Original Research Article

The Effect of Biofertilizer Type and Chicken Manure Dosage on the Growth and Yield of Kale (*Brassica oleraceae* L.)

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ABSTRACT

Aims: To study the effect of the type of biofertilizer and the dose of chicken manure on the growth and yield of kailan (*Brassica oleraceae* L.).
Study design: Experimental design, using factorial randomized block design consisting of two factors with three replications.
Place and Duration of Study: Experimental Station of the Faculty of Agriculture, Universitas HKBP Nommensen in Medan, from June to October 2023.
Methodology: The research used a factorial randomized block design consisting of two factors, namely the type of biofertilizer (P) and the dose of chicken manure (A), with three replications. The type of biofertilizer consisted of four levels, namely: P0 = No application of biofertilizer (control), P1 = IMO of pineapple peel (100 ml/l water), P2 = Eco-enzyme (1 ml/liter water), and P3 = Bio-Extreme biofertilizer (5 ml/m2). The dose of chicken manure (A) consisted of three levels, namely: A0 = 0 tons/ha (control), A1 = 15 tons/ha, and A2 = 30 tons/ha. Biofertilizer according to the treatment level was applied four times at 1 week before transplanting and 1, 2 and 3 weeks after transplanting, while the chicken manure was applied at 1 week before transplanting. The parameters observed were: plant height, number of leaves, root volume, root length, wet weight per plot, selling weight per plot, and yield per hectare.
Results: Both the type of biofertilizer and the dose of chicken manure treatments had no significant effect on all parameters, whereas the interaction between the type of biofertilizer and the dose of chicken manure had a significant effect on root length, but had no significant effect on other parameters. The relation between root length and the dose of chicken manure using IMO of pineapple peel was positive linear, with mathematical equation $yP_1 = 0.1733x + 6.3833$, with coefficient of determination $R^2 = 0.0788$ and coefficient of correlation $r = 0.2807$, while the one using EE was positive quadratic, with mathematical equation $yP_2 = -0.3867x^2 + 0.5733x + 7.25$, with coefficient of determination $R^2 = 1$ and coefficient of correlation $r = 1$.
Conclusion: The interaction between the type of biofertilizer and the dose of chicken manure had a significant effect on the root length of kale but had no significant effect on plant height and number of leaves at 4 WAT, root volume, wet weight per plot, selling weight per plot and yield per hectare. The best combination was obtained in P2A1 (eco enzyme as biofertilizer and chicken manure dose of 15 tons/ha) but it was not significantly different from the combinations of P1A0, P1A1, P2A2, P3A0, P3A1 and P3A2. With eco enzyme treatment, the relationship between the dose of chicken manure and root length was positive quadratic with the optimum dose of chicken manure for a maximum root length of 7.5 cm being 7.4 tons/ha. The dose of chicken manure had a significant effect on root length, but had no significant effect on other parameters, while the type of biofertilizer had no significant effect on all parameters.

Keywords: biofertilizer, chicken manure, eco enzyme, kale, indigenous microorganisms, root length

1. INTRODUCTION

Apart from being popular for most groups of the community, kale (*Brassicaceae olaraceae* L.), which belonged to the Brassicaceae Family, was also beneficial for health because it contained minerals, fiber, antioxidants, B vitamins, etc. According to [1], the potential yield of the Yama F1 kale variety was 20 tons/ha, but production at the farmer level was still below this potential yield, even with high use of urea fertilizer. This was caused, among other things, by: pest attacks, low soil fertility, and the use of excessive doses of chemical fertilizers in which ultimately caused soil degradation. According to [2], excessive and continuous use of chemical fertilizers had a negative impact on agricultural land, resulting in flat or even declining productivity. Furthermore, [3] stated that the use of pesticides during the experiment on kale might limited, or even terminated, the activity of some or all of the microbes applied through EM-4 addition. The solution to reducing the use of inorganic fertilizer was by replacing the function of inorganic fertilizer as a nutrient source with organic materials derived from plant and animal waste, and by using microorganisms provided as biofertilizer. This was especially important in cultivating plants in Ultisol which was poor in nutrients and had a low organic matter content. An agricultural cultivation system aimed at overcoming the decline in soil quality and environmental damage due to uncontrolled use of chemical fertilizers and pesticides and producing a sustainable quantity and quality of healthy products was known as organic agriculture [4]. The cultivation process was carried out traditionally using natural ingredients so it was environmentally friendly. The natural materials used included manure from livestock wastes, green manure and vegetable pesticides derived from plants, and biofertilizers which contained microorganisms which were useful as soil ameliorant and for plant growth.

