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THE IMPACT OF A LIQUID ORGANIC FERTILIZER OF PLANTAIN (*Musa paradisiaca* L.) PEEL ON THE GROWTH OF PAKCOY (*Brassica rapa* L.)

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Abstract
Plantain peels are an underutilized waste product that is often discarded without being processed, resulting in an unpleasant odor in the surrounding environment. However, plantain peels are rich in nutrients that can benefit plant growth, making them a potential ingredient in liquid organic fertilizers. This study aimed to investigate the growth response of pakcoy plants when treated with POC (plantain peel organic fertilizer). A complete randomized design (CRD) was used with five treatments and four replications in each treatment, including a control group (N0) and four POC treatments (N1-N4) with varying concentrations (50-125 ml). The results showed that plantain peel POC had a significant effect on plant height growth, number of leaves, and fresh weight in the N4 treatment, which had the highest concentration of 125 ml plantain peel POC.

Keywords: *Organic Liquid Fertilizer, Pakcoy Plan, Plantain Peel*

1. INTRODUCTION

Various sources of vitamins, minerals, and fiber that are all needed by the body can be found in vegetables. According to (Hermina & Prihatini, 2016), the majority of Indonesian people consume vegetables, one of which is pakcoy. According to Statistics (2018), Indonesia's *pakcoy* production fluctuated between 2013 and 2018. According to (Safitri, 2019), to strive for pakcoy production to grow well is by applying inorganic fertilizer. However, if this effort is carried out continuously, it will have an unfavorable impact such as increasing the amount of residue in the soil which will reduce the carrying capacity or soil fertility. According to (Khoiriyah & Nugroho, 2018), the negative impact will potentially make plant growth less than ideal.

The use of inorganic fertilizers has a negative impact, so an alternative is needed to use organic fertilizers that are better for the environment and free of chemical residues for plants (Triyono et al., 2019). Liquid organic fertilizer is a type of organic fertilizer made from the decay of animal or plant waste into liquid and contains up to 5% chemicals in it and has the potential to replace inorganic fertilizers (Siboro et al., 2013). Fruit peels, which are unused waste, can be useful for making liquid organic fertilizer because they are made from organic materials. If left unused, this fruit peel waste will cause unpleasant odors, disrupt environmental hygiene, and even endanger health. Therefore, it is better to be utilized into something useful and beneficial, one of which is by becoming the main ingredient for making POC. Making POC from fruit peel waste not only saves costs, but can also help reduce these negative impacts because it contains many compounds that inorganic or chemical fertilizers do not have (Marjenah et al., 2018).

Plantain peels can be used as the main ingredient for POC because they contain more nitrogen and banana peels are often underutilized and discarded after the fruit is consumed (Aini, 2013). Plantain peel is the banana peel used in this experiment. According to research by (Sukriyadi, 2010), plantain peel is one of the best because the peel is thicker than other banana peels and the potassium content is higher, making it optimal for use in the production of liquid organic fertilizer. This paper examines the effect of making POC from plantain peels on the growth of *pakcoy* based on this information.

2. RESEARCH METHODS

The research was conducted using a Randomized Group Design (RAK) with five treatments and four repetitions, resulting in a total of 20 units of *pakcoy* plants. The study focused on the influence of Technological, Pedagogical, and Content Knowledge (TPACK) possessed by Economics teachers on students' learning motivation and creativity in the subject of Economics at SMA Negeri 59 Jakarta.

The research was carried out at SMA Negeri 59 Jakarta during the period from October 2022 to November 2022. The data collection tools included questionnaires and observation sheets. The questionnaire was used to assess the TPACK of Economics teachers, as well as students' learning motivation and creativity. Meanwhile, the observation sheets were used to evaluate the implementation of TPACK by teachers during the teaching process.

The study population consisted of Economics teachers and students at SMA Negeri 59 Jakarta, and a sample size of both teachers and students was selected using random sampling techniques. Data were analyzed using descriptive statistics, correlation analysis, and multiple regression analysis to determine the relationship between TPACK, learning motivation, and creativity.

