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# Effects of Differences in Installation Slope on Growth and Yield of Rice (*Oryza sativa* L.) Hydroponically

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## ABSTRACT

Rice (*Oryza sativa* L.) is a staple food for Indonesian people to fulfill their daily needs. Rice planting is expected to be able to produce high value, but nowadays it is constrained by the increasing condition of the land. Hydroponic cultivation is the right solution because it can be done on a narrow area but the response of plants to the slope of the hydroponic land is not yet known. This study aims to determine the effect of the slope of the hydroponic installation on the growth and yield of hydroponic rice plants. The research was carried out from June to September 2022, at the experimental field of the Faculty of Agriculture, UPN "Veteran" East Java. The experiment used in this study was a Randomized Block Design with 3 replications and each replication had 10 samples. Treatment of the slope of the building consists of 0%, 3%, and 5%. Data were analyzed by the F test and continued with Duncan's multiple distance test with a level of 5%. The results showed that the installation slope of 0% gave the best results for plant and root length.

**Keywords**; Rice, Hydroponics, Installation slope

## INTRODUCTION

Rice (*Oryza sativa* L.) is one of the annual food crops in the form of grass and clumps. Rice is widely developed in Indonesia because it has high adaptability to various environmental conditions. Rice can grow in the lowlands with an altitude of 0-650 meters above sea level and in the highlands with an altitude of 650-1500 mdpl (Kurniawan, 2020).

Rice (*Oryza sativa* L.) is the main commodity crop in Indonesia. Most Indonesians think that if they do not eat rice, they are declared to have not eaten. This condition requires farmers in Indonesia to produce large quantities of rice. This must be supported by the availability of extensive agricultural land. The percentage decrease in irrigated rice fields in Indonesia from 2012-2016 was 0.47%, non-irrigated rice fields were 0.31%, and upland fields were 0.74%. Alternative problem-solving that can be done is to cultivate plants hydroponically (Ningtyas, 2017).

*Deep Flow Technique* or DFT is a hydroponic plant cultivation system by placing plant roots in a layer of water at a depth of 4-6 cm. The advantage of the DFT system is that it is very suitable to be developed in areas that often experience power outages, while the disadvantage of the DFT system is that it requires more nutrients than other systems (Makruf, 2021).

The DFT hydroponic system has many models such as table models, pyramid models, and ladder models. In addition, the DFT hydroponic system can also be arranged in one plane or zig zag. The principle of nutrient solution flow from a hydroponic system using a DFT zig zag model is the same as the staircase model. The difference between the three models of the DFT hydroponic system is only in its shape. These models are liked by the public because they are considered to have high aesthetic value (Wibowo, 2020).

*Nutrient Film Technique* or NFT is a type of hydroponic system with the basic concept of cultivating plants with plant roots

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growing in a shallow and circulating nutrient layer. The NFT system has a constant flow of nutrients so there is no need for a timer to control the water pump. The NFT system has many advantages such as plant roots getting sufficient nutrients, oxygen, and water supply. The NFT system is a good planting system but it takes a long time, especially in observing the nutrient stock (Setiawan, 2018).

The AB-Mix nutritional solution is made from mineral salts dissolved in water. Stock A and Stock B cannot be mixed directly because if Ca cations in stock A meet with sulfate anions in stock B, it can cause a precipitate to produce calcium sulfate (Afrizal *et al*., 2018). The hydroponic system uses a nutrient solution consisting of 2 variables, namely pH and EC. The pH level must be constant to keep the plant roots absorbing nutrients because too low a pH can damage plant roots. EC is used to measure the concentration of a solution (Pramono et al., 2020). The provision of nutrients must be done optimally so that the availability of plant nutrients meets the needs of plants.

*Cocopeat* is often used in hydroponic cultivation because it has advantages such as being able to bind and store water strongly. *Cocopeat* has a water content of 119% and a water storage capacity of 695.4% so it is expected to increase water absorption when used. *Cocopeat* can store water up to 6-8 times so that it has always moist properties and is good for root growth (Aulia et al., 2019).