Chicken manure came from decomposed chicken waste was often used by farmers because it functioned better as an ameliorant because it decomposed more quickly in the soil and contained more complete and higher levels of nutrients than manure sourced from other livestock. Chicken manure contained the highest N, P and K [5], namely: 2.79% N, 0.52% P2O5, 2.29% K2O [6]. Chicken manure also contained microorganisms that were capable of decomposing soil organic matter, both from organic fertilizer and organic matter that was already in the soil. [7] suggested the recommended dose for chicken manure was 20 tons/ha, while [6]Purba *et al.* (2019) showed that broiler manure had a very significant effect on the growth and yield of Chinese cabbage (*Brassica chinensis* L.) with the best dose being 30 tons/ha which produced a wet weight of 30.10 tons/ha.

In order to accelerate the chicken manure decomposition in the soil, various types of biofertilizer were used as decomposing starters, namely indigenous microorganisms (IMO) of pineapple peel, eco enzyme (EE) and Bio-Extrim biofertilizer that was available at the market. Biofertilizer was an inoculant made from active living microorganisms which functioned to facilitate the availability of nutrients in the soil for plants. The functions included increasing plant access to nutrients, for example by arbuscular mycorrhizal fungi, dissolution by phosphate-dissolving microbes, fixation of nitrogen from the air by bacteria, and through decomposition by bacteria and fungi [8]. The microorganisms in biofertilizer was also able to inhibit the growth of plant diseases. Growth hormones such as auxin and gibberellin were also produced by many microorganisms such as *Azotobacter* sp, *Azospilium* sp and *Bacillus* sp [9]. According to [10], fertilizer from organic waste helped to improve the structure and quality of the soil. Biofertilizers also contained nutrients that can directly meet the nutritional needs of plants to be used in the formation of biomass through the photosynthesis process. It was hoped that the microorganisms contained in biofertilizer were going to multiply rapidly in the soil and break down the organic material provided through chicken manure. The biofertilizers used were self made and consisted of IMO of pineapple peel and EE, as well as those purchased on the market, to see a comparison of the effectiveness of the three types of biofertilizers in increasing the growth and production of kale.

IMO was a solution containing a collection of microorganisms produced from the fermentation of various fruit and vegetable waste. IMO solution played a role in improving soil health so that it was suitable for plant growth. Apart from improving soil conditions, IMO had the potential ability to decompose organic matter in the soil, break down complex organic compounds such as animal and plant remains into nutrients that can be absorbed by plants, fix nitrogen from the air, improve soil fertility and produce plant growth hormones [11]. IMO contained not a single but a multiple cultures of beneficial microorganisms; the mixture of different good microorganisms were living together in harmony with the surrounding nature [11]. IMO of tamarillo peels had microbial colonies of *Pseudomonas* sp., *Azotobacter* sp., *Bacillus* sp. and P solubilizing microbes with the largest number (102 to 107 cfu), followed by IMO of pineapple peels, and then by IMO of orange peels [12]. The IMO solution contained complete nutrients, both macro (N, P, K, Ca, Mg and S) and micro (Zn, Cu, Mo, Co, B, Mn and Fe) nutrients. Beside nutrients, another organic material decomposition product was humus, an organic soil colloid that played a role in increasing the cation exchange capacity of the soil. Microbial metabolite products which were collectively referred to as microbial gums were binding agents for primary soil particles to form aggregates so that a loose soil structure which was suitable for plant growth was formed. According to [13], IMO was a group of microorganisms that were useful as starters in the decomposition of organic matter. In this study, a pineapple peel IMO concentration of 100 ml/l water was used [14].

