Pertanika J. Trop. Agric. Sci. 45 (3): 805 - 813 (2022)

PERTANIKA JOURNALS

TROPICAL AGRICULTURAL SCIENCE

Journal homepage: http://www.pertanika.upm.edu.my/

Growth Analysis of Lettuce (*Lactuca Sativa* L.) Using Nutrient Film Technique (NFT) in Hydroponic Systems

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ABSTRACT

This study aims to determine the effects of planting media and gutter slopes on the growth of lettuce (*Lactuca sativa* L.) using the Nutrient Film Technique (NFT) in a hydroponic system. This research was conducted at the Experimental Garden of the Faculty of Agriculture, Universitas Lakidende Unaaha, Konawe Regency, Indonesia, in October 2021. The two treatments were arranged in a randomized block design (RBD) and repeated in three replications. The first treatment consisted of two types of growing media: sponge medium (M1) and rockwool medium (M2). The second treatment consisted of two kinds, i.e., a 3% gutter slope of pipes (K1) and a 5% gutter slope of pipes (K2). The observed variables were plant height, number of leaves, and plant fresh weight. All collected data were analyzed using analysis of variance (ANOVA) followed by the least significant difference (LSD) test at a 5% level. This study has revealed three major results. Firstly, the interaction between planting media and the slope of the gutter pipes significantly affects plant height and the fresh weight of lettuce. Secondly, the planting media or the slope of the gutter pipes independently has a significant effect on plant height, several leaves, and the fresh weight of lettuce plants. Lastly, the treatment of rockwool planting media and a 5% slope of gutter pipes significantly improved the lettuce growth.

Keywords: Pipes, rockwool, slope, sponge, yield

ARTICLE INFO

Article history:
Received: 17 May 2022
Accepted: 14 June 2022
Published: 09 August 2022

DOI: https://doi.org/10.47836/pjtas.45.3.16

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INTRODUCTION

Hydroponics is the latest model of plant maintenance that does not use soil, water, and porous material media, such as burnt husks, fine sand, sponge, or rockwool. Therefore, nutrient adequacy is fulfilled

ISSN: 1511-3701
e-ISSN: 2231-8542

from the nutrient solution from the watering. Agricultural cultivation technology using a hydroponic system is a second option for people with limited land or yards, who want to grow beneficial plants (Mavianti & Irawan, 2021).

Plant maintenance through a hydroponic system requires support by using vehicles that can increase plant growth and development. These supporting vehicles have roles integrated with hydroponic technology, including greenhouses, irrigation, planting media, managers, seeds, land management, and nursery systems. The primary goal of farming using a hydroponic method is commercial. Moreover, a hydroponic method does not require a large area of land but can significantly work in front or side of the house and yard.

The nutrient film technique (NFT) is hydroponic that is extensively utilized in the production of vegetables such as lettuce. Plant roots are placed in a thin layer of nutrient solution in a hydroponic technique. This system is an example of plant preservation. The nutrient solution is circulated and has nutritional content considering the needs of the plants. The root system can grow on a mixture of nutrients. Moreover, several factors must be considered, such as when excessive water will occur and factors decreasing the amount of oxygen. The nutrient content of the NFT method is specially designed, with a maximum solution height of 3 mm, so that water, nutrients, and oxygen needs can be met.

The NFT is one of the hydroponic water culture techniques that allow plants to receive nutrients and water by circulation in a shallow and sloped layer. It is also a planting technique that grows lettuce on paragon pipes with a 1–5% slope. This system does not need growing media because the roots of plants are submerged in a thin layer of nutrients circulated and regulated using a timer. The NFT (Figure 1) has been widely used to produce vegetable crops, such as curly lettuce (Eprianda et al., 2017).