*Cocopeat* has the highest c/n ratio value compared to rice husk charcoal, hydroton, and a combination of husk charcoal and cocopeat growing media (Aulia *et al*., 2019). *Cocopeat* growing media has the highest organic matter content of 12.54% compared to husk charcoal and compost (Pratiwi et al., 2017).

The DFT hydroponic system produces higher biomass and higher water requirements than the NFT hydroponic system (Tulung *et al*., 2019). The size of the planting hole can affect plant biomass. The larger the size of the planting hole used, the more biomass is produced. In addition, the larger the size of the planting hole can increase the rate of photosynthesis by up to 30% (Poorter et al., 2012).

Cultivation of plants with a hydroponic system can grow all year round because they can be planted in all seasons and requires little labor. Farmers in Thailand prefer to grow vegetables hydroponically because the product is for consumer needs, is not contaminated (toxicity), and is less attacked by pests and diseases. Hydroponic cultivation can control pests and diseases because it avoids contact between soil and plants (Wiangsamut & Wiangsamut, 2021).

## MATERIALS AND METHODS

### Time and Place

This research was conducted in the experimental field of the Faculty of Agriculture, UPN "Veteran" East Java in June-September 2022.

### Tools and materials

The equipment and materials used: a set of hydroponic circuits, nursery tray, sprayer, analytical balance, oven, measuring cup, spoon, bucket, calico cloth, net pot, flannel, TDS and EC meters, pH meter, stationery, ruler, meter, camera and ingredients for Mentik Susu rice seeds, *topsoil*, *cocopeat*, table salt, vegetable AB-Mix nutrition, fruit AB-Mix nutrition, and PAM water.

### Research methods

The study was conducted using a Randomized Block Design (RAK) with a single factor, namely the slope of the installation. The installation slope consists of (N): N1 (0% slope DFT system), N2 (3% slope NFT system), N3 (5% slope NFT system). Each treatment was repeated 3 times and each replication had 10 plant samples so there were 90 plants.

### Research Implementation

### Preparation of Hydroponic Installation Media

There are 3 hydroponic installations, each 1 installation consists of 3 series with a net pot diameter of 10 cm. The hydroponic

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installation has a size of 2 m x 0.5 m x 1 m with different slopes of 0%, 3%, and 5% and a spacing of 20 cm x 20

