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Conference Paper

Root Length and Root Weight of Pak Choy (*Brassica chinensis* L.) in Wick System Hydroponics Impact of Liquid Organic Fertilizer

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ABSTRACT

Organic farming is gaining attention worldwide because it is healthier. Pak choy plants (*Brassica chinensis* L.) have various benefits and are widely consumed by the public. Roots are plant organs that function in holding the plant up and absorbing water and nutrients into the plant body. Many pak choy plants are cultivated using a hydroponic system. Liquid organic fertilizer (LOF) can be a nutritional alternative for plants that are cultivated hydroponically but organically. This research aims to determine the effect of concentration and interval of application of liquid organic fertilizer on the hydroponic wick system on pak choy plants. The research was carried out from August to September 2022 at Green House Emak Farm and Hydroponic Wadungasri, Waru, Sidoarjo Regency. This research is a factorial experiment with two factors arranged in a Completely Randomized Design (CRD). The first factor is NASA liquid organic fertilizer nutrient concentration with 4 treatment levels (5, 10, 15, 20 ml/L), while the second factor is the time interval for administering liquid organic fertilizer which consists of 3 treatment levels (3, 5, and once every 7 days). Control treatment using AB mix nutrition. Each treatment was repeated 3 times and used 4 plant samples. The results of the research showed that the combination of liquid organic fertilizer treatment with a concentration of 10 ml/L and at intervals of once every 3 days had a real impact on the observation parameter of fresh root weight of 11.07 grams. The interval treatment for applying liquid organic fertilizer had a significant effect on the root length parameters of pak choy plants, namely 10.79 cm.

Keywords: NASA liquid organic fertilizer, hydroponic, root

Introduction

The growth of plants in hydroponic systems is a cultivation method highly dependent on the availability of appropriate nutrients for the plants. Pak choy (Brassica rapa var. Chinensis) is one of the most commonly grown plants in hydroponic systems due to its rapid growth and high yields. The application of liquid organic fertilizer in hydroponic systems is a crucial practice to ensure optimal growth. Liquid organic fertilizers offer several benefits that can influence the root growth of pak choy plants in hydroponic systems.

Liquid organic fertilizers contain essential nutrients required by pak choy plants, such as nitrogen (N), phosphorus (P), and potassium (K), as well as important microelements like iron (Fe), copper (Cu), and zinc (Zn). These nutrients are readily absorbed by plant roots in a form more easily utilized compared to inorganic fertilizers. Consequently, the application of liquid organic fertilizers can enhance the availability of necessary nutrients for root growth and development.

Liquid organic fertilizers also contain organic materials that can boost microbial activity within the hydroponic system. These microorganisms play a role in breaking down organic matter

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into simpler compounds that are more easily absorbed by plant roots. Microbial activity contributes to improving the quality of the hydroponic medium, making it more conducive to root growth.

Regularly applying liquid organic fertilizers in hydroponic systems can also enhance the overall health of the hydroponic medium. A healthy and fertile medium supports the development of strong and extensive root systems. Healthy roots can absorb more nutrients and water, subsequently promoting increased root length and weight.

Liquid organic fertilizers can increase the organic content in hydroponic substrates. This organic matter helps improve the structure of the medium and its water-holding capacity, which, in turn, aids in reducing plant stress caused by fluctuations in water availability within the hydroponic system.

The application of liquid organic fertilizers in hydroponic systems is a crucial practice for enhancing root growth in pak choy plants. Liquid organic fertilizers contribute to increased nutrient availability, microbial activity, medium quality, and organic content in hydroponic substrates. All of these factors have a positive impact on the root growth of pak choy plants, ultimately leading to improved harvest yields in hydroponic cultivation.

Material and Methods

The tools used in this research include measuring cups, tubs seedbed, hydroponic container with a volume of 10 liters, bucket, meter, paper labels, pH Meter, TDS Meter, toothpicks, duct tape, impraboard the size of a tub hydroponic container, netpot, flannel cloth, rockwool, ruler and scales digital. The materials used in this research include pak choy seeds Nauli F1 variety, water, NASA multipurpose liquid organic fertilizer and AB Mix liquid fertilizer.