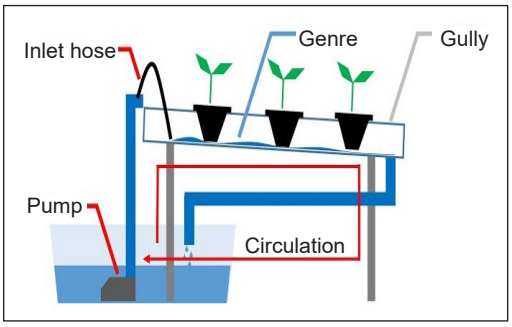

Figure 1. Nutrient Film Technique (NFT) of the hydroponics system scheme

Another technique of planting is using a wick system applied to some flannel in a capillary action of nutrient solution, which is a passive way (Silviana et al., 2020). Suaib et al. (2020) have grown tomato plants in a wick system and studied the effects of aluminum on the plants' growth and production using a hydroponic wick system. Lettuce (*Lactuca sativa* L.) is a plant that belongs to the Compositae family and can grow in cold and tropical areas. Lettuce marketing is getting higher along with economic and population growth (Siregar et al., 2015).

Lettuce is one of the leaf vegetable plants generally consumed in raw material. It is a horticultural plant with good nutritional content for humans (Kim et al., 2016). Moreover, it has a relatively high nutritional content and contains high-quality values, such as nutrition, color, aroma, taste, and texture. This research observed the NFT system to plant lettuce and examined the combination between several planting media and slopes of gutter pipes as a treatment.

Research on hydroponics with the nutrient film technique (NFT) method in plant cultivation, especially vegetables, has been carried out. However, no study has investigated the combination of sponge and rockwool growing media with a 5% slope of gutter pipes, especially on lettuce plants. Sponge and rockwool plants media combined with a 5% slope of gutter pipes are one of the new and strategic studies to support sustainable vegetable production and meet national nutritional needs. Therefore, this study aims to determine the effect of sponge and rockwool growing media combined with the slope of the gutter pipe on the growth and yield of lettuce.

METHODS

This experimental study was conducted at the Experimental Garden of the Faculty of Agriculture, Universitas Lakidende Unaaha, Konawe Regency Southeast Sulawesi, Indonesia, in October 2021. The materials used in this study were lettuce seeds, planting media (sponge and rockwool), plant nutrients (AB MIX fertilizer, Indonesia), and water. Meanwhile, the tools used were a ruler, line meter, aerator (aquarium pump), total dissolved solids (TDS) (metal measuring device of dissolved in water), pH meter, 7 mm polyethylene (PE) hose, 7 mm seal, 250-liter capacity water reservoir, 4-meter-long gutter, inch pipe, drill, grinder, Korean hacksaw glue, and ultraviolet (UV) plastic.

Furthermore, the study employed a randomized block design (RBD) and two treatments: sponge and rockwool planting media, as well as 3 and 5% of gutters. Each treatment was repeated three times. Thus, four treatment combinations and three repetitions were obtained. The experimental units were $4 \times 3 = 12$ with 12 samples. Randomization was carried out directly on 12 experimental units.

Variable measurement was done in non-destructive and destructive ways. Non-destructive measurements were carried out once a week or one month after planting. Plant height (cm) was measured from the base of the stem to the tip of the highest leaf using a ruler. Observations were conducted for a week. The number of leaves was observed every seven days for a month. This study only measured perfectly formed leaves that contain chlorophylls and could photosynthesize. Destructive observations on another side were carried out at the end of the observation with the variable of fresh weight (g). The observation was carried out by weighting all parts of the fresh plants directly after the harvesting. All data collected were analyzed by ANOVA followed by the least significant difference (LSD) test at a 5% significance level.

RESULTS

Plant Height

The finding of the variance analysis indicates that the planting material and the slopes of the gutter pipes have an interaction. Independent treatment of planting media and the slope of the gutter pipes affects the plant height (cm). The best treatment was the combination of the M2K2 (rockwool medium with gutter slope) as shown in Table 1. The average difference of treatment combinations on plant height is presented in Table 1.