EE was a solution of complex organic substances produced from the fermentation process of organic wastes, sugar and water under anaerobic conditions facilitated by living organisms. EE solution was useful in improving soil and plant quality, controlling pest organisms, and improving the quality and taste of fruit and vegetables [15]. EE solution was able to function as organic fertilizer and pesticide. EE also produced various enzymes, including: lipase, trypsin and amylase. The recommended EE concentration was 1 ml/liter of water [16].

Bio-extrim was one of the biofertilizers purchased in the market. Bio-extrim contained several important microorganisms, including: *Azospirillum* sp. (2.10 x 109 cfu/ml), *Azotobacter* sp. (1.20 x 109 cfu/ml), *Rhizobium* sp. (7.5 x 109 cfu/ml), phosphate solubilizing bacteria (5.5 x 107 cfu/ml) and potassium solubilizing bacteria (2.7 x 106 cfu/ml). This biofertilizer also had a very high C-organic content (>25%), C/ N ratio 25, total N 1.06%, total P2O5 5.76% and K2O 3.16% [17].. The recommended dose of Bio-extrim for kale was 5 ml/plot.

The aim of this research was to study the effect of the type of biofertilizer and the dose of chicken manure and the interaction between the two on the growth and yield of kale (*Brassica oleraceae* L.).

2. MATERIAL AND METHODS

The research was carried out from June to October 2023 at the Experimental Station of Faculty of Agriculture, Universitas HKBP Nommensen Medan, at Simalingkar B Village, Medan Tuntungan District. The altitude was 33 meters above sea level and the soil type was ultisol.

The research was designed using a factorial randomized block design consisting of two treatment factors and was repeated three times. The first factor was the type of biofertilizer which consisted of four levels, namely: P0 = No biofertilizer(control), P1 = IMO of pineapple peels (100 ml/l water), P2 = EE (1 ml/liter water) and P3 = Bio-Extrim biofertilizer (5 ml/m2). The second factor was the dose of chicken manure and consisted of three levels, those were: A0 = No chicken manure, A1 = 15 tons/ha and A2 = 30 tons/ha. As samples five plants were chosen randomly per plot.

The research included the following steps: production of IMO and EE, seeding, land processing, application of chicken manure and the three types of biofertilizer, transplanting, plant maintenance, harvesting and measurement of parameters

The IMO was made of pineapple peel waste. A 3 kg of pineapple peel waste that had been finely cut was put into a plastic bucket with a capacity of 20 liters. Then into the bucket was added 5 L of coconut water, 5 L of rice washing water and 1 kg of melted brown sugar so that the weight ratio of sugar: pineapple peels: (coconut water + rice water) = 1:3:10. After all the ingredients were mixed together, the plastic bucket was closed tightly. After 1 week, the ingredienst were stirred again, then the plastic bucket was closed tightly again. Fermentation was carried out for 21 days and a good IMO solution was characterized by a clear liquid with an alcoholic aroma.

The eco-enzyme was made of fruit peel waste and was fermented in an airtight container for three months using molasses as a starter [16]. The weight ratio of molasses: organic material: water was 1:3:10. A total of 3 kg of fruit peel waste that had been washed and cut into small pieces was put into 1 kg of molasses which has been mixed evenly with 10 liters of clean water and then the bucket was closed tightly. In this study, the fruit peels being used consisted of five types of fruit peels, namely orange, mango, carrot, cucumber and banana peel waste with the same weight ratio, which was 600 g each. Three months later the EE was ready to be harvested and the good EE was characterized by a brown liquid color and an aroma like vinegar with a pH less than 4.

Each dose of chicken manurewais applied 2 weeks before planting by spreading it evenly on the experimental plot and mixing it evenly with the soil to the depth of the hoe's eye. IMO was applied at a concentration of 100 ml/l water, EE was applied at a concentration of 1 ml/l water, while Bio-extreme biofertilizer was applied at a dose of 5 ml/m2; each of the three was applied 4 times, namely: 7 days before transplanting, and 7, 14 and 21 days after transplanting (DAT). The water volume needed for each plot was determined using the calibration method (until the soil water content reaches around field capacity), in this case the water volume needed per plot was 3 liters.