This research is a factorial experiment that was prepared using Completely Randomized Design (CRD) with 2 factors. The first factor is giving nutrient concentration of liquid organic fertilizer with 4 levels and the second factor is interval time to apply liquid organic fertilizer with 3 levels, repeated 3 times. This experiment resulted in 12 treatment combinations plus 1 control treatment also repeated 3 times so that there were 39 experimental units.

Factor 1: LOF concentration treatment consisting of 4 concentrations:
S1: Concentration 5 ml/L of water
S2: Concentration 10 ml/L of water
S3: Concentration 15 ml/L of water
S4: Concentration 20 ml/L of water
Factor II: Treatment interval for giving LOF which consists of 3 levels:
I1: Interval every 3 days
I2: Interval every 5 days
I3: Interval every 7 days

Wick system hydroponic tub measuring 38x31x12 cm, total volume 10 liters. Each tub consists of 4 planting holes as samples of each experimental unit. The total sample from this research was 156 sample.

Planting hydroponics

Seed Preparation and Seeding

Nursery is done with the help of a toothpick in placing the seeds in the planting medium moistened rockwool (not soaked in water) over the seedbed.

Preparation of Wick System Hydroponic Installation

The wick system hydroponic installation relies on the main material being a tub nutrient solution container and also a tub cover in the form of an impraboard at the same time base for the netpot in each planting hole that has been made. On the netpot paired flannel fabric as a wick that is used as a place for nutrients to absorb and reach rockwool and go straight to the plants.

Preparation of Nutrient Solutions

Providing nutrient solutions in hydroponic wick systems is by diluting the concentrated nutrient solution with water in each tub hydroponics. Start with measuring and adjusting each level of concentration with a reference of 5 liters of water, then add water to each nutrient solution. Each experimental unit has a total volume of 5 liters.

Planting

The results of the pak choy plant nursery are transplanted, namely from the seedbed to the netpot planting hole. Criteria for plants to be moved, plants are those that already have a minimum number of 4 leaves or more 14 days after planting (dap).

Harvesting

Harvesting is done when the pak choy plants are 40 days after transplanting (dat).

Observation of Plant Results

Fresh weight of roots (grams)

The fresh weight of plant roots was obtained after the plants were harvested (40 dat) and the roots were separated and weighed using digital scales.

Root Length (cm)

The length of the roots from each planting hole was measured using ruler help. Root length measurements were carried out on the root's longest. Root length calculation was carried out at 40 dat.

Data analysis

Research data were analyzed using analysis of variance (ANOVA) in accordance with the research design used, namely a Completely Randomized Design (CRD) factorial. If from the results of the CRD variance analysis it is known that there is a real influence on the level of 5%, then further testing is carried out. Further testing that the test used is Duncan's Multiple Range Test (DMRT 5%) which is used to compare all treatments.

Results and Discussion

The results of the analysis of variance showed that there was a significant interaction between various LOF concentration factors and the LOF treatment interval on the fresh weight of pak choy plant roots at harvest age, namely 40 dat. The average fresh weight of pak choy plant roots resulting from the combination of the two treatments is presented in Table 1.

Table 1. Average fresh weight of pak choy plant roots (grams) due to treatment of various liquid organic fertilizer concentrations and liquid organic fertilizer application intervals at harvesting age 40 dat.

Treatment	LOF Application Intervals		
	I_1 (every 3 days)	I_2 (every 5 days)	I_3 (every 7 days)
Control		13,76	
LOF Concentrations			
S_1 (5 ml/L)	6,14 bcd	5,53 abc	5,19 ab
S_2 (10 ml/L)	11,07 g	7,81 ef	6,66 cde
S_3 (15 ml/L)	8,89 f	6,43 bcd	6,04 bcd
S_4 (20 ml/L)	7,21 e	5,46 abc	4,42 a

Note: The mean number followed by the same letter indicates that it is not significantly different in the 5% DMRT test

Table 1. shows the effect of the combination of various LOF concentrations and LOF application intervals which have a real influence on the fresh weight of pak choy plant roots. At 40 dat, the S2I1 treatment combination (10 ml/L and 3 days intervals) showed a higher mean figure of 11.07 grams, which was also significantly different from other treatment combinations. The S4I3 treatment combination (20 ml/L and every 7-day interval) had a lower mean number than the other treatment combinations, namely 4.42 grams but was not significantly different from the S1I3 treatment (5 ml/L and every 7-day interval), S4I2 (20 ml/L and every 5 days interval) and S1I2 (5 ml/L and every 5 days interval). This average figure was 19.55% lower than the control treatment for the parameter of fresh weight of plant roots for pak choy at harvest age of 40 dat, namely 13.76 grams.

