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EFFECTIVENESS OF TWO GARDEN SYSTEMS IN A SCHOOL GARDENING PROJECT

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ABSTRACT

Vegetable growing is essential in people's health as well as in the economic aspect of their lives. This study sought to find out the level of plant health and growth grown in hydroponic and container gardens. A purposive sampling of the plant selection was used in the study following the criteria on plant health and growth as indicated on plant height (cm); number of leaves; width of leaves (cm); length of leaves (cm); and color of the leaves. The researcher recorded the data every week with a structured observation tool. Data were analyzed using descriptive and inferential statistics. Findings reveal that plants in the hydroponic garden had a significant difference in terms of plant height, length of leaves, width of leaves and number of leaves compared to the plants in the pot garden which means that the hydroponic garden is more effective in growing plants than in the pot garden. On the other hand, results show that there is no significant difference on hydroponic and pot garden in terms of color of the leaves implying that both plants had similar color. The finding points to the need of utilization of the hydroponic garden in the schools and eventually to the homes of the residents in the community.

Keywords: Hydroponic, Pot, Health, Growth, School garden

INTRODUCTION

School gardens are established to provide learners the opportunity to learn the basics of nutrition and to provide input for supplementary feeding. However, the schools are facing challenges on the garden spaces which hamper the realization of the program goals. In order to address the gap on the utilization and functionality of space which will not sacrifice the plant health and production, several researches on crop production focused on the maximization of vertical garden such as the pot gardens and the recent technology on hydroponics gardening which are

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found to have made serious contributions aesthetically and in terms of its functionality (Qasim & Güngör, 2019). The two planting methods are designed to cater to the need on limited availability of garden lands and in response to concern on food security and plant reproduction.

Consequently, the concern on food is aggravated by the increasing population growth rate and decreasing availability of land for food production especially in the school areas where construction of classroom buildings has been the top priority. Currently, different sectors in the community posted challenge on utilization of land spaces for gardening with the advent of housing plans and close competition on land use especially in urban areas (Drescher, Holmer & Iaquinta, 2006; Kenyon, 2002). Wong (2017) also added that pot gardens can hold less substantial plants because of its minimal space and when compared to the plants grown in the ground.

With this, scientists are using innovative methods to breed more productive and nutritious crops. Researches on advancing the breeding and genetics of plants are allowing farmers to grow plant varieties that are healthier and more resilient to drought and losses from pests and diseases. One method accepted and practiced already in garden homes and vegetable-rearing groups is the use of pot gardens. Masabni (2020) confirms that the use of pot gardens or container gardening is an answer to limited gardening spaces and soil borne diseases among plants because of poor soil conditions. He added that it is considered a sure way to introduce children to the joys and rewards of vegetable gardening.

However, it was also pointed out that the success of this type of gardening rely on careful attention by regularly inspecting the plants which require time. Careful attention varies from the careful attention from preparation in terms of container selection—from its type (clay, cast concrete pots, plastic and fiberglass and wood) to its size (large and small) Masabni (2020) The Editors (2018) and Bareja (2010).

Many studies venture on the inclusion of the hydroponic vertical gardens which is a potential water saver and is found to incur positive effect on plant growth in approximately seven (7) days. The study further found out that the hydroponic technology is suitable when compared to conventional farming (Kalantari, 2017; Pascual, M.P., Lorenzo, G.A. and Gabriel, A.G., 2018 & Specht et al., 2014). Therefore, this is relatively considered as the answer to the primary goal of Gulayan sa Paaralan and sustainable food production amidst the pressing number of issues on the environmental, social and economic advancement and unavailability of space specifically in urban areas.

In view of the aforementioned facts, the researcher is encouraged to conduct an experimental study on the case of the plant health and growth using the Hydroponic Garden and the Pot

Garden. The prime focus of this study is to investigate which between the Hydroponic Gardens and Pot Garden is better in terms of plant health and growth.

THEORETICAL CONCEPTUAL FRAMEWORK

The study is anchored on the concept of Gashgari, Khawla, Khadija, Jan, and Glolam (2018) that the planting system has a significant effect on the plant growth and in such case, the hydroponic system has a higher growth rate when compared to the plantsfrom soil. To determine the degree of effectiveness, the planting system must be given importance.