Before being sown, the Yama F1 kale seeds were soaked in water for 15 minutes. Kale seeds were sown in a mixture of top soil and sand with a ratio of 2:1 in small polybags. After the seedlings were 2 weeks old or had 2-4 leaves, transplanting was carried out. The soil on the research area was loosened and plots were made of the size of 1m x 1m, 30 cm high, 40 cm between plots and 60 cm between blocks. Seeds were planted at a distance of 20 cm x 20 cm and watered until the soil was moist.

Plant maintenance included: watering, replanting, weeding and hilling as well as pest and disease control. Watering was done twice a day in the morning and evening and was not carried out when it rained. Replanting was carried out at 7 DAT. The seedlings used for replanting were taken from the previous plant nursery. Weeding and hilling were carried out simultaneously at 2 and 3 weeks after transplanting (WAT). Pest control was carried out using technical methods by manually picking and removing pests from plants. Plants that were attacked by pests and diseases were also treated with the vegetable pesticide neem oil at a dose of 25 ml/liter of water by spraying it on the affected plant parts, carried out at the ages of 1, 2 and 3 WAT. Harvesting was carried out at 30 DAT.

The parameters being observed included: plant height and number of leaves at 4 WAT, root volume, root length, wet weight per plot, selling weight per plot and production per hectare. The obtained data were analyzed using analysis of variance and continued with the 5% DMRT test.

3. RESULTS AND DISCUSSION

The parameters observed included: plant height and number of leaves at 4 WAT, root volume, root length, wet weight per plot, selling weight per plot and production per hectare. The results of the variance test stated that the treatment dose of chicken manure and the type of biofertilizer had no significant effect on all observed parameters, while the interaction effect between the dose of chicken manure and the type of biofertilizer had a significant effect on root length but had no significant effect on other parameters.

The mean value of plant height, number of leaves, root volume, root length, wet weight per plot, selling weight per plot and yield per hectare due to treatment of the type of biofertilizer and dose of chicken manure were presented in Tables 1, 2, 3, 4. 5, 6 and 7. The relationship between the root length of kale and the dose of chicken manure using the IMO (positive linear) and eco enzyme (positive quadratic) was presented in Figure 1.

Table 1. Average of plant height at the age of 4 WAT due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	**Chicken Manure Dosage**			**Mean (cm)**
	A0 (0 kg/plot)	A1 (1,5 kg/plot)	A2 (3 kg/plot)	
P0 = Control	9,39	9,30	15,27	11,32
P1 = IMO	8,67	8,60	8,67	8,65
P2 = Eco enzyme	8,40	9,20	10,13	9,24
P3 = Bio Extrim	8,72	9,00	9,23	8,98
Mean (cm)	8,79	9,02	10,82	

Table 2. Average of number of leaves at the age of 4 WAT due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	Chicken Manure Dosage			Mean (sheet)
	A0	A1	A2	
	(0 kg/plot)	(1,5 kg/plot)	(3 kg/plot)	
P0 = Control	7,93	7,60	8,33	7,96
P1 = IMO	7,33	6,60	7,40	7,11
P2 = Eco enzyme	7,80	8,20	8,53	8,18
P3 = Bio Extrim	8,07	7,53	7,87	7,82
Mean (sheet)	7,93	7,60	8,33	

Table 3. Average of root volume due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	Chicken Manure Dosage			Mean (ml)
	A0	A1	A2	
	(0 kg/plot)	(1,5 kg/plot)	(3 kg/plot)	
P0 = Control	11,01	12,39	12,43	11,95
P1 = IMO	12,25	12,60	12,53	12,46
P2 = Eco enzyme	11,67	12,05	12,00	11,90
P3 = Bio Extrim	12,24	11,85	11,77	11,95
Mean (ml)	11,79	12,22	12,18	

