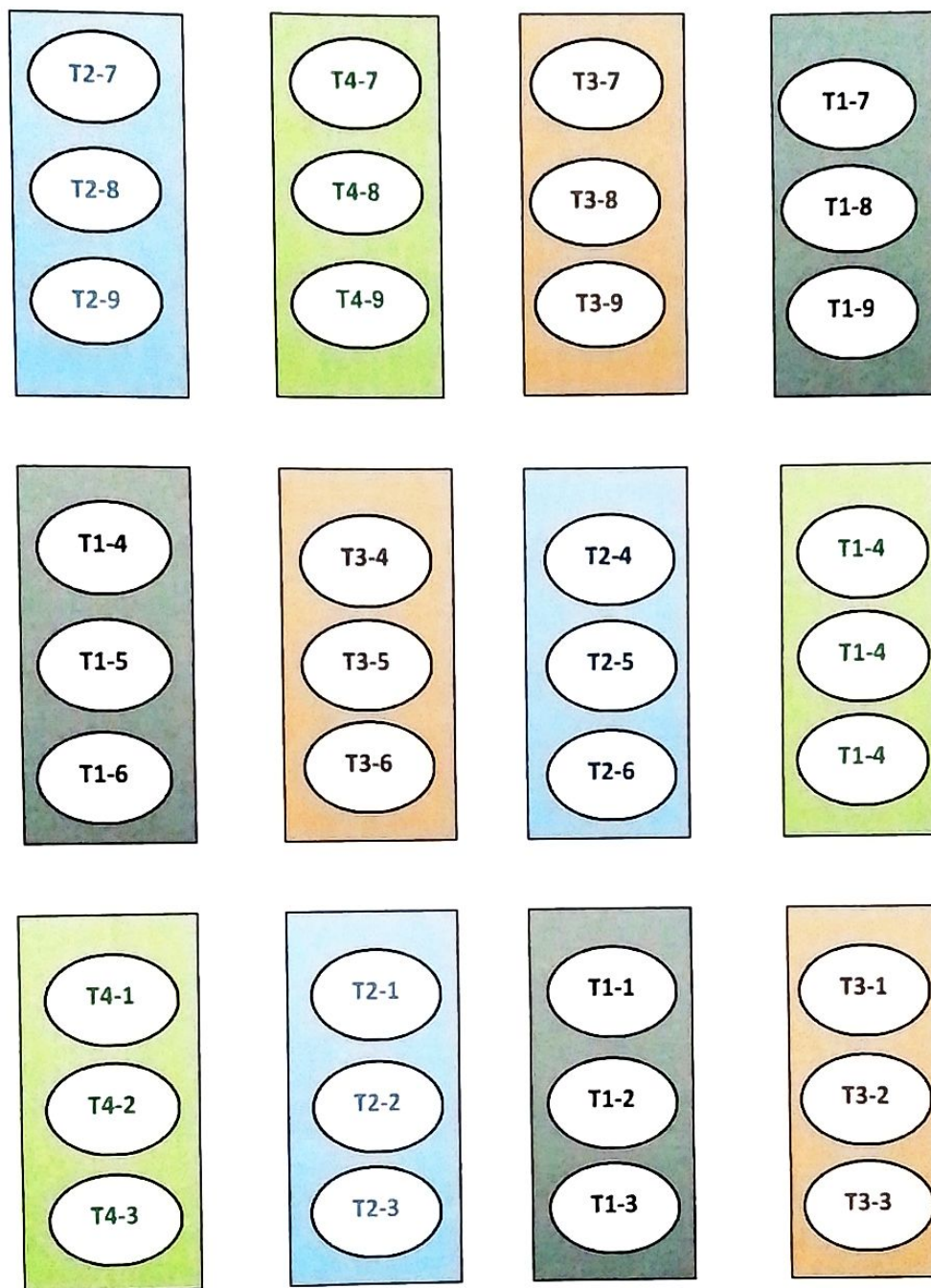
Research Materials

The materials used in this experiment were seeds of Mache or Lamb's lettuce variety, egg tray for seed germination, Urea (46-0-0) as nutrient solution, 2 inch PVC pipes, end caps and elbows, tee-connector and coupling, PVC solvent cement, seal tape, substrate (mixed humus and soil), 13W submergible water pump, ½-inch diameter irrigation poly tubing, ¼-inch diameter level hose, garden hose, 2-inch net pots, measuring materials, electrical drill, lumber, polyethylene

transparent film for protective structure, container as reservoir, and identification tags.