The results of the analysis of variance showed that each of the two factors was different in influencing the root length parameters of pak choy plants at the harvest age of 40 dat, the various LOF concentration factors did not have a real influence while the LOF application interval factor had a very real influence on the root length parameters of pak choy plants. The combination treatment of the two did not have a significant effect on the root length of pak choy plants.

The average root length weight of pak choy plants resulting from each of the two treatments is presented in Table 2. Table 2. shows that the treatment interval for administering LOF every 3 days (I1) shows a higher average root length of pak choy plants, namely 10.79 cm. This mean figure is significantly different from the other two LOF administration interval treatments. The LOF interval treatment with a lower mean was the once every 7 days interval treatment (I3), namely 8.38, which was not significantly different from the once every 5 days interval treatment (I2). The once every 3 days interval treatment (I1) as treatment was higher than the other interval treatments, namely 10.79 cm, indicating that the mean was 6.17% lower than the control treatment.

Table 2. Average pak choy plant root length (cm) due to treatment of various liquid organic fertilizer concentrations and liquid organic fertilizer application intervals at harvesting age 40 dat

Treatment	Pak Choy Plant Root Length (cm)
	40 dat
Control	11,5
LOF Concentrations	
S_1 (5 ml/L)	10,45
S_2 (10 ml/L)	11,58
S_3 (15 ml/L)	10,18
S_4 (20 ml/L)	10,67
DMRT 5%	ns
LOF Application Intervals	
I_1 (every 3 days)	10,79 c
I_2 (every 5 days)	9,26 ab
I_3 (every 7 days)	8,38 a
DMRT 5%	

Note: The mean number followed by the same letter indicates that it is not significantly different in the 5% DMRT test, ns= not significantly different

One effort to provide the best hydroponic pak choy plant results is to provide nutrients with varying concentrations (ppm) according to the pak choy's needs, the nutrient dose in the first week is 600 ppm, the nutrient dose in the second week is 700 ppm, the nutrient dose in the third week is 900 ppm, in the fourth week until just before harvest it is 1.200 ppm (Karim, 2021).

After conducting research and observing the nutrient concentration (ppm) content of the nutrient solution, it was seen that in the first week, the concentration of the LOF nutrient solution

was 10 ml/L and 15 ml/L with an interval of giving every 3 days according to the needs of the pak choy plant, which was around the recommended figure from (Sulistyowati, 2021), namely 620 ppm, in a 10 ml/L LOF nutrient solution while 660 ppm in a 15 ml/L LOF nutrient solution.

One of the main NASA LOF contents is macro nutrients, namely Nitrogen (N), Phosphorus (P), and Potassium (K). According to PT. Nusantara Indah (2018), the nutritional content of macro nutrients, it can see that NASA LOF has a Nitrogen content of 4.15%, Phosphorus of 4.45% and Potassium of 5.66%, which is far below the nutritional content of macro nutrients. AB Mix is 2 times more abundant, de Sousa et al. (2023) stae that AB Mix contains the macro nutrients Nitrogen of 18.1%, Phosphorus at 5.1%, and Potassium of 25.3%.

At the age of 20 dat and so on until just before harvest at the age of 35 dat, the pak choy plant's need for nutrition is greater while the macro nutrients provided by NASA LOF are limited, in contrast to the availability of AB Mix nutrients.

The 20 ml/L concentration treatment showed lower numbers compared to various lower LOF concentrations, namely 15, 10 and 5 ml/L. The number that is always linear with the LOF concentration level is the pH value which becomes increasingly alkaline when the LOF concentration is higher. Every treatment with a concentration of 20 ml/L always has a very alkaline pH value, even since the first observation of the pH level was carried out, which showed a pH value of 7.78. The pH value continued to increase along with the LOF administration interval until the last pH observation reached a pH value of 9.07.