Table 4. Average of root length due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	Chicken Manure Dosage			Mean (cm)
	A0	A1	A2	
	(0 kg/plot)	(1,5 kg/plot)	(3 kg/plot)	
P0 = Control	5.84 ab	6.16 abc	5.89 ab	5.96
P1 = IMO	7.25 cd	7.24 cd	5.49 a	6.66
P2 = Eco enzyme	5.87 ab	7.67 d	6.39 abcd	6.64
P3 = Bio Extrim	7.10 bcd	6.63 abcd	7.39 cd	7.04
Mean (cm)	6.52	6.93	6.29	

Note: Numbers followed by the same letter in the same column or row have no significant effect at the α = 0.005 level by the DMRT test

Table 5. Average of wet weight per plot due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	Chicken Manure Dosage			Mean (g/plot)
	A0	A1	A2	
	(0 kg/plot)	(1,5 kg/plot)	(3 kg/plot)	
P0 = Control	276,67	378,00	376,00	355,56
P1 = IMO	312,67	305,00	276,67	326,11
P2 = Eco enzyme	339,67	303,00	294,67	312,44
P3 = Bio Extrim	293,00	363,67	355,67	337,44
Mean (g/plot)	305,50	337,42	325,75	322,89

Table 6. Average of selling weight per plot due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	Chicken Manure Dosage			Mean (g/plot)
	A0	A1	A2	
	(0 kg/plot)	(1,5 kg/plot)	(3 kg/plot)	
P0 = Control	174,33	350,33	399,00	307,89
P1 = IMO	296,33	265,00	389,33	316,89
P2 = Eco enzyme	244,33	282,67	332,33	286,44
P3 = Bio Extrim	248,33	386,33	374,00	336,22
Mean (g/plot)	238,33	299,33	373,55	303,74

Table 7. Average of yield per hectare due to the treatment of biofertilizer types and chicken manure dosage

Type of Biofertilizer	Chicken Manure Dosage			Mean (tons/ha)
	A0	A1	A2	
	(0 kg/plot)	(1,5 kg/plot)	(3 kg/plot)	
P0 = Control	7,69	10,5	10,44	9,54
P1 = IMO	8,69	8,47	10,02	9,06
P2 = Eco enzyme	9,44	8,42	8,19	8,68
P3 = Bio Extrim	8,14	10,1	9,88	9,37
Mean (tons/ha)	8,49	9,37	9,63	9,16

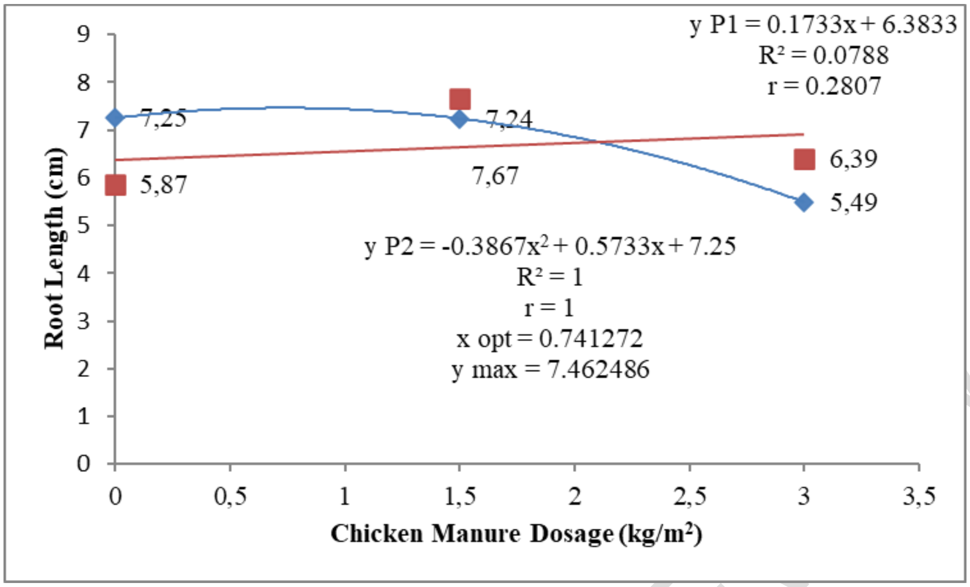

Fig. 1. Relationship between root length of kale and dosage of chicken manure under the treatment of biofertilizer IMO of pineapple peels (P1) and eco-enzyme (P2)