Research Design

The experiment was laid out in a complete randomized design (CRD), as shown in Figure 1, consisting of four treatments where each treatment was replicated 3 times. The irrigation regimes evaluated were continuous flooding (T1), intermittent irrigation at 2-day interval (T2), intermittent irrigation at 3-day interval (T3), and intermittent irrigation at 5-day interval (T4). This study used Nutrient Film Technique (NFT), a hydroponic technique where in a very shallow stream of water containing all the dissolved nutrients required for plant growth is re-circulated past the bare roots of plants in a watertight gulley or channels using water pump.



T1- Continuous Flooding

T2- 1-day interval irrigation regime

T3- 3-day interval irrigation regime

T4- 5-day interval irrigation regime

Tn-n- Replication number

Figure 1. Complete Randomized Design (CRD) Experimental Lay-out

Research Procedure

The hydroponic cultivation was carried out in a chapel-type greenhouse (6m long, 6m wide and 4m high) set up as the protective structure (Figure 2) for the hydroponically- grown lettuce using the transparent polyethylene film for roofing and covering in order to control pest, humidity and temperature or where the environment is controlled.



Figure 2. Greenhouse used as protective structure for the hydroponics system.

The hydroponic system used was the Nutrient Film Technique (NFT), where the nutrient solution was distributed in the culture channels by a re-circulating pump. The NFT structure (Figure 3) was assembled with the help of labor worker. Each PVC pipe treatment-replications used in the hydroponic system measure 120 cm with 3 lettuce plants. Each treatment has one submersible water pump used to

circulate nutrient solution from a reservoir through an irrigation tubing to each plant within each treatment.



a)



b).

Figure 3. a) Assembling the PVC pipes in a NFT system, b) Setting-up the PVC pipes into the bench

The cultivar seed selected was Mache or Lamb's lettuce since it was one of the common lettuce variety grown hydroponically. The seeds were bought from the local market and propagated by placing the seeds in the germination medium using egg tray. In each hole of the egg tray, one seed was sown (Figure 4). The germinated plants were placed with low solar radiation or rays since most lettuce require light at low radiation to germinate inside the protected structure or greenhouse. Germinating seeds was sub-irrigated through overhead daily watering. Seeds were allowed to grow for one week prior to transplanting. After one week of germinating the seeds, seedling were transplanted into net pots and placed it on the pipes or channels with the spacing of 24 cm between plants as per recommended.



Figure 4. Seeding of Lettuce into seed tray.

On the day of transplanting, the plants were irrigated. The nutrient used was Urea dissolved and mixed in the nutrient reservoir for irrigation. For continuous

flooding irrigation regime, the plants were irrigated daily until the maturity of the plants. For intermittent irrigation regimes at 1-day, 3-day and 5-day intervals, the plants were irrigated with an interval of 1, 3 and 5 days from the day of transplanting until the maturity of the plants respectively. For crop management and pest control, the hydroponically-grown lettuce were monitored everyday until the day of harvesting or maturity period.



Figure 5. One (1) week-old lettuce after transplanting.

Data Gathering and Analysis

Plant height of the hydroponically-grown lettuce obtained by direct measurement using a ruler from the lettuce head to the bottom stem of the plant after harvesting from all replications in each treatment thru their average value. For plant weight, the hydroponically-grown lettuce were directly weighed after harvesting or after getting the matured plants from the system for all replications

in each treatment. Likewise, for root depth, the plant was carefully uprooted from the system and directly measured from the top of its root to the bottom from all replications in each treatment after harvesting and get the average mean in each replication. Data for leaf area was collected from each replication of the four treatments after harvesting using the following equation by Montgomery (1911):

$$\text{Leaf area (cm}^2\text{)} = L \times W \times K$$

where;

L = leaf length,

W = maximum width of the leaf and

K = a correction factor of 0.75.