Overall, this research aimed to provide valuable insights into the role of TPACK in enhancing students' learning experiences and creativity in Economics education, contributing to the improvement of teaching practices and curriculum development in the field of Economics education.

3. RESULTS AND DISCUSSION

3.1. Plant Height

Starting with plants aged 14 HST, height growth in *pakcoy* plants is measured with a ruler from the bottom of the embedded stem to the tip of the top leaf. The Kolmogorov-Smirnov normality test for plant height produces a significance level> 0.05 which means that the samples tested are normally distributed and belong to the same population and the Homogeneity test proves that the samples have the same variation (homogeneous), then the One-Way Anova test proves that there is a real difference in plant height with a significance value <0.05. Duncan's Multiple Range Test or DMRT conducted at the 5% level is shown below:

Table 1. Height Gain of Pakcoy

Treatment	Height Gain of Pakcoy Repeat To...(cm)			
	1	2	3	4
N0 (Without POC)	1,30a	1,41a	1,30a	1,30a
N1 (50 ml/l POC)	1,65a,b	1,74a	1,75a,b	1,70a,b
N2 (75 ml/l POC)	1,70a	1,72a	1,90a,b,c	2,18a,b,c
N3 (100 ml/l POC)	2,31a,b	2,45a,b	2,42b,c	2,51a,b,c
N4 (125 ml/l POC)	2,82b	2,74a,b	2,60c	2,82b,c

Notes: According to the DMRT test, numbers with similar letter notations indicate that the numbers are not significantly different.

The following are the results of the difference in the calculation of the average height of *pakcoy* in each treatment:

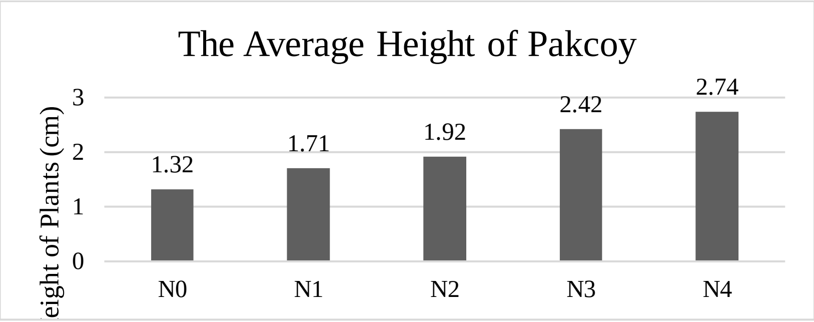

Figure 1. Diagram of Average Difference in Plant Height

Based on the results obtained, it shows that plant height in each treatment has an influence when given liquid organic fertilizer on plantain peel. Based on the DMRT test, the table shows the difference between the control treatment (N0) and treatment N4 in the first re-observation, but vice versa in treatments N1, N2, and N3. The control treatment (N0) showed no difference in the second observation against all treatments. The control treatment (N0) was significantly different from N3 and N4, but vice versa with N1 and N2, at the third re-observation. The control treatment (N0) was significantly different from N4 at the fourth replication, but vice versa with NI, N2, or N3.

In the use of plantain POC with 125 ml treatment on each plant produced plants whose height was greater than the others. The occurrence of this is because the provision of plantain peel POC which is more than the provision of other POC which is less proven to be able to optimize the availability and absorption of nutrients for plant growth. The content of nitrogen nutrients in plantain peel POC is relatively high, nitrogen is a constituent of every living cell which is also part of the constituent enzymes and chlorophyll molecules because it is found in all parts of the plant. In addition, there is also phosphorus which plays a very active role in transferring energy in the cell, converting carbohydrates, and increasing the efficiency of chloroplast work.

Haryadi, et al. (2015) in Langga (2001) stated that the optimal amount of nitrogen can contribute to the acceleration of plants to grow because it contains nitrogen that can trigger overall growth. Plants can experience stunted growth and imperfection due to nitrogen deficiency because the process of forming new cells is limited to its ability to produce protein and other organic materials so that the amount of nitrogen content plays a major role in plant growth.

