RESEARCH

Comparison between Growing Plants in Hydroponic System and Soil Based System

Presenters

MASLANIK, HIEI KYLE C.
OCAMPO, PHIL WALTER B.
SOTOR, JOSHUA MCCANE E.

Authors

RANEEM GASHGARI
KHAWLAH ALHARBI
ABEER GLOLAM
KHADIJA MUGHRBIL
AJWAN JAN

Introduction

World population is projected to reach 9.7 billion by 2050. At the same time, it has been estimated that 50% of the arable land around the world will be unusable for farming [1]. Consequently, the food production has to be increased by 110% to meet the high demand. According to the United Nations Organization (UN), today many countries are facing a food crisis, especially in Africa. The food crisis is expected to last to 2050 if the demand will not be covered [2]. The major reason for this crisis is the climate change due to drought or floods as they became more frequent. Because of that, the world needs to develop and apply techniques to improve and increase the productivity of farming systems. Today farming systems are fundamentally based on soil, water and resilience to disasters. Hence, the need to change and develop the economic policies of current farming systems.

Introduction

Nowadays, the traditional farming system does not meet the current and future demand of food.Therefore, there is a real need for adapting a new farming system that stimulates plants to grow faster.This system should cover the fast-growing demand with less cost and minimum consumption of natural resources. The specific objectives of this paper is to: Compare and select between growing plants in a hydroponic system and growing plants in a traditional soil system, Formulate and test the hypotheses, Use the statistical approach to support the hypothesis of the study and provide recommendations for future works.

Introduction

In the hydroponics system, plants' roots are suspended in nutrient-rich water so they can grow without the need for any chemicals. The offers both home gardeners and commercial vegetables to grow food in places where in traditional soil systems is not possible or cost-effective [1]. Plants in the hydroponic system can achieve 20-25% higher yields than a soil-based system with productivity 2-5 times higher [1]. There has been a lot of questioning whether hydroponic plants are actually more effective than plants grown in soil. An experimental study done by Maeva Makendi, showed a competitive analysis between the plant's growth in hydroponic and soil systems [3]. The hypothesis stated as follows “If the hydroponic plants and plants grown in soil are given the same germinating and growing conditions, then the hydroponic plants will do as well if not even better than the plants grown in soil” [3]. The experiment was done on different kinds of plants for one month. Hydroponic plants did germinate and grew faster than soil plants [3]. Although many studies have proven that hydroponics takes the advantages over regular soil farming, there are still some limitations to using this system. In fact, the hydroponic system requires having good knowledge of its principles to maintain the production [6]. Furthermore, and because this system depends on electricity, power outages can cause damage to the planted crops [7], [8].

Methodology

Gathering Materials (Hydroponic system) → Gathering Materials (Soil based system) → Experiment and Variables → Procedures (Soil based system) → Procedures (Hydroponic System) → Data Collection

Symbol	Description
S(1,1)	Cucumber seed in soil planting system. No.1
S(1,2)	Cucumber seed in soil planting system. No.2
H(1,1)	Cucumber seed in hydroponic planting system. No.1
H(1,2)	Cucumber seed in hydroponic planting system. No.2
S(2,1)	Armenian cucumber seed in soil planting system. No.1
S(2,2)	Armenian cucumber seed in soil planting system. No.2
H(2,1)	Armenian cucumber seed in hydroponic planting system. No.1
H(2,2)	Armenian cucumber seed in hydroponic planting system. No.2

Length of Leaves (mm)		Seed Type (A)			
		Cucumber		Armenian Cucumber	
Planting System (B)	Soil	65	51	60	43
	Hydroponic	50	76	69	57

Height (mm)		Seed Type (A)			
		Cucumber		Armenian Cucumber	
Planting System (B)	Soil	94	105	93	78
	Hydroponic	190	146	177	150

Source	Sum of Squares	DF	Mean Square	F Value	Prob > F	
Model	10947.38	3	3649.13	9.70	0.0263	significant
A	*171.13*	*1*	*171.13*	*0.45*	*0.5371*	
B	*10731.12*	*1*	*10731.12*	*28.51*	*0.0059*	
AB	*45.13*	*1*	*45.13*	*0.12*	*0.7466*	
Pure Error	1505.50	4	376.37			
Cor Total	12452.88	7				

Figure 1: ANOVA results from Design-Expert for height response.

Results and Discussion

The Model F-value of 9.70 implies the model is significant. There is only a 2.63% chance that a "Model F-Value" this large could occur due to noise. Values of "Prob > F" less than 0.0500 indicate model terms are significant. In this case, B (the planting type factor) is the significant model term. Values greater than 0.1000 indicate the model terms are not significant which include both A and AB (the type of seed factor and the interaction between two factors). See Figure 1 results which represent height response.

Source		Sum of Squares	DF	Mean Square	F Value	Prob > F	
Model		178.38	3	59.46	0.36	0.7834	not significant
	A	*21.12*	*1*	*21.12*	*0.13*	*0.7371*	
	B	*136.13*	*1*	*136.13*	*0.83*	*0.4127*	
	AB	*21.12*	*1*	*21.12*	*0.13*	*0.7371*	
Pure Error		652.50	4	163.13			
Cor Total		830.88	7				

Figure 2: ANOVA results from Design-Expert for length of leaves response.