Statistical Treatment

All results were subjected to a one-way analysis of variance ANOVA on the effects of hydroponically-grown lettuce plant in terms of root depth, plant height, plant weight, leaf area, and number of leaves. At each replication means were separated at $P= 0.05$ level of significance.

DEFINITION OF TERMS

The key of terms in the study are given the following definitions:

Complete Randomized Design. It is one where the treatments are assigned completely at random so that each experimental unit has the same chance of receiving any one treatment.

Continuous Flooding (CF) Regime. It is known as flood irrigation which means delivery of irrigation water by the design or practice of flowing of water continuously over the surface.

Hydroponic System. It is a term which also means hydro agriculture. It is a technology for soilless growing plants in nutrient solutions (water and fertilizers) with or without the use of artificial medium (e.g., sand, gravel, vermiculate, rockwool, peat, coir, sawdust) to provide mechanical support.

Intermittent irrigation. A method of alternately irrigating and, passively or actively, drying for several days.

Irrigation regimes. A regular pattern of irrigation method which serve as treatment in this study.

Nutrient Film Technique. It is hydroponic system where in a very shallow stream of water containing all the dissolved nutrients required for plant growth is re-circulated past the bare roots of plants in a watertight gully or channels using water pump. The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir.

Chapter 2

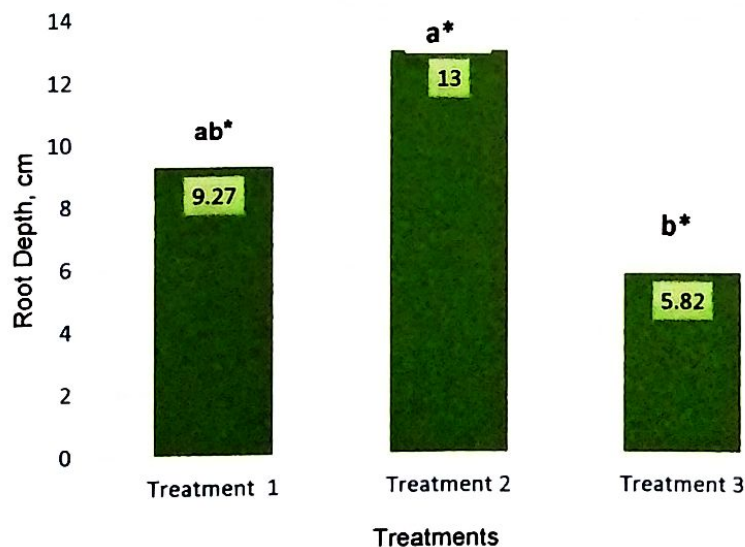
PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter deals with the presentation, analysis and interpretation of data of hydroponically-grown lettuce using different irrigation regimes. These includes the root depth, plant height, plant weight, the leaf area and the number of leaves of the hydroponically-grown lettuce.

The gathered data was based on Complete Randomized Design (CRD) where three treatments were evaluated namely; continuous flooding, intermittent irrigation at 1-day interval, intermittent irrigation at 3-day interval, and intermittent irrigation at 5-day interval. All treatments were replicated three (3) times.

Analysis Response of Root Depth

As shown in Figure 6, Treatment 2 was significantly higher than Treatment 3 but with comparable value to Treatment 1.



* Significant difference at 5% confidence interval

Figure 6. Summary of Result of the Root Depth of Hydroponically-grown Lettuce

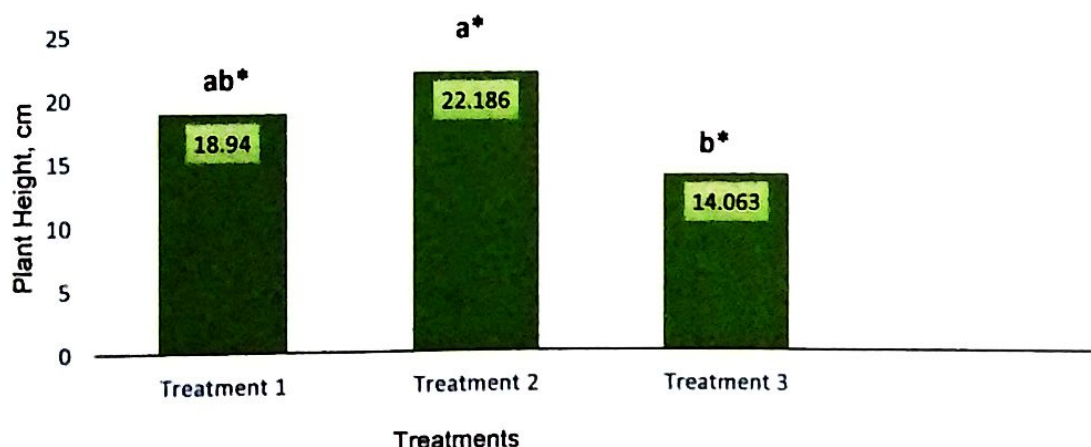
From the ANOVA Table 1, the result implied that at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of root depth. Thus, the null hypothesis was rejected.