3.2. Number of Leaf Blades

The number of leaf blades of *pakcoy* plants is determined by summing up the fully opened leaves, and the calculation is taken since the plants are 14 HST. With a significance level > 0.05, the Kolmogorov-Smirnov normality test on the number of leaflets states that the samples are normally distributed and come from the same population. Homogeneity test also states the significance value> 0.05 which means the sample has the same variation (homogeneous). Then the One-Way Anova Test states that there is a difference in the number of leaf blades because the significance value is <0.05. Duncan's Multiple Range Test or DMRT conducted at the 5% level can be seen as follows:

Table 2. Average Number of Leaflets Growth

Treatment	Number of Leaflets Growth Repeat To...(cm)			
	1	2	3	4
N0 (without POC)	1,00a	1,00a	1,00a	1,14a
N1 (50 ml/l POC)	1,14a,b	1,28a,b	1,28a,b	1,28a
N2 (75 ml/l POC)	1,14a,b	1,42a,b	1,42a,b	1,57a
N3 (100 ml/l POC)	1,57b	1,57a,b	1,57b,c	1,42a,b
N4 (125 ml/l POC)	1,57b	1,71b	2,28c	2,00b

Notes: According to the DMRT test, numbers with similar letter notations indicate that the numbers are not significantly different.

The following are the results of the differences in the calculation of the average number of pakcoy leaves in each treatment:

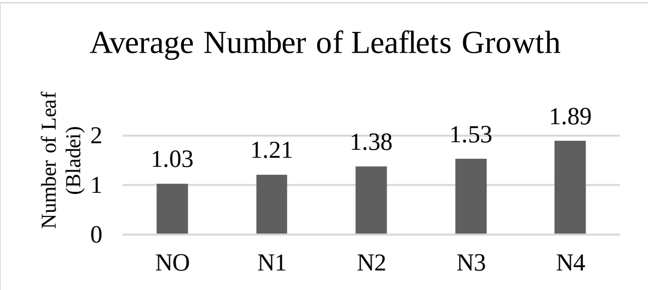

Figure 2. Diagram of Average Difference in Number of Leaf Blades

From the diagram of the average difference in the number of leaf blades on pakcoy, it shows that the difference in the number of leaf blades increases in each treatment, with the N4 treatment, namely the provision of 125 ml of plantain peel POC having the highest value. According to Ausgutien and Hadi Suhardjono (2016) the availability of nutrients containing nitrogen and phosphorus has an optimal influence on leaf formation because both elements play a role in the formation of the main components of organic compounds including amino acids, nucleic acids, chlorophyll, ADP, and ATP. Chlorophyll is contained in leaves that contribute to photosynthesis as a place to carry out the formation process. Hardjowigeno (2014) states that one of the chlorophyll components consists of nitrogen elements where the amount of chlorophyll will also increase in proportion to the nitrogen content that will accumulate to produce more leaf blades.

Observation of the first replication, the results of the DMRT test table show the results of the control treatment (N0) significantly different from the treatment of N3 and N4 but vice versa in N1 and N2. The control treatment (N0) is significantly different from the treatment (N4) in the second repetition, but vice versa in N1, N2, and N3. The control treatment (N0) was significantly different from N3 and N4, but vice versa in N1 and N2, in the third repetition. The control treatment (N0) was significantly different from the N4 treatment in the fourth repetition, but vice versa in N1, N2, and N3.