Further, the study is supported by the concept of Salas et al. (2017) that hydroponics is a plant growing system which utilizes nutrient solutions with the absence of soil. With this technology, plant production happens with the roots planted in a mineral nutrient solution in an organic medium. The most important benefits of using hydroponics can be practiced even in places where ordinary gardening is impossible.

In addition, the Humus Theory, according to Jones (2013) was used in the context of pot gardens which hypothesized that plant nutrition, including plant health and production, is dependent on soil since they are soil eaters. Hence, soil feeds the plants with humus and likewise gets mineral elements mainly from the soils which become the components of the plants body. This is also shown in the concept of Brevick (2020) that posited the use of soil material is considered important to plant growth. Healthy plants require soils with an appropriate balance of nutrients in which to grow.

It was also claimed by various researchers that some chemical elements in the air and water and in the soil sustain plant health and plant life. As cited by Chastain (2020), the principle of Helmont (1634) derived from his pot experiment, concluded that water, not soil, is responsible for the increase in plant. Furthermore, the source and type of substances in which roots absorb will affect the health of a plant and in turn, the quality of produced product Jones (2013). For hydroponic growing, the use of organic materials and substances in a nutrient solution will help the effect of the elements in both plant growth at 30-50 percent faster and its yield than soil plant.

Similarly, the study is anchored on the postulation of the Naked Science (2017) that plant health is best measured through their growth including its leaves, stems and color of its foliage. Hence, in this study, the leaves and height of the plant are the focus in measuring the health and growth of the plant. Pavlovic, et al. (2014) also mentioned that determination of the color pigments (chlorophyll) in leaves is one of the key techniques in studying the process of photosynthesis which is important in measuring plant productivity.

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This study further assumes that health and growth are affected by the materials and maintenance of any planting method. This study also presupposed that plant health and productivity is a challenge specifically in areas where there's lack of available planting area for the full implementation of the Gulayan since 2007. This study asserts that the health and growth of a pechay plant which is used in this study is determined by its height, number, width and length of leaves. Hence, alternative ways such as the hydroponic gardening system and the traditional pot gardens must be sought among implementing schools.

The flow of the study is described in Figure 1. Two planting methods are used in determining the degree of effect to the plants' health and growth. Both hydroponic gardening system and pot gardens vary in the materials to be used including the planting methods and maintenance systems.

STATEMENT OF THE PROBLEM

The study aimed to investigate which type of garden, Hydroponic Garden System or Pot Garden scan yield better plant health and growth. Specifically, it sought to answers the following questions:

1. What is the level of plants health and growth in the hydroponic and pot gardens considering:

    1.1 Height of the plant

    1.2 Number of leaves

    1.3 Width of leaves

    1.4 Length of leaves

    1.5 Color of the leaves

2. Do the health and growth of the plants in the 2 garden types significantly differ?

3. Based on the findings, what action plan may be proposed?

RESEARCH DESIGN

This study used an experimental research design. This included a test on hypothesis which focused on the difference of the two planting methods, referred as the pot gardens and hydroponics gardens, in terms of plant health and growth. According to Harland (2002), the variables in this research, the materials and maintenance procedures in both planting methods, were controlled and manipulated by the researcher. The variables in this study were measured,

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and compared at the end of the experimental period. The quantified data obtained following an experimental research design were taken from the comparative results of the inter raters and experts in the field of plant production as a result of the close observation of the variables involved namely: the plant height, length and width of leaves and the number of leaves of the plant under the experiment.

MATERIALS AND SAMPLING PROCEDURE

A purposive sampling of the plant selection was employed in the study following the criteria that it germinates quickly to expedite the experiment. Hence, the study was limited on the use of ten (10) pechay plants for each intervention namely: hydroponics and pot gardens.