Table 1
ANOVA Table on the Analysis of the Root Depth on Hydroponically-grown Lettuce

Source	Type II Sum of Squares	df	Mean Square	Computed F-value	Tabular F 5%
Treatment	77.2933	2	38.6466	8.61	0.0173
Error	26.9381	6	4.489		
Total	104.2314	8			

Analysis Response of Plant Height

As presented in Figure 7, among the three treatments, Treatment 2 has the highest measurement as compared to Treatments 1 and 3. As noted, T2 had a comparable height average with T1 and T3, respectively.



* Significant difference at 5% level confidence interval

Figure 7. Summary of Result of the Plant Height on Hydroponically-grown Lettuce

From the ANOVA Table 2, the result implied that at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of plant height. Thus, the null hypothesis was rejected.

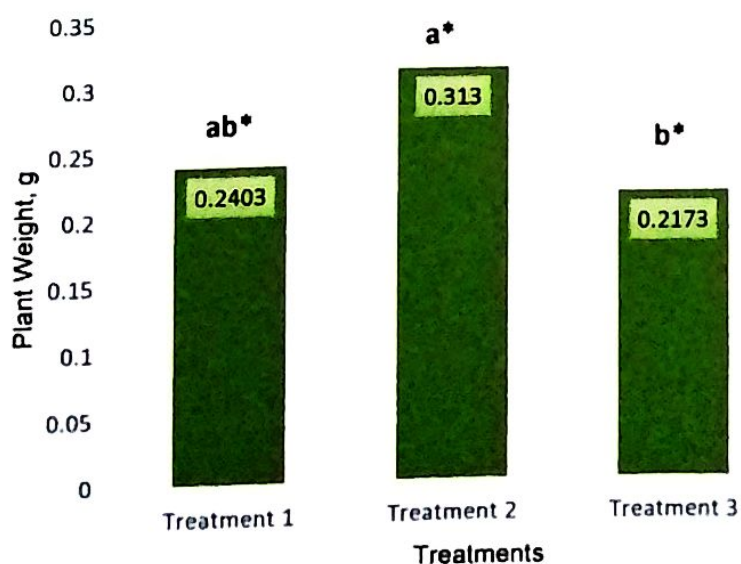
Table 2

ANOVA Table on Analysis of the Plant Height on Hydroponically-Grown Lettuce

Source	Type II Sum of Squares	df	Mean Square	Computed F-value	Tabular F 5%
Treatment	100.313	2	50.1556	5.09	0.05
Error	59.1661	6	9.8610		
Total	159.4774	8			

Analysis Response on Plant Weight

As shown in Figure 8, Treatment 2 significantly higher than Treatment 3 but with comparable value Treatment 1.



*Significant difference at 5% level confidence interval

Figure 8. Summary of Result of the Plant Weight on Hydroponically-grown Lettuce

From the ANOVA Table 3, the result implied that at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of plant weight. Thus, the null hypothesis was rejected.