Table 1
Effects of planting media and gutter slopes of pipes on plant height (cm)

Planting media	Gutter slopes of pipes (%)		Average scores
	K1(3%)	K2 (5%)	
M1 (Sponge)	13.67[a]	16.30[b]	14.98[a]
M2 (Rockwool)	15.57[b]	16.40[b]	15.99[b]
Average scores	14.62[a]	16.35[b]	
LSD 0.05 = 0.96			

Note. Numbers followed by different letters in the same rows or columns show a significant difference

Number of Leaves

The variance analysis has revealed that the treatment of planting media and the slope of the gutter pipes have no interaction effects. However, the number of leaves is significantly influenced independently by planting media treatment or the level of the gutter's slope. The best treatment in Table 2 was the combination of the M1K2 treatment (sponge medium with 5% gutter slope). Table 2 shows the results of the mean difference test evaluating the influence of the treatment on the number of shoots.

Table 2
Effects of planting media and gutter slopes of pipes on the number of leaves

Planting media	Gutter slopes of pipes (%)		Average scores
	K1(3%)	K2 (5%)	
M1 (Sponge)	6.33[a]	7.33[b]	6.83[a]
M2 (Rockwool)	5.67[a]	6.00[a]	5.84[b]
Average scores	6.00[a]	6.67[b]	
LSD 0.05 = 0.66			

Note. Numbers followed by different letters in the same rows or columns indicate a significant difference

The highest number of leaves is affected by the 5% slope treatment (K2). Meanwhile, the treatment of the growing media has the highest number of leaves in the treatment using a sponge (M1) growing medium.

Leaf Fresh Weight

The variance analysis has revealed that planting media treatment and the gutter pipe slope significantly affect the fresh leaf weight. The best treatment in Table 3 was the combination of the M2K2 treatment (rockwool medium with 5% gutter slope. The results of the mean difference are presented in Table 3.

Table 3
Effects of planting media and gutter slopes of pipes on fresh leaf weight (g)

Planting media	Gutter slopes of pipes (%)		Average scores
	K1(3%)	K2 (5%)	
M1 (Sponge)	203.33[a]	283.33[c]	234.33[a]
M2 (Rockwool)	250.00[b]	288.33[c]	269.17[b]
Average scores	226.67[a]	285.83[b]	
LSD 0.05= 20.78			

Note. Numbers followed by different letters in the same rows or columns show a significant difference

Table 3 describes that the treatment of rockwool (M2) planting medium and 5% gutter slope of pipe (K2) produce the highest fresh leaf weight of lettuce because the rockwool has a much higher porosity than the sponge medium.

DISCUSSION

This experiment has revealed that the planting media and the slopes of the gutter pipe affect the growth of lettuce plant height because the plants could bind some water and nutrients. The ability to bind water and nutrients in a medium depends on the particle sizes, shapes, and porosity of the medium. The smaller the particle size, the larger the pore surface area, and the greater the media's ability to absorb and hold some water. Porous media also have a greater ability to hold water. Sponge media have a much higher porosity than rockwool media. Thus, the effects of planting media (sponge and rockwool) on lettuce's growth in this study are in line with those on certain plants' growth (Bachtiar et al., 2017; Perwitasari et al., 2012; Suryani et al., 2017). A good planting medium can give enough water and nutrients for plant growth. It may be established in soil with good air and water management, solid aggregates, good water holding capacity, and sufficient root space (Lim et al., 2021). The results of this research conclude that lettuce plants growing on rockwool medium with a slope of 5% has fast growth.

In addition, the nutrient film technique is a plant cultivation system that circulates plant roots in a thin stream of water and contains elements required by plants. The root system in the NFT is submerged in the nutrient solution in only a certain part of the root layer. Meanwhile, the aeration of the root zone depends on several factors, such as pore space, medium particle sizes, and container height. The container height (pot) affects the ratio between water and air in root media (Tai et al., 2014). Therefore, growing media is one of the crucial factors in hydroponics. Besides soil media, hydroponic planting can use other media, such as water. The most important requirements for hydroponic media are light and porous. Since each medium has a different weight and porosity, it should be determined by taking into account the lightest and the best porosity (Primatoro & Yovita, 2005).