The materials needed for creating the hydroponic system are the following:

coco peat, seedling plugs (used cups), pechay nutrient solution (Master Blend Solution – Calcuim (10g), magnesuim (10g), sulfate (5g), growing boxes (used Styrofoam boxes), rain protection (or roof shade facing east for the earliest and longest possible sunlight), and plastic container where the pechay nutrient solution was mixed (for commercial production only).

For the traditional pot garden, the following materials were used:

rubber pot, planting soil, nutrient solution (Complete fertilizer (8.9g), Ammonium Phosphate (6.25g) and Urea (0.54g), water, and sprinklers

In reviewing the results, four Crop Science Faculty and a representative expert from the Department of Agriculture validated study. Further, for the reliability of the results and findings of the study, the five(5)School Garden coordinators in the secondary schools in the Province of Camiguinwere invited to help observe the rate of the growth and health of the plants.

Data Gathering Procedure and Ethical Considerations

Prior to the conduct of the study, permission to conduct the experiment was obtained from the School Administration After which, the setting up of the two experimental conditions followed. Presence of the inter-raters composed of the three Technology and Livelihood Education Teachers, two School Gardening Project coordinators in the select secondary schools in the Province of Camiguin and an expert from the Department of Agriculture helped the researcher in checking and monitoring the conduct of the experiment.

The following procedures in planting pechay adapted from the Department of Agriculture (2019) was followed in the pilot test and in the main experiment which was conducted for six (6) weeks from December 20, 2021 to January 29, 2022

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Procedure of Planting Pechay Using Pot Garden System

First, the pechay seeds were soaked in water overnight before planting it the next day and seed tray was prepared for the seedlings that was about 2 1/2 inches tall would be planted. Second, the soaked pechay seeds were planted and transplanted the seedlings after 5 - 10 days in the pot when it had at least three leaves. Then the plants were watered everyday so it would grow fast. The growth was observed and approximately after 40 days, the pechay was harvested.

While the procedure of hydroponic system which is adapted from Agron (2012) is summarized in the following steps:

Procedure Using Hydroponic Garden System

The procedure of hydroponic system which is adapted from Agron (2012) is summarized in the following steps: First, the pechay seeds were soaked in water overnight before planting them the next dayand a seed tray with coco peat for the seedlings that is about 2 1/2 inches tall was planted. The soaked pechay seeds were planted and transplanted the seedlings after 5-10 days in when it had at least three leaves. The growing boxes were organized on a constructed bench in the shelter with the lid taken off. Then, the nutrient solution (MASTER BLEND SOLUTION) was dissolved in 19 liters of water and the solutions which were properly dissolved and were added to each of the box. Then, growing box must be filled with 5 liters of water and place the box cover. The seedlings plugs must be placed on the holes of the cover. All the cups were evenly and uniformly inserted with the same level with one another. Checking was done to ensure that the bottom of the box touched the nutrient solution. Then, more water was added until the desired level was reached and leaks were attended immediately. As early as one can visit the condition of the plants every morning to catch any insect larva that may destroy the plants, one can expect that the nutrient solution level would go down when the plants were much bigger than were they were still small seedlings. There is a need to refill the solution with more than (1) one inch from the cup bottom until it decreases. The solution level should never reach the bottom of the rum.; hence, it must be changed if about ½ inch below the cup's bottom.

Research Instrument

To determine the plant health and growth of both hydroponic and pot gardens, an observation tool was used to measure the plant height, number of leaves, width of leaves, length of leaves and color of the leaves .The pechay seeds were planted in two gardening systems and the same number of containers were used in both systems.

Statistical Treatment

To answer problem No.1, descriptive statistics such as frequency, percentage, mean, and standard deviation were used to determine the plants' health and growth and productivity in terms of its height, number of leaves, width and length of leaves and the color of leaves in both garden types.