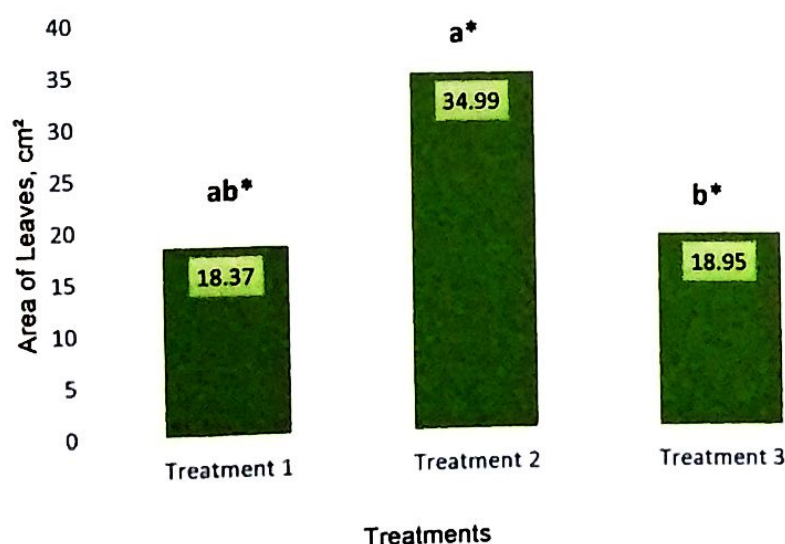
Table 3

ANOVA Table on Analysis of the Plant Weight on Hydroponically-grown Lettuce

Source	Type II Sum of Squares	df	Mean Square	Computed F-value	Tabular F 5%
Treatment	0.0150	2	0.0075	5.20	0.0490
Error	0.0086	6	0.0014		
Total	0.0236	8			

Analysis Response of Area of Leaves

Figure 9 shows that Treatment 2 was significantly higher than Treatment 3 but with comparable value to Treatment 1.



*Significant difference at 5% level of confidence interval

Figure 9. Summary of Result of the Area of Leaves on Hydroponically-grown Lettuce

From the ANOVA table 4, the result implied that at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of area of leaves. Thus, the null hypothesis was rejected.

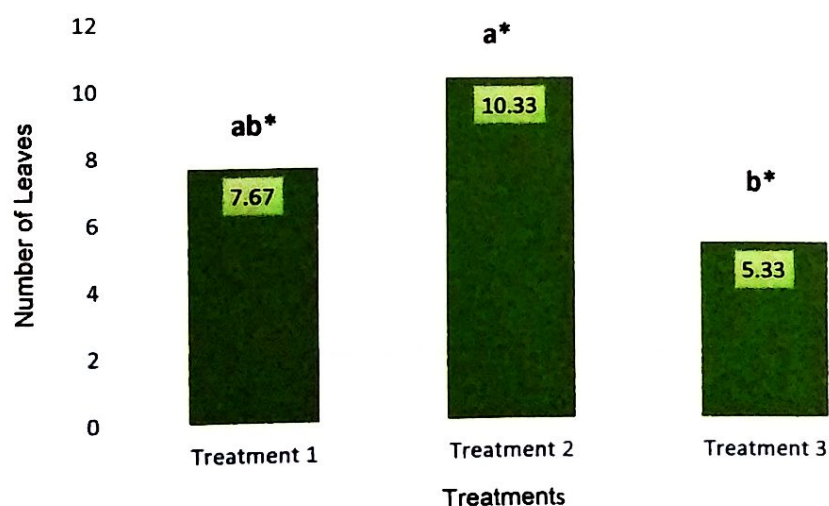
Table 4

ANOVA Table on Analysis of the Area of Leaves on Hydroponically-grown Lettuce

Source	Type II Sum of Squares	df	Mean Square	Computed F-value	Tabular F 5%
Treatment	533.8424	2	266.9212	6.19	0.0348
Error	258.6652	6	43.1104		
Total	792.5076	8			

Analysis Response on Number of Leaves

Figure 10 shows that Treatment 2 was significantly higher than Treatment 3 but with comparable value to Treatment 1.



*Significance difference at 5% confidence level interval

Figure 10. Summary of Result on Number of Leaves of Hydroponically-grown Lettuce

From the ANOVA Table 5, the result implied that, at 0.05 level of significance, there is significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of number of leaves. Thus, the null hypothesis is rejected.