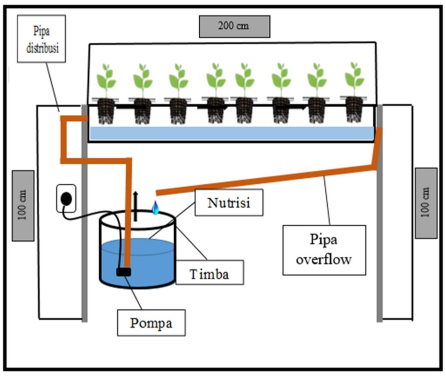

Figure 1. Construction of a 0% Slope DFT Hydroponic Installation

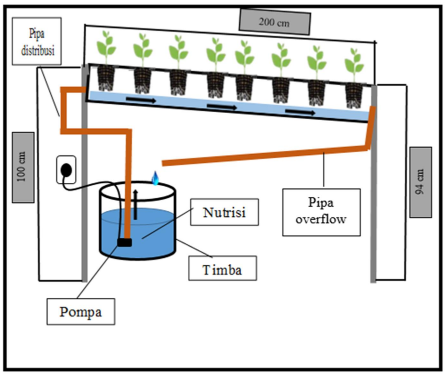

Figure 2. Construction of a 3% Slope NFT Hydroponic Installation

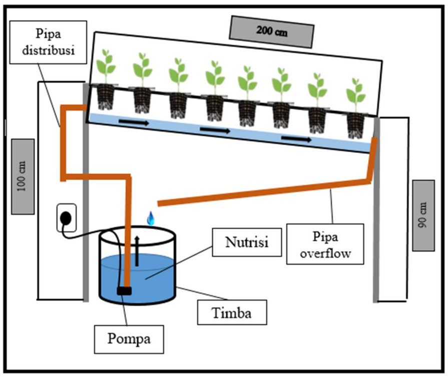

Figure 3. Construction of a 5% Slope NFT Hydroponic Installation

## Rice Seed Nursery

Seedling is done by soaking the seeds in clean water 3 times and soaking them in salt water at a dose of 3 g/l of water for 15 minutes. Seeds that float during soaking are discarded and seeds that sink are soaked in clean water for 24 hours. The soaked seeds were cured by wrapping them in a calico cloth for 24 hours.

## Nursery

Seeds are sown in rice nursery trays measuring 60 x 25 cm. The planting medium used for seeding rice is a mixture of topsoil and cocopeat with a ratio of 2:1. The seeds that have been sown are then covered with a calico cloth for 3 days. Rice seed maintenance is done by watering every day from the age of 3 DAS to 14 DAS (Days After Seedling).

## Preparation of Planting Media

The planting medium used for planting rice seedlings is a mixture of *topsoil* and *cocopeat* with a ratio of 2:1. The planting media that has been mixed well is then filled into the net pot hole until it is full. The net pot that has been filled with planting media is then arranged in a hydroponic installation.

## Planting

Seedlings are planted when the plants are 14 DAS (Days After Seedling). The transplanted seedlings are characterized by a dark green color. Each net pot is filled with 3 rice seeds. Planting is done in the afternoon with the aim of the plant not wilting easily because in the afternoon the temperature in the field is not too hot. At 7 DAP the rice seeds were removed and only 1 seed was left in each net pot.

## Nutritional Provision

Nutrition is provided by mixing nutrients A and B with water from reservoir water until it reaches the required ppm limit. The ppm required for hydroponic rice is 1400 ppm. AB-Mix nutrition used in the vegetative phase of rice is AB-Mix nutrition for vegetables, while in the generative phase it uses AB-Mix nutrition for fruit.

## Stitching

Embroidery is done on rice seedlings that wither or die after transplanting. Embroidery is done 5-7 days

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after planting and a maximum of 10 days after planting with the aim that plants can grow simultaneously.

Embroidery is done by removing wilted or dead plant seeds and then replacing them with new plants that are still left from the previous nursery.

**Maintenance**

Plant maintenance aims for plants to grow and develop optimally. Plant maintenance is carried out by checking the water quality, EC, ppm, pH, availability of plant nutrients, controlling plant pests and diseases, and periodically sanitizing hydroponic installations.

**Observation**

Observations of rice plants were carried out by measuring plant length, leaf width, number of leaves, number of tillers per clump, root length, number of productive tillers, flowering age, harvest age, number of panicles per clump, number of seeds per panicle, number of pithy seeds per panicle, the weight of dry seed harvested per clump, the weight of dry seed harvested per hectare, the weight of dry seed harvested per 10 grains per clump, the weight of dry seed stored per clump, the weight of dry seed stored per hectare, and weight of dry seed stored per 10 grains per clump.

## RESULTS AND DISCUSSION

### Effect of Installation Slope on Rice Plant Growth and Yield

The results showed that there was a significant effect on the parameters of plant length and root length which can be seen in Table 1.

Table 1. Average Effect of Installation Slope on Growth and Yield of Rice Plants

| Installation Tilt (%) | Parameter | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PL | LW | NL | NT | RL | NPT | FA | HA |
| 0 | 89,49c | 1,76 | 166,11 | 43,72 | 42,61 b | 7,90 | 66,44 | 93,93 |
| 3 | 82,24ab | 1,67 | 149,41 | 39,93 | 42,56 b | 8,87 | 66,26 | 92,32 |
| 5 | 82,14a | 1,66 | 137,30 | 36,77 | 36,17 a | 10,08 | 68,37 | 92,42 |
| DMRT 5% | | tn | tn | tn | | tn | tn | tn |