The number of leaves formed is different because it is related to the reduced amount of carbohydrates in the leaves with the porosity of the growing media. Due to cell division, elongation, and differentiation, lettuce leaves more significantly grow on sponge medium. In this condition, carbohydrate is needed (Maulana et al., 2020; Rahardjo et al., 2013).

According to Sari (2013), the slope of the pipe in a hydroponic system will impact the growth and yield of a plant. The slope, in this case, will affect leaf production, width, plant height, and root length.

Porosity is the proportion of medium pore space in a medium volume occupied by water and air, and it measures drainage and soil aeration. A porous medium has adequate pore space to allow water and

air to move more flexibly. It reported that planting medium with high porosity could increase the mung bean's lateral root length and shoot its dry weight (Kusuma et al., 2013; Moschou et al., 2022; Thalib, 2019). Increasing soil porosity can increase plant growth (Anastasia et al., 2014). A good hydroponic planting medium is a medium that has good porosity so that water and air can circulate well around the plant root system (Barus et al., 2021; Gui et al., 2010; Titouna & Bougoul, 2013). It is no surprise that rockwool's porous structure helps lettuce plants grow faster than they would in a sponge medium.

The slope of the pipe or pipe gutter in a hydroponic system influences the plant's growth and yield. The slope, in this case, will affect the production of whole leaves, leaf width, plant height, and root length. This influence can reach up to 5% (Sari, 2013).

The slope of the gutter is one factor that increases plant production. It has been shown that the best treatment was the M2K2 treatment combination (rockwool medium with 5% gutter slope) in Tables 1 and 3, while the M1K2 treatment combination (sponge medium with 5% gutter slope) was in Table 2. Simbolon (2011), as well as Surtinah and Lidar (2018), have revealed that the slope of the gutter affects plant growth and production in terms of root length, fresh root weight, dry root weight, number of leaves, leaf areas, plant height, crown diameters, bulb diameters, fresh crown weight, and canopy dry weight. This diversity occurs because the gutter's slope affects the roots' ability to absorb nutrients and the thickness of nutrient layers. Too thin layers will hamper roots from absorbing nutrients; in contrast, too thick layers will hamper roots from absorbing nutrients; too thick layers will hamper plants from breathing (Asmana et al., 2017).

The different responses to plant growth in the two treatment factors are visible in the fresh leaf weight, as presented in Figures 2 and 3.

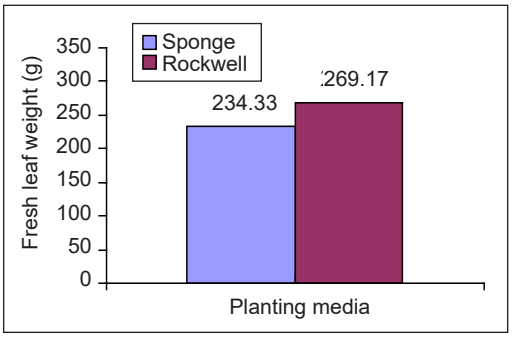

Figure 2. Fresh leaf weight of lettuce plants on different types of planting media treatment

Figure 3. Fresh leaf weight of lettuce plants on pipe gutter slope treatment

CONCLUSION

The study revealed three major factors that could affect the growth of lettuce plants using NFT in hydroponic systems. First, the interaction between planting media and

the slope of the gutter pipes significantly affects plant height and the fresh weight of lettuce. Second, the planting media or the slope of the gutter pipes independently has a significant effect on plant height, several leaves, and the fresh weight of lettuce plants. Third, the treatment of rockwool planting media and gutter pipe slope 5% (M2K2) is the best and is more real in growing lettuce.

ACKNOWLEDGEMENTS

The authors wish to thank the Rector, the Dean of the Faculty of Agriculture, and the fellow lecturers of the Agribusiness Study Program of Universitas Lakidende, for their assistance and encouragement in completing this study successfully.

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