3.3. Plant Wet Weight

Digital scales were used to measure plant wet weight, which is the calculation of *pakcoy* plant biomass after it is ready for harvest. The level of Shapiro-Wilk normality test on plant wet weight is > 0.05, which means that the samples are normally distributed and belong to the same population. Homogeneity test showed results >0.05, which means that the samples are homogeneous or have the same variation. Followed by One Way Anova Test, the result level is <0.05, which means that there is a real comparison in plant fresh weight. Duncan's Multiple Range Test or DMRT was then conducted at the 5% level. The following are the results of the DMRT test:

Tabel 3. Average Plant Wet Weight

Treatment	Plant Wet Weight (g)
N_0 (Without POC)	$27{,}75^a$
N_1 (50 ml/l POC)	$30{,}75^b$
N_2 (75 ml/l POC)	$33{,}75^c$
N_3 (100 ml/l POC)	$37{,}75^d$
N_4 (125 ml/l POC)	$42{,}00^d$

Notes: According to the DMRT test, numbers with similar letter notations indicate that the numbers are not significantly different.

The following are the results of the difference in the calculation of the average wet weight of pakcoy in each treatment:

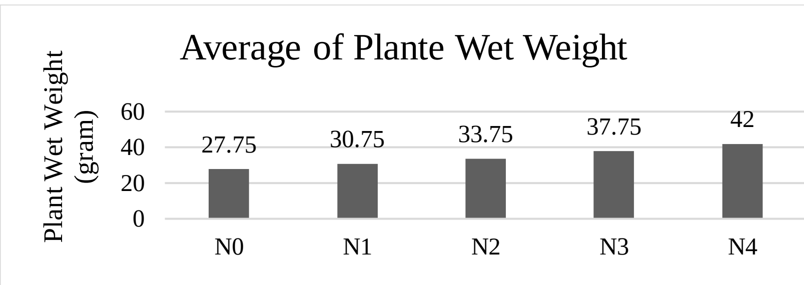

Figure 3. Diagram of Average Pakcoy Wet Weight

Based on the diagram above, the average wet weight of plants shows that in each treatment there is a difference with the N4 treatment which includes 125 ml of plantain peel POC has the highest average. The net weight produced by plants is influenced by plant height, number of leaves, and fertility level. The net weight of *pakcoy* is directly proportional to the height and number of leaves and the fertility of the planting soil. This means that the greater the height of the plant and the greater the number of leaves, the heavier the weight of the plant will be.

The presence of inorganic materials in the soil will optimize the absorption of nutrients and increase the amount of photosynthesis produced by plants causing an increase in plant length and the number of leaf blades as a result the fresh weight of the plant will also increase. Thus, along with the progress of cell elongation and enlargement, the wet weight of the plant will also grow along with the increase in cell size (Gardner et al, 1991).

In the DMRT test results table, it can be seen that the results in each treatment are significantly different, but the results in the N3 and N4 treatments show the opposite. When compared with other treatments, the 125 ml POC dose showed a greater wet weight of *pakcoy* than the other treatments. This proves that banana peel POC which is given more to each plant can also increase the level of availability and absorption of nutrients, especially nitrogen, phosphorus, and potassium nutrients needed by plants to stimulate growth because they are included in macro nutrients. Meanwhile, if the results of the DMRT test at the 5% level there is no significant difference, it is likely due to the wrong dose or lack of one of these elements so that it will produce less than ideal results.

4. CONCLUSION

In conclusion, this research highlights the significant positive effects of using plantain peel liquid organic fertilizer (POC) on the growth and development of pakcoy plants. The varying doses of POC application demonstrated clear differences in plant height, number of leaf blades, and wet weight. Notably, the treatment with 125 ml/l POC consistently yielded the most favorable results across these growth parameters, indicating that a higher POC dose promotes plant growth and productivity. These findings suggest that POC can be an effective and eco-friendly alternative to conventional chemical fertilizers, offering a sustainable and cost-effective solution for agricultural practices.

Furthermore, the successful implementation of POC in promoting pakcoy growth has implications for sustainable agriculture and environmental conservation. By utilizing organic waste materials like plantain peels to produce POC, farmers can reduce waste and environmental pollution while also improving crop productivity. This research emphasizes the importance of exploring and adopting innovative, nature-based solutions to enhance agricultural practices and contribute to global efforts towards sustainable food production. With further studies and widespread adoption, liquid organic fertilizers derived from agricultural waste materials like POC can play a vital role in promoting sustainable agriculture and ensuring food security in a resource-constrained world.

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