Further, to answer problem No.2, inferential statistics (independent samples t-test) was used to determine any significant difference in the recorded plant height, length and width of leaves between the two planting methods, *pot gardens and hydroponics gardens.*

RESULTS AND DISCUSSION

Table 1 presents the frequency, percentage, means and standard deviation of plant height from the beginning to the end of observation. Data show that from the beginning, all plants in both groups were found *poor* in their growth in terms of plant height. However, at the end of six weeks of observation, the plants in both hydroponic and pot gardens had an increase in their height as made evident in the incremental changes of their scores. It is shown in the table that all plants from hydroponic garden increased from "poor" to "very good" growth. On the other hand, the plants in the pot garden were also found to have "good" growth in terms of plant height. The data further indicate that plant heights increased from the beginning to the end of observation among the plants from hydroponic and pot gardens. This means that plants grown hydroponically tend to grow faster than those in the pot garden because oxygen and nutrients are delivered directly and intensively to their roots The finding is further supported by Chastain (2020), that the principle derived from his experiment, concluded that water, not soil, is responsible for the increase in plant size.

Table 1: Frequency, Percentage, Mean Distribution of Plant Height of both Plants Planted in Hydroponic and Pot Gardens

Range	Interpretation	Hydroponic				Pot			
		Beginning		End		Beginning		End	
		F	%	F	%	F	%	F	%
20 and above	Very Good	0	0	10	100	0	0	0	0
15.00–19.99	Good	0	0	0	0	0	0	10	100
10.00–14.99	Moderate	0	0	0	0	0	0	0	0
5.00–9.99	Fair	0	0	0	0	1	10	0	0
Below 5	Poor	10	100	0	0	9	90	0	0
Total		10	100	10	100	10	100	10	100
Overall Mean		**3.39**		**22.23**		**3.65**		**19.37**	
Description		**Poor**		**Very Good**		**Poor**		**Good**	
Standard Deviation		**0.74**		**0.53**		**1.03**		**0.25**	

Table 2 presents the frequency, percentage, means distribution in terms of number of leaves. Data show that in the beginning both groups of plants have different description of number of leaves. The finding reveals that nine or (90%) from the hydroponic garden and six or (60%) from pot garden had "poor" number of leaves. Table also reflects that only one or (10 %) out of ten (10) plants from the hydroponic garden and four or (40 %) out of ten (10) plants in pot garden had "fair" growth of number of leaves. However, at the end of the observation, data show that plants increased in their number of leaves. The finding further reveals that seven or (70%) from hydroponic garden had "very good" leaves while from pot garden only eight or (80%) had "good" growth of number of leaves. The data furthermore indicate that the plants grown from hydroponic garden is more productive in terms of number of leaves as compared to the plants in the pot garden. This means that in the hydroponic garden, the nutrients are delivered directly to the root system in almost surgical quantities. This method ensures that plants receive exactly the right quantity of nutrition at the right times allowing the plant to spend their energy producing more leaves. The findings confirm what Dyer (2020) found in his study that ensuring that the plant is healthy would determine its success. Hence, all parts of the plant, starting from the leaves would determine the success of any planting method. A healthy plant is equated to the number of healthy new growth.

Table 2: Frequency, Percentage, Mean Distribution of Number of Leaves both Plants Planted in Hydroponic and Pot Gardens.

Range	Interpretation	Hydroponic				Pot			
		Beginning		End		Beginning		End	
		F	%	F	%	F	%	F	%
11 and above	Very Good	0	0	7	70	0	0	2	20
9 – 10	Good	0	0	3	30	0	0	8	80
6 – 8	Moderate	0	0	0	0	0	0	0	0
4 – 5	Fair	1	10	0	0	4	40	0	0
1 – 3	Poor	9	90	0	0	6	60	0	0
Total		10	100	10	100	10	100	10	100

Table 3 shows the marked increase of the width of leaves of the plants grown in both hydroponic and in pot gardens. Specifically, both plants had poor growth in the leaves at the start. But notably, at the end of observation, the plants grown in hydroponic garden had very good growth on the width of the leaves as indicated in the overall mean of 13.59.

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Table 3: Frequency, Percentage and Mean Distribution of the Width of Leaves of both Plants Planted in Hydroponic and Pot Gardens.