| Installation Tilt (%) | Parameter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | NP | NS | NPS | DHC | DHH | DH10G | DSC | DSH | DS10G |
| 0 | 8,57 | 40,82 | 14,71 | 0,81 | 143,06 | 0,20 | 1,26 | 122,36 | 0,14 |
| 3 | 10,44 | 38,27 | 17,54 | 1,93 | 346,32 | 0,22 | 3,16 | 325,65 | 0,17 |
| 5 | 11,04 | 41,33 | 23,89 | 2,02 | 352,56 | 0,23 | 3,17 | 331,34 | 0.18 |
| DMRT 5% | tn | tn | tn | tn | tn | tn | tn | tn | tn |

Note: The numbers followed by the same letter in the same column show no significant difference in the 5% DMRT test; tn= not real; PL= Plant Length; LW= Leaf Width, NL= Number of Leaves; NT= Number of tillers; RL= Root Length; NPT= Number of productive tillers; FA= Flowering Age, HA= Harvest age; NP= Number of panicles; NS= Number of Seeds; NPS= Number of pithy seeds; DHC= Dry Harvest Per Clump, DHH= Dry Harvest Per hectare, DH10G= Dry Harvest Per 10 grains; DSC= Dry store per clump, DSH= Dry store per hectare, DS10G= Dry store per 10 grains

Table 1. shows that the installation slope treatment had a significant effect on plant length and root length but had no significant effect on leaf width, number of leaves, number of tillers per clump, number of productive tillers, flowering age, harvest age, number of panicles per clump, number of seeds per clump. panicle, number of pithy seeds per panicle, dry weight of harvest per clump, dry weight of harvest per hectare, dry weight of harvest per 10 grains per clump, dry weight of storage per clump, dry weight

of storage per hectare, and dry weight of storage per 10 grains per clump. The 0% installation slope gives the best results for the growth of plant length and root length.

The highest average value of rice plant length (*Oryza sativa* L.) was found in the 0% installation slope treatment of 89.49 cm, while the lowest average value of rice plant length was found in the 5% installation slope treatment of 82.14 cm. The results of the 5% DMRT further test showed that the installation slopes of 0% and 3% gave significantly different results, as well as the 0% and 5% installation slopes showed significantly different results, but at 3% and 5% slopes the results were not significantly different.

The average value of the longest root length of rice plants (Oryza sativa L.) was found in the 0% installation slope treatment of 42.61 cm, while the average value of the shortest rice root length was found in the 5% installation slope treatment of 36, 17 cm. The results of the 5% DMRT further test showed that the installation slope of 0% and 3% gave no significantly different results, but 0% and 5% slopes showed significantly different results, as well as the 3% and 5% slopes, which showed significantly different results.

Rice is a type of plant that requires a lot of water in its growth process, especially in the vegetative phase where the vegetative phase is the phase of plants producing tillers. The 0% installation slope is better for rice growth in the vegetative phase because the plant roots are submerged in AB-Mix nutrients compared to the 3% and 5% slopes which are only able to create a shallow flow of nutrients.

The 0% installation slope treatment was able to increase plant length higher than the 3% and 5% slopes. It is suspected that AB-Mix nutrients can meet the nutrient requirements needed by rice plants during the vegetative phase. Plants will grow well if the nutrients available for growth are optimally fulfilled. This is the opinion (Alavan *et al*., 2015), which mention that complete and balanced fertilization greatly affects the growth and yield of rice plants because it can add and restore lost nutrients either due to washing or carried away by plants at harvest. Another opinion expressed by (Syah *et al*., 2021), states that nutrients will be used by plants for the process of photosynthesis and increasing metabolic processes in plants that result in cell division. This cell division can increase plant height, the number of leaves, leaf area, and root volume.