Table 5
ANOVA Table on Analysis of Number of Leaves on Hydroponically-grown Lettuce

Source	Type II Sum of Squares	df	Mean Square	Computed F-value	Tabular F 5%
Treatment	37.5556	2	18.778	8.05	0.0200
Error	14.0000	6	2.3333		
Total	51.5556	8			

To sum up the result, analysis and interpretation of data it shows that there is significant difference on the application of different irrigation regimes as treatments namely: (T1) continuous flooding, (T2) intermittent irrigation at 1-day interval and (T3) at 3-day interval on hydroponically grown lettuce in terms of root depth, plant weight, area of leaves and the number of leaves at 0.50 level of significance. On the other hand, Treatment 4 which is the intermittent irrigation at 5-day interval was not included in the presentation, analysis and interpretation of data since the lettuce plant died or did not survived at 5-day interval of irrigation.

Chapter 3

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

This deals with the summary of findings, conclusion, and recommendation from the data gathered to its analysis and interpretation of data of hydroponically - grown lettuce using different irrigation regimes.

Summary of Findings

The study was conducted at Brgy., Maitum, Catigbian, Bohol. The study aimed to assess and evaluate the growth of hydroponically-grown lettuce using different irrigation regimes and were based on Complete Randomized Design (CRD).

Among the four treatments, Treatment 2 which is the intermittent irrigation at 1-day interval have the higher average value of measurement compared to the rest of the treatments while Treatment 4, the lettuce plant died or did not survive at 5-day interval of irrigation.

Specifically, for root depth, Treatment 2 was significantly higher than Treatment 3 but with comparable value to Treatment 1. The result also implied that, at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of root depth.

For the plant height, among the three treatments, Treatment 2 has the highest measurement of 22.186 cm as compared to Treatments 1 and 3. As noted, T2 had a comparable height average with T1 and T3 respectively which implied

that, at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of plant height

For the plant weight, Treatment 2 significantly higher than Treatment 3 but with comparable value Treatment 1. The result also implied that, at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of plant weight.

For leaf area, Treatment 2 was significantly higher than Treatment 3 but with comparable value to Treatment 1. The also result implied that at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of area of leaves.

For the number of leaves, Treatment 2 significantly higher than Treatment 3 but with comparable value to Treatment 1. The result also implied that, at 0.05 level of significance, there was significant difference on the application of the different irrigation regimes on hydroponically-grown lettuce in terms of number of leaves.

In summary of the findings, Treatment 2 which is the 1-day interval of irrigation which has the highest average value measurement that implies good quality of lettuce plants grew hydroponically compared to the rest of the two treatments. Furthermore, the findings shows that there was significant difference on the application of different irrigation regimes as treatments namely: continuous flooding, intermittent irrigation at 1-day interval, and at 3-day interval on

hydroponically grown lettuce in terms of root depth, plant weight, area of leaves and the number of leaves at 0.50 level of significance. On the other hand, treatment 4 which is the intermittent irrigation at 5-day interval was not included in the presentation, analysis and interpretation of data since the lettuce plant died or did not survived at 5-day interval of irrigation.

Conclusion

From the result and findings, it can be concluded that hydroponically-grown Mache or Lamb's lettuce plant best grew at 1-day interval of irrigation regime which gave significantly difference result in terms of root depth, plant height, plant weight, area of leaves and the number of leaves. Thus, the results gave ideas on where we should establish new way or means of growing plants in soil less medium while conserving land and water resources.

Recommendation

Based on the findings and conclusion of the study, the following recommendation are offered:

1. Hydroponically-grown lettuce or any plants must be monitor every day in from pest that can ruin the quality of plants and facilitate irrigation and maintenance.
2. Growing plants in hydroponics system must have a thorough and intensive plan from cost analysis and design for efficient, effective and successful farming.
3. The researcher recommends the use of 1-day interval intermittent irrigation regimes.

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APPENDICES

Appendix A

Table 6

Average Measurements of Hydroponically-grown Lettuce Plant Growth

Treatments	Replications	Root depth	Plant Height	Plant Weight	Area of Leaves	Number of Leaves
T1	1	7.9	20.33	0.253	19.56	10
T1	2	9.96	17.96	0.246	19	6
T1	3	9.96	18.53	0.222	16.55	7
T2	1	15.33	21	0.256	32.06	10
T2	2	11.63	20.36	0.373	27.38	12
T2	3	12.03	25.2	0.31	45.53	9
T3	1	8.86	19.36	0.246	26.01	6
T3	2	3.3	11.1	0.206	14.65	5
T3	3	5.3	11.73	0.2	16.19	5