Range	Interpretation	Hydroponic				Pot			
		Beginning		End		Beginning		End	
		F	%	F	%	F	%	F	%
12.00 and above	Very Good	0	0	10	100	0	0	0	0
9.00 – 11.99	Good	0	0	0	0	0	0	10	100
6.00 – 8.99	Moderate	0	0	0	0	0	0	0	0
3.00 – 5.99	Fair	0	0	0	0	0	0	0	0
0.01 – 2.99	Poor	10	100	0	0	10	100	0	0
Total		10	100	10	100	10	100	10	100
Overall Mean		**0.54**		**13.59**		**0.82**		**11.23**	
Description		**Poor**		**Very Good**		**Poor**		**Good**	
Standard Deviation		**0.05**		**0.51**		**0.23**		**0.36**	

Meanwhile, the plants in the pot garden had only "good" growth in terms of the width of leaves as reflected by the overall mean of 11.23. This means that hydroponic plants grew faster compared to the plants in the pot garden because the perfect blend of nutrients is delivered directly to the root system where the grown plants do not need to expend energy on an extensive root system to find the food it needs, so all of its energy goes into upward leaf growth. Results were further supported by Kenyon (2020) that plants love to grow in hydroponics and it has been recorded that it grows fast and gives up to ten times the yield than soil-grown plant.

As reflected in Table 4, plants from hydroponic garden yielded a very good growth of leaves as indicated in the overall mean of 19.63. Meanwhile, plants from pot garden had only "good" growth as shown in the overall mean of 16.59. The plants in the hydroponic planting system increased in length faster. These findings confirm what Jones (2013) espoused that the source and type of substances in which roots absorb affect the health of a plant, the quality of produced product, since the use of organic materials and substances in a nutrient solution will help the effect of the elements in both plant growth at 30-50 percent faster and its yield than soil plant.

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Table 4: Mean scores in terms of Length of Leaves between Hydroponic and Pot Garden.

Range	Interpretation	Hydroponic				Pot			
		Beginning		End		Beginning		End	
		F	%	F	%	F	%	F	%
16.80andabove	Very Good	0	0	10	100	0	0	5	50
12.60 – 16.79	Good	0	0	0	0	0	0	5	50
8.40 – 12.59	Moderate	0	0	0	0	0	0	0	0
4.20 – 8.39	Fair	0	0	0	0	0	0	0	0
0.01 – 4.19	Poor	10	100	0	0	10	100	0	0
Total		10	100	10	100	10	100	10	100
Overall Mean		**1.35**		**19.63**		**2.35**		**16.59**	
Description		**Poor**		**Very Good**		**Poor**		**Good**	
Standard Deviation		**0.27**		**0.72**		**0.94**		**0.54**	

Table 5 shows that all plants from hydroponic garden and pot garden had “moderate” nutrients with light green color after six weeks. This means that there were improvements in the color of the leaves of the plants planted in both the pot and in the hydroponic garden system. The finding confirms with the postulation of Naked Science (2017) that plant health is best measured through their growth including its leaves, stems and color of its foliage. In this study, the leaves and height of the plant are the indicators that show the health and growth of a plant and this was supported by Pavlovic, et al. (2014) that determination of the color pigments (chlorophyll) in leaves is one of the key techniques in studying the process of photosynthesis which is important in measuring plant growth.

Table 5: Frequency and Percentage Distribution on the Color of Leaves in the Beginning and After Transplanting in both Gardens.

Range	Interpretation	Hydroponic				Pot			
		Beginning		End		Beginning		End	
		F	%	F	%	F	%	F	%
5	Dark Green(High Nutrient)	0	0	0	0	0	0	0	0
4	Light Green(Moderate)	0	0	10	100	0	0	10	100
3	YellowGreen(Low Nutrients)	10	100	0	0	10	100	0	0
2	Yellowish(VeryLowin Nutrients)	0	0	0	0	0	0	0	0
Total		10	100	10	100	10	100	10	100

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Problem 2: Do the health and growth of the plants in the 2 garden types significantly differ?