The installation slope of 0% gave the best average yield for rice growth, namely the parameters of plant length, leaf width, number of leaves, number of tillers per clump, and root length, but for rice productivity results, 5% installation slope gave the best average yield. This is presumably because the factors studied have not been able to change from the vegetative phase to the generative phase. This can be seen from the growth of rice tillers that continue to grow until the rice plants are harvested. Thus, the available AB-Mix nutrients cannot focus on rice fertilization but must compete with the growth of rice plants. The high and low growth and yield of plants are influenced by external factors and internal factors. Differences in growth and yields obtained can be influenced by one or both of these factors (Alavan *et al*., 2015). The number of pithy seeds produced in each rice clump can be seen in Figure 1.

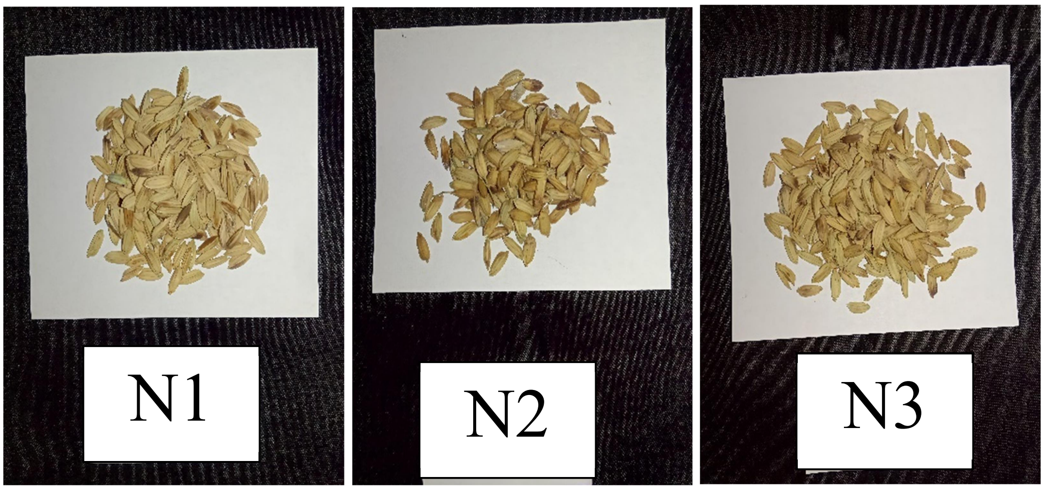


Figure 1. Rice Seeds per Clump in Each Treatment

Figure 1 shows that the rice seeds in treatments N1, N2, and N3 have almost the same size, shape, and number. The results showed that the factors studied had not been able to give high yields of rice productivity so the number of pithy seeds produced was only small. This is presumably because the nutrients used are not sufficient for rice growth in rice grain filling.

Rice growth is in dire need of nutrients, both macro and micro nutrients. In addition to getting nutrients from AB-Mix nutrients, rice growth also gets nutrients from soil and cocopeat growing media which are placed in the net pot. However, the nutrient content of soil and cocopeat growing media in the net pot was deemed insufficient for the growth and yield of rice plants. This is the result of the study (Humaerah, 2013), which explains that conventional rice growth gives higher yields than hydroponically because the nutrient content in rice soil media is naturally higher than in hydroponic growing media consisting of roasted husks. This is because the complex compounds in the paddy soil media can provide nutrients directly for plants, on the contrary, the fuel husk planting media in the hydroponic system cannot directly provide nutrients for plants.

The inundation factor also affects the yield of rice productivity where rice plants that are constantly inundated with water can disrupt the circulation of nutrients and oxygen so that the ability of plant roots to absorb nutrients will be disrupted. This is the opinion (Retnaningrum *et al*., 2013), which states that inundation can affect the availability of N in the soil, the higher the inundation, the efficiency of N absorption will decrease. Another opinion was also conveyed by (Rahmadani *et al*., 2020), which states that rice plants can survive if they are constantly inundated, but excessive water will cause rice plants to not be able to provide optimal productivity results.

## CONCLUSIONS

The results showed that the 0% installation slope treatment gave a significant difference in the parameters of plant length and root length. The factors studied have not been able to provide high yields of rice productivity so the number of pithy seeds produced is only small.

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