Original Research Article

RESPONSE TO GROWTH AND YIELD OF PURPLE EGGPLANT (*Solanum melongena* L.) YUFITA F1 VARIETY ON THE MUTIARA NPK FERTILIZER AND KAYABIO BIOLOGICAL FERTILIZER

ABSTRACT

The aims of this study were: (1) to determine the response of the growth and yield of the purple eggplant variety Yufita F1 to the application of Mutiara NPK fertilizers and KayaBio biological fertilizers and their interactions and (2) to obtain appropriate doses of Mutiara NPK fertilizer and KayaBio biological fertilizers to produce good growth and yield of purple eggplant of the Yufita F1 variety. This research was conducted from March to June 2020 at the Experimental Garden of the East Kalimantan Institute for Agricultural Research and Technology, Jalan Gunung Lingai, Kelurahan Gunung Lingai, Sungai Pinang District, Samarinda City. The study used a 4x4 factorial experiment in a randomized block design (CRBD). The first factor was the dose of Mutiara NPK fertilizers (N) consisting of 4 levels, namely: without Mutiara NPK (n0), 200 kg ha^{-1} (n1); 300 kg ha^{-1} (n2), and 400 kg ha^{-1} (n3). The second factor was the dose of KayaBio biological fertilizers consisting of 4 levels, namely: without KayaBio biological fertilizer (k0), 20 kg ha^{-1} (k1), 25 kg ha^{-1} (k2), and 30 kg ha^{-1} (k3). Overall there were 16 treatment combinations, each repeated three times. The results showed that: (1) response to plant height at 14, 28, and 42 days after planting, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant, and fruit production were significantly different to very significantly different from fertilizer application Mutiara NPK. The highest fruit production was produced in the 300 kg ha^{-1} (n2) treatment, namely 16.59 tons ha^{-1}, and the lowest was produced in the treatment without Mutiara NPK fertilizer (n0), which was only 10.53 tons ha^{-1}; (2) the response of plant height at 14, 28, and 42 days after planting, the number of fruits per plant, fruit length, fruit weight per plant, and fruit production were not significantly different. In contrast, the response of fruit diameter was highly different from the application of KayaBio biological fertilizers. The highest fruit production was produced in the 25 kg ha^{-1} (k2) treatment, namely 16.18 tons ha^{-1}, and the lowest was produced in the treatment without KayaBio biological fertilizers (k0), which was only 12.57 tons ha^{-1}; and (3) the response of plant height aged 14, 28, and 42 days after planting, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant, and fruit production were not significantly different to the interaction between Mutiara NPK fertilizer and KayaBio biological fertilizer.

Keywords: Mutiara NPK Fertilizers, Kayabio Biological Fertilizers, Purple Eggplant

INTRODUCTION

Purple eggplant (Solanum melongena L.) is a plant native to the tropics which is well known in Indonesia. As one of the indigenous vegetables, eggplant is almost always found in farmer's markets or traditional markets at relatively low prices. The eggplant business has provided good market opportunities, especially in meeting domestic demand (Rukmana, 2009).

According to data from the Central Statistics Agency, eggplant production in Samarinda City in the last three years was 370.80, 284.30, and 7040.00 tons. Demand for eggplant continues to increase along with increasing awareness of the benefits of vegetables in meeting the nutritional needs of families, so it is necessary to increase eggplant production.

Even though eggplant is a popular vegetable, it seems that the cultivation of eggplant is not as intensive as the cultivation of other favorite vegetable crops such as chilies, tomatoes, onions, and others. The low productivity of eggplant plants is closely related to suboptimal cultivation techniques and low soil fertility.

One of the obstacles to increasing the productivity of eggplant in East Kalimantan is the level of soil fertility because Ultisols dominate it. Therefore, various efforts must be made to optimize agricultural land yield and productivity. According to Jumini and Marliah (2009), one way to increase eggplant production can be by using fertilizer.

Fertilizer application aims to increase the availability of nutrients in the soil needed by plants. Fertilization can be done by providing inorganic fertilizers and organic fertilizers. Mutiara NPK fertilizers is a compound fertilizers containing the elements Nitrogen (N), Phosphorus (P), and Potassium (K). This fertilizer is widely available in various agricultural shops/kiosks, and the price is relatively affordable. However, inorganic fertilizers N, P, and K are often excessive and uncontrolled by farmers. As stated by Iwuagwu et al. (2016), the continuous use of inorganic fertilizers can damage the soil's physical, chemical, and biological properties so that the soil fertility level decreases. This is supported by the results of a study reported by Pangaribuan et al. (2019) that excessive application of inorganic fertilizers to the soil can affect environmental factors and soil quality and cause reactions in the soil such as P fixation, NO3, and N2O volatilization. Inorganic fertilizers can also reduce soil organic matter levels to <2.00% and damage the soil structure.

Solutions to increase the value of agricultural production can be done by preserving agricultural resources, strategies, and appropriate efforts such as utilizing biological fertilizers. Fadiluddin (2019) stated that biological fertilizers contain symbiotic bacteria (*Rhizobium*) and non-symbiotic bacteria (*Azotobacter* and Azospirillum), which correlate with each other in improving soil fertility and increasing crop yields. Furthermore, Setiawati et al. (2020) stated that the bacterial content in biological fertilizers can provide nutrients and increase crop yields.