Table 6: Results showing the significant difference in the mean increment in the health and growth of the plants in both gardens

	Hydroponic		Pot		t	p
	Mean Increment	SD	Mean Increment	SD		
Height of Plant	18.84	0.90	15.72	1.06	7.067**	.000
Width of Leaves	13.05	0.48	10.41	0.47	12.408**	.000
Length of Leaves	18.28	0.71	14.24	0.93	10.955**	.000

***Significant at the .01 level (two-tailed)*

Significant differences were noted in the height of the plants (t=7.07, p=.000); the width of the leaves (t=12.41, p=.000) and the length of the leaves (t=10.96, p=.000) with the plants in the hydroponic garden consistently showing higher mean increment values. Thus, the null hypothesis can be rejected. There is sufficient evidence to show that the plants exposed to water in the hydroponic system have grown significantly taller in height, and have wider and longer leaves; thus productivity is higher. Results are parallel to the findings of Pandey, Jain and Sing (2013) who concluded that hydroponics leads to higher yields; higher returns and excellent quality of produce.

Furthermore, these results confirm the findings of Pavlovic, et al. (2014) whose results reveal that the leaves and height of the plant measuree the health of the plant and the determination of the color pigments (chlorophyll) in leaves is one of the key techniques in studying the process of photosynthesis which is important in measuring plant health.

Table 7: Results of Mann-Whitney U-Test between Hydroponics and Pot Garden Plants

	Mean	SD	Mean	SD		
Number of Leaves	7.60	0.52	6.80	0.42	16.000**	.009
Color of the Leaves	1.30	0.48	1.20	0.63	46.500	.796

***Significant at the .01 level (two-tailed)*

Considering that the number and color of the leaves are discrete, Mann Whitney U test was employed. Data in Table 7 reveal that the number of leaves significantly differ (u=16.000, p=0.009) with the plants in the hydroponic gardens having generally more leaves (M=7.60). Thus the null hypothesis can be rejected in this dimension of the plants' productivity. The plants in the hydroponic gardens have produced more leaves as compared to pot plants. It can be

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inferred that the treatment given to the hydroponic plants is effective. In terms of the color of the leaves, however, the mean increment do not significantly differ. Thus, the null hypothesis cannot be rejected in this component. This means that both systems exposed the plants to light which allow for the process of photosynthesis and because of the accurate input of nutrients making the leaves green.

The table further shows that there was no significant difference hydroponics and pot gardens in terms of the color of leaves implying similarities of leaves color of both plants grown in hydroponic and in pot gardens. This findings confirms with what Sardane & Amande, (2013) found in their study citing that that there has been no recorded significant effect in the color of plants using hydroponics and the soil-grown or the traditional potted gardens.Bonar (2016) also espoused that plant leaves indicate nutrient deficiency, little water or possible presence of insect damage. The symptoms of stress and unhealthy signs among plants are visible in their color such as yellow-green color, purplish or dark green color and wilted or burnt looking leaves. The yellow-green color shows nitrogen deficiency; a purplish or dark green color shows lack of phosphorous and a wilted or burnt leaves as a sign of potassium deficiency. These nutrients were basically available and supplied to plants via soil gardening and hydroponic gardening.

CONCLUSION

The findings of the study confirmed that the two groups of plants have marked improvement in terms of their plant height, length and width of leaves, number of leaves and color of leaves after six weeks of observation. However, the hydroponic garden is found more effective, because plants grown hydroponically are longer and have wider leaves with perfect blend of nutrients which is delivered directly to the root system. The study points to the need of exploring other vegetable plants to increase the generalizability of the finding on the use of the two gardens systems.

RECOMMENDATIONS

Based on the conclusion of the study, the following recommendations are suggested to the following sectors: that the:

1. School Administrators may consider implementing the proposed action plan in the School Gardening Project with emphasis on the use of hydroponic garden;

2. Agriculture teachers are encouraged to assist and promote the implementation of School Gardening Project using hydroponic garden;

3. Students may put into action their knowledge for this kind of gardening and apply actualize this knowledge in their respective homes.

4. Parents may adopt the technology on gardening and apply it to their respective homes

5. Local Government Units may share to the community the opportunity to embark on hydroponic system as a form of urban gardening to augment people's income and raise their consciousness on the need for healthy lifestyle particularly in eating nutritious diets.

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