Results and Discussion

The "Model F-value" of 0.36 implies the model is not significant relative to the noise. There is a 78.34 % chance that a "Model F-value" is large could occur due to noise. In this case, there are no significant model terms. All values (A, B and the interaction AB) greater than 0.1000 indicate the model terms are not significant. See Figure 2 results which represent length of leaves response.

Results and Discussion

According to the results from Design-Expert software, the planting system did have a significant effect on the height of treatments. On the other hand, it will not affect the length of leaves. The other terms, seed type and their interaction between the planting system and seed type, did not affect the growth- height, and length of leaves of the treatments.

After the plants were germinated, the difference in the speed of growth was noticeable in the height of the treatments. For example, cucumber treatments equal 94 mm in soil and 190 mm in hydroponic. Similarly, for Armenian cucumber treatments equal 78 mm in soil and 177 mm in hydroponic. As for the length of the leaves, the differences were little. For instance, cucumber treatments equal 50 mm in soil and 76 mm in hydroponic. Similarly, for Armenian cucumber treatments equal 43 mm in soil and 69 mm in hydroponic.

All plants in the hydroponic and soil systems germinated and grew. The hypothesis of the experiment is accepted for changing the planting system will influence the plants' height. In this case, the hydroponic system has a better effect as it makes the plant grow faster

Conclusion and Recommendations

High demand for food production is increasing as the world population is growing. Meanwhile, the traditional farming using soil system will not cover the world's growing demand for food. Thus, developing a new farming and planting system techniques is required to avoid food crisis issue in the future. This study aimed to examine an efficient technique for alternative planting system which is the hydroponic system. The statistical experimental design approach was used to analyze and compare between traditional soil system and hydroponic system by planting two types of seeds: cucumber and Armenian cucumber in both systems. The analysis of variance (ANOVA) is used to test two factor factorial design with two levels hypothesis, whether the hydroponic system is better than the traditional system. The final results from Design Expert software show that hydroponic planting system has a better effect than traditional soil system as it makes plants heights grow faster. On the other hand, the planting system has no significate effect on the length of leaves. Moreover, seed type and the interaction between seed type and the planting system have no signification effect on plant growth. For future work, the experiment can be done on a larger scale, this will help in reflecting whether the hydroponic system will meet the demand of today and future market. Considering different factors such as soil type and solution type will help in implanting the experiment on a larger scale. Also, the period of the experiment should be extended as new changes may appear after a while. An important note to consider is the type of plants. In this experiment, only two plants were considered. However, the experiment can be done with different types of seeds to see if the results can be generalized to more plants.

REFERENCES

- U. Nation, “World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100,” United Nation, 21 June 2017. [Online]. Available: https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html
- E. Okemwa, “Effectiveness of Aquaponic and Hydroponic Gardening to Traditional Gardening,” International Journal of Scientific Research and Innovative Technology, vol. 2, no. 2313-3759, p. 35, 2015.
- D. C. Montgomery, Design and Analysis of Experiment, 8th ed. John Wiley & Sons, Inc, 2013.
- C. Somerville, M. Cohen, E. Pantanella, A. Stankus and A. Lovatelli, “Small-scale aquaponic food production,” 2014.
- M. M. S. G, “Comparative Analysis of Two Plant Growth Mediums: Hydroponic vs. Soil,” The Academy of Science, Research and Medicine, 2014.
- M. Samangooei, P. SaSSi and A. lack, “Soil-less systems vs. soil-based systems for cultivating edible plants on buildings in relation to the contribution towards sustainable cities,” Future of Food: Journal on Food, Agriculture and Society, vol. 4, no. 2, pp. 24-39, 2016.
- M. Sardare and S. Admane, “A Review on Plant without Soil -Hydroponics,” International Journal of Research in Engineering and Technology, vol. 2, no. 3, pp. 299-304, 2013.
- R. Pandey, V. Jain and K. P. Singh, “Hydroponics Agriculture: Its Status, Scope and Limitations,” in Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi, 2009.
- C. Treftz, Comparison of Nutritional and Sensory Qualities between Hydroponic and Soil-Grown Strawberries and Raspberries. Reno: ProQuest LLC, 2015.
- C. Treftz and S. T. Omaye, “Nutrient Analysis of Soil and Soilless Strawberries and Raspberries Grown in a Greenhouse,” Food and Nutrition Sciences, vol. 6, no. 9, pp. 805-815, 2015.

Introduction

SOP

Nowadays, the traditional farming system does not meet the current and future demand of food. Therefore, there is a real need for adapting new farming system that stimulates plants to grow faster. This system should cover the fast-growing demand with less cost and minimum consumption of natural resources.

Objectives

The main goal of the study is to find an alternative system that covers the current and future demand with less cost and minimum consumption of natural resources.

- Compare and select between growing plants in hydroponic system and growing plants in a traditional soil system.
- Formulate and test a hypothesis.
- Use the statistical approach to support the hypothesis of the study
- Provide recommendations for future work.

Introduction

Hypothesis

Significance and Scope

The main goal of the study is to find an alternative system that covers the current and future demand with less cost and minimum consumption of natural resources.

- Compare and select between growing plants in hydroponic system and growing plants in a traditional soil system.
- Formulate and test a hypothesis.
- Use the statistical approach to support the hypothesis of the study
- Provide recommendations for future work.