3.1 THE EFFECT OF BIOERTILIZER TYPES ON THE GROWTH AND YIELD OF KALE (*Brassicca olareaceae* L.)

Analysis of variance showed that the type of biofertilizer treatment had no significant effect on all plant parameters. This meant that there was no difference in the growth and yield of kale that had been treated with IMO of pineapple peel, EE, or Bio Extrim. Likewise, there was no difference in kale growth and yield wether it was treated with biofertilizer or not.

Due to the short lifetime of kale as an annual plant, the three types of biofertilizers as materials containing microorganisms were not yet able to decompose organic materials, both those had been applied as chicken manure or organic materials that had previously existed in the soil, to create a suitable condition for kale's growth. This was shown from the research results that the kale plants with no treatment of biofertilizers was not significantly different from those with both IMO, EE and Bio Extrim biofertilizers treatments. The situation of the root area and the condition of soil microbial diversity was expected to be the cause of the insignificant effect of biofertilizer on the growth and yield of kale plants. The diversity of microorganisms in the soil was very unique, which in turn created unique interactions among microorganisms and between microorganisms and plant roots and other abiotic factors in the soil. The interactions between plant roots and microorganisms and between microorganism and microorganism were very complex and depended on the diversity of microorganism in the soil and the environmental conditions in which these microorganisms lived. According to [2], changes in root conditions was even able to change pathogenic microbes into epiphytes that benefit plants, and vice versa. This explained why biofertilizers was able to be successful in one place, but not in another. It was suspected that the diversity of microorganism in the research field did not perform beneficial interactions on the growth of kale plants. [18] even stated that biofertilizers were often specific to certain plants: a biofertilizer was able to successfully increase the growth and yield of certain plants, but not other plants.

The three types of biofertilizer applied were not significantly different in influencing the growth and yield of kale. Although the three types of fertilizer both contained microorganism (for example *Pseudomonas* sp., *Azotobacter* sp., and *Rhizobium* sp.) which were expected to be able to decompose organic matter and provide nutrients through nitrogen fixation and solubilization of phosphorus and potassium, in this study the microorganisms contained in the biofertilizer had not been able yet to carry out its role in improving the physical, chemical and biological properties of the soil to support the growth and yield of kale. This was because it takes a longer time for organic matter to decompose compared to the relatively short lifespan of kale plants

3.2. THE EFFECT OF CHICKEN MANURE DOSAGE ON THE GROWTH AND YIELD OF KALE (*Brassicca olareaceae* L.)

The analysis of variance showed that the dose of chicken manure had no significant effect on all parameters, except for root length. This insignificant effect was thought to be caused by the fact that chicken manure had not been completely decomposed in the soil because soil moisture during field research was high due to heavy rain fall of average of 1-2 days every week. This was in line with the statement by [19] that humidity had a very important role in microbial metabolic processes and oxygen supply. If the compost was too moist then the composting process was going to be slower. Another reason was that the chicken manure being applied had not been fermented properly because the time needed to decompose in the soil was longer than the kale lifespan. Although according to [20], chicken manure was a fertilizer with a low C/N value, it still required a fermentation period before being applied to the soil. According to [21], chicken manure should be applied after the fertilizer had decomposed or fermented properly or had been kept for 2-3 months. On the other hand, kale was a short-lived plant that was harvested at the age of 30 DAT.

The effect of chicken manure dosage was significant on root length. It was expected that the decomposition process of chicken manure was going quite well in the root area because the area rich in root exudate attracted microorganisms that were beneficial for the growth of kale plants [2].