An important characteristic of a nutrient solution is that it must contain ions that can be absorbed by plants so that in a hydroponic system plant productivity is closely related to nutrient uptake and pH regulation (Trejo & Gomez, 2012). Apart from that, Mayavan et al. (2017) stated through a graph of the relationship between nutrient availability in plants and the pH level of the solution that pH has an impact on the plant's absorption capacity for nutrients where a pH above 7.5 reduces the availability of iron, manganese, copper, zinc, and boron, even conditions when the pH is above 8 to 8.5 will inhibit and reduce the availability of macro elements such as Nitrogen and Phosphorus.

Kholidin et al. (2016) stated that in achieving maximum growth, the fulfillment of macro nutrients (N, P, K) and micro are the main elements that must be fulfilled, and if plants lack these elements then growth will be hampered. According to Islam et al. (2012) stated that the availability of sufficient and appropriate fertilizer concentrations can increase plant productivity. According to Kantikowati and Khotimah (2022), adequate nutrient and water supply will have a favorable effect on plant growth to a certain extent, by the addition of nutrient and water supply. Plant growth rates tend to increase if the nutrients needed by plants are available and can be utilized immediately by plants, such as nitrogen. This is in line with the opinion of Kusumawardhani and Widodo (2003) which states that if elements are available in sufficient quantities, better protein will be formed so that plant growth can take place better.

The LOF concentration treatment did not have a significant effect on the yield of pak choy plants, especially on root length parameters at harvest or 40 dat. This can happen because the availability of nutrients, especially macro nutrients in pak choy plants, is not maximally sufficient. According to Kirmansyah et al., (2022) the element Phosphate (P) is a basic ingredient for strengthening cell walls so that plants are resistant to disease attacks. By providing sufficient Phosphate (P), plant roots will increase in number and length, thereby increasing the effectiveness of nutrient absorption. When pak choy plants reach the age of over 20 dat, the plants maximize their roots and leaves to obtain nutrients because the leaves are getting bigger. The nutritional levels of macronutrients contained in NASA LOF, especially the P or Phosphate element, show that the P element in AB Mix and NASA LOF is only 0.40% different, but the factor that causes the loss of phosphorus (P) levels is the pH level in the nutrient solution. This occurs in pak choy plants with concentration treatment which has a pH reaching above 8 (Mayavan et al., 2017).

The pH level in the NASA LOF nutrient solution with a concentration of 10 ml/L has a better nutrient level in providing an effect compared to higher or smaller concentrations. The pH level

at a LOF concentration of 15 ml/L itself reaches 8.76, while at a LOF concentration of 20 ml/L, the pH level reaches 9.07 so that various macro and micro nutrients that should be available to pak choy plants are increasingly scarce and inhibit absorption as well as growth and development to plant yields.

According to Putra et al. (2021) stated that the older the age of seedlings reflects the faster the ability to adapt to the environment, the faster the plant adapts, and the faster the productivity because it is related to the plant's ability to adapt to the environment. When applying fertilizer, plants only use nutrients according to their needs because the plants are still relatively small so only a small amount of nutrients are needed. After reaching the age of over 10 dat until the harvest age of pak choy plants is 35 dat, the interval of giving LOF has a real effect. This is because the nutrients provided through the administration interval are working well.

LOF interval treatment had a significant effect on root length parameters. The root length itself was measured using a ruler which refers to the longest root of each pak choy plant sample. An interval of every 3 days provides a better range than an interval of 5 days and every 7 days. This means that sample plants that are given LOF at 3-day intervals can maintain the presence of nutrients, especially Nitrogen and Phosphorus. Even so, the average numbers for the two treatments, both various LOF concentrations and LOF administration intervals, were not greater than the control treatment using AB Mix. Because AB Mix can better accommodate the availability of various elements needed by pak choy plants.

Conclusion

It is recommended to use a liquid organic fertilizer (LOF) concentration of 10 ml/L and the interval for giving LOF is once every 3 days to pak choy plants using the wick system hydroponic method (Wick System).

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