Appendix B
Research Documentations



a)



b)

Figure 11. a) One (1) week old hydroponically-grown lettuce after transplanting b) Three (3) weeks old hydroponically-grown lettuce.



a)



b)



c)

Figure 12. a) T1R1 3-week Lettuce Plant no. 1-3 b) T1R1 3-week Lettuce Plant no. 4-6 c) T1R1 3-week Lettuce Plant no. 7-9



a)



b)

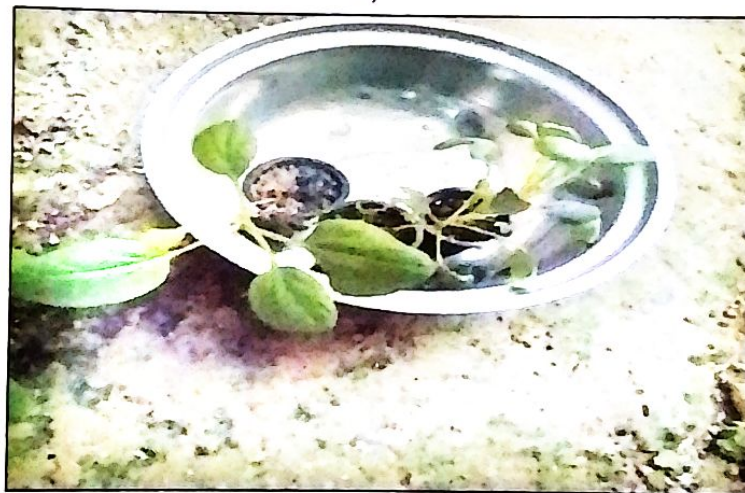


c)

Figure 13. a) T2R1 3-week Lettuce Plant no. 1-3 b) T2R1 3-week Lettuce Plant no. 4-6 c) T2R1 3-week Lettuce Plant no. 7-9



a)



b)



c)

Figure 14. a) T3R1 3-week Lettuce Plant no. 1-3 b) T3R1 3-week Lettuce Plant no. 4-6 c) T3R1 3-week Lettuce Plant no. 7-9



a)



b)

Figure 15. Treatment 4 (5-day intermittent irrigation regimes)- Died lettuce plant



Appendix C
Letter of Request
 Republic of the Philippines
 Bohol Island State University - Bilar Campus
 Zamora, Bilar, Bohol
 College of Agriculture and Natural Resources
Department of Agricultural and Biosystems Engineering



Vision: A premier S&T university for the formation of a world class and virtuous human resource for sustainable development in Bohol and the country.

Mission: Committed to provide quality and innovative education in strategic sectors for the development of Bohol and the country.

Dr. Noel T. Lomosbog
 CANR Dean/Thesis Committee Chairperson
 BISU-Bilar Campus
 Zamora, Bilar, Bohol

Sir;

Greetings!

As part of the requirement for the degree in Bachelor of Science in Agricultural and Biosystems Engineering (BSABE), we are currently conducting our individual thesis entitled: "HYDROPONICALLY-GROWN LETTUCE USING DIFFERENT IRRIGATION REGIMES" and "GROWTH OF PECHAY: THRU ALTERNATE WETTING USING HYDROPONICS SYSTEM".

With this regard, we would like to request from your good office to allow us to conduct our experimental thesis at Brgy. Maitum, Catigbian, Bohol for the reason of there will be people who will help to assist us especially in setting up the hydroponics system and since the chapel-type greenhouse that we will be using was already built there. We will just assure to provide documentations in setting up the hydroponics system and including the necessary procedures or processes needed upon conducting our experimental study which serve as our evidence. We are hoping for your approval with this request. Your usual support will be a great help to us to realize our dreams.

Respectfully yours,

HONEY P. BULAQUIÑA
 BSABE Student

ANALYN M. LLOREN
 BSABE Student

Noted by:

ENGR. ERWIN G. LUDEVESE
 Member/ Thesis Adviser

JULIAN E. TORILLO JR., Ph.D.
 Thesis Expert

Approved by:

NOEL T. LOMOSBOG, Ph.D.
 Thesis Committee Chairperson