3.3. THE EFFECT OF INTERACTION BETWEEN BIOFERTILIZER TYPE AND CHICKEN MANURE DOSAGE ON THE GROWTH AND YIELD OF KALE (*Brassicca olareaceae* L.)

The analysis of variance showed that the interaction effect of the type of biofertilizer and the dose of chicken manure was significant on the root length of kale but was not significant on other observed plant parameters. This meant that chicken manure was able to stimulate the performance of the microorganisms contained in the biofertilizer applied to the root area. It was also suspected that PGPR (Plant Growth Promoting Rhizobia), whose population was high in the rhizosphere, increased its activity more easily than other soil microorganisms. These PGPR microorganisms helped the growth and development of plant roots. This was in line with the statement of [22] that PGPR was able to support root growth. In addition, PGPR produced growth hormones (IAA, cytokinin, gibberellin) and sped up the composting process. On the other hand, the rhizosphere was a region rich in plant exudates that attract microorganisms thereby creating a microbial reserve in the soil. Plants had a tendency to attract microorganisms to the rhizosphere that would help their biological functions, such as nutrient absorption and growth and development of the plant [2]. The accumulation of these microorganism made the decomposition of chicken manure in the root area became more intensive so that improvements in the physical and chemical properties of the soil due to decomposition of organic matter by these microorganisms was first going to affect the root length.

The best combination for root length was obtained at P2A1 (eco enzyme as biofertilizer type and chicken manure dose of 15 tons/ha) but it was not significantly different from the combinations of P1A0, P1A1, P2A2, P3A0, P3A1 and P3A2. In the IMO treatment of pineapple peel, the relationship between root length and chicken manure dose was positive linear, meaning that the optimum dose of chicken manure had not been obtained. Meanwhile, in the EE treatment, where the relationship was postitive quadratic, the optimum chicken manure dose was obtained at 7.4 tons/ha which resulted in a maximum root length of 7.5 cm.

Although the kale yield was still below the yield potential, this research showed that the use of biofertilizer and chicken manure in the cultivation of kale plants had a good prospect. The short-term benefit was reducing yield costs for fertilizers and pesticides, while in the long term the soil was going to be healthier and more fertile and was able to be used sustainably. According to [11], the benefits of using the natural farming methods included the following: 1. Lower costs by as much as 60 percent, meaning saving cost for the farmers, 2. Better crops, and stronger, healthier and more nutritious plants, 3. Higher and better quality of yield, 4. Farmer and consumer friendly, and 5. Zero waste emission.

The positive effect of the interaction between type of biofertilizer and chicken manure dosage on root length was expected to be more pronounced when biofertilizer and chicken manure were applied on plants with a longer lifespan. In plants with a longer lifespan, it was expected that the interaction effect was not only going to be seen in the root length parameter, but also in the yield parameters.

The interaction of the type of biofertilizer and the dosage of chicken manure had no significant effect on the parameters of plant height and number of leaves at 4 WAT, root volume, wet weight per plot, selling weight per plot and production per hectare. This was because the chicken manure dosage treatment affected these parameters more strongly than biofertilizer type treatment did, thereby the effect of chicken manure dosage covering up the effect of the type of biofertilizer. This statement was supported by [23], that the interaction between two factors was not detected because one factor was more dominant than the other, so that the other factor was covered up and was not able to perform its effect.

4. CONCLUSION

The interaction between the type of biofertilizer and the dose of chicken manure had a significant effect on the root length of kale but had no significant effect on plant height and number of leaves at 4 WAT, root volume, wet weight per plot, selling weight per plot and yield per hectare. The best combination was obtained in P2A1 (eco enzyme as biofertilizer and chicken manure dose of 15 tons/ha) but it was not significantly different from the combinations of P1A0, P1A1, P2A2, P3A0, P3A1 and P3A2. With eco enzyme treatment, the relationship between the dose of chicken manure and root length was positive quadratic with the optimum dose of chicken manure for a maximum root length of 7.5 cm being 7.4 tons/ha. The dose of chicken manure had a significant effect on root length, but had no significant effect on other parameters, while the type of biofertilizer had no significant effect on all parameters

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