KayaBio is a biological fertilizer that contains beneficial microorganisms such as *Pantoea* sp., *Azospirilium* sp., *Aspergillus niger*, and *Penicillium* sp. This biological fertilizer decomposes soil organic matter, improves soil aggregates, increases the population of microorganisms in the soil to increase fertility, and improves the soil's physical, chemical, and biological properties. According to Ogboma (2011), giving inorganic fertilizers combined with organic fertilizers/biological fertilizers will be better than providing only one organic fertilizer or inorganic fertilizers.

The aims of this study were: (1) to determine the response of the growth and yield of the purple eggplant variety Yufita F1 to the application of NPK Mutiara and KayaBio biological fertilizers and their interactions and (2) to obtain appropriate doses of Mutiara NPK fertilizer and KayaBio biological fertilizers to produce good growth and yield of purple eggplant of the Yufita F1 variety.

RESEARCH METHODS

A. Time and Place

This research was conducted from March to June 2020 at the Experimental Garden of the East Kalimantan Institute for Agricultural Research and Technology, Jalan Gunung Lingai, Kelurahan Gunung Lingai, Sungai Pinang District, Samarinda City.

B. Materials and Tools

The materials used in this study were purple eggplant seeds of the Yusfita F1 variety, Mutiara NPK fertilizer and KayaBio biological fertilizers, goat manure, mulch plastic, nursery plastic, well water, and Curacron 500 EC insecticide.

The tools used in this study were cultivators, hoes, rakes, machetes, hand sprayers, tape measure, buckets, analytical scales, name pamphlets, ropes, stationery, and documentation cameras.

C. Experimental design

The study used a 4x4 factorial experiment in a randomized block design (CRBD). The first factor was the dose of NPK Mutiara (N) consisting of 4 levels, namely: without Mutiara NPK fertilizer (n_0), 200 kg ha^{-1} (n_1); 300 kg ha^{-1} (n_2), and 400 kg ha^{-1} (n_3). The second factor was the dose of KayaBio biological fertilizer consisting of 4 levels, namely: without KayaBio fertilizer (k_0), 20 kg ha^{-1} (k_1), 25 kg ha^{-1} (k_2), and 30 kg ha^{-1} (k_3). Overall there were 16 treatment combinations, each repeated three times.

D. Stages of Research Activities

The research activities carried out include seed nurseries. Land preparation in the form of 48 research units, each measuring 2.8 x 2 m, applying essential fertilizer in goat manure as much as 2 kg $plot^{-1}$, installing plastic mulch and making planting holes, fertilizing Mutiara NPK according to the given treatment dose. Delivered in 2 stages: ½ amount given seven days before planting and the remaining ½ dose given 14 days after planting. KayaBio fertilizer was given according to the treatment dose given in 2 stages: ½ amount given at planting and the remaining ½ dose given 28 days after planting; Planting, plant maintenance (watering, replanting, stake installation, and pest control), and harvesting.

E. Data collection

The primary data observed were: plant height at 14, 28, and 42 days after planting; the number of fruits per plant, fruit length, fruit diameter, the weight of 1 fruit and fruit production; and supporting data, namely: results of analysis of soil chemical properties in the laboratory of the Samarinda Agricultural Technology Study Center and data on weather conditions during the study (March - June 2020).

F. Data Analysis

The data obtained were analyzed statistically using analysis of variance (ANOVA). If the results of the ANOVA in the treatment had no significant effect (F count ≤ F table 5%), no further tests were carried out, whereas if the results of the ANOVA had a significant effect (F count > F table 5%) or had a very significant effect (F count > F table 1 %), then to compare the two treatment averages, a follow-up test was carried out with the Least Significant Difference (LSD) test at the 5% level (Steel and Torrie, 1991).

RESULTS AND DISCUSSION

A. Preliminary Soil Analysis

The results of analysis at the Samarinda Agricultural Technology Research Center Laboratory (2020) show that the research planting medium (soil) has a slightly alkaline soil pH of 7.67, low C-organic content is low (0.92%), total N is very low (0. 09%), C/N ratio is low (10.22), K_2O content is low (0.81 mg.100 g^{-1}), P2O5 is very low (6.35 mg.100 g^{-1}), and soil texture is silty loam. Based on this, the Ultisols have low soil fertility status, so efforts are needed to increase soil fertility.

B. Response of Eggplant Plants to Mutiara NPK Fertilizer

The results of ANOVA showed that the response to plant height aged 14, 28, and 42 days after planting was significantly different to highly significant to the treatment of NPK Mutiara fertilizer. The research results in Table 1 show that the treatment without Mutiara NPK fertilizer (n0) produced the lowest purple eggplant plant height, namely 7.93 cm, 17.03 cm, and 41.90 cm. A lack of N nutrients causes this situation; the laboratory's soil analysis results show that the total N element content is only 0.09%, which is very low. Winarso (2005) states that if plants lack N, the leaves will turn yellow, and plant growth will be slow and stunted.

The results also showed that various doses of Mutiara NPK fertilizer produced higher purple eggplant plants, with the more significant the amount given, the higher the plants grown. Plants cause this increased availability and uptake of nutrients, especially N elements. Munawar (2011) stated that adequate N elements can improve plant vegetative growth. Added by Rop et al. (2019), the nutrients N and P are needed by plants in the growth process to be precise in the vegetative phase.

The results of the ANOVA showed that the response to the yield components (number of fruits, fruit diameter, and fruit weight per plant) and fruit production was significantly different to very significantly different to the NPK Mutiara fertilizer treatment, except for the other fruit length responses, which were not significant. The research presented in Table 1 shows that applying various doses of Mutiara NPK fertilizers (200 kg ha^{-1}, 300 kg ha^{-1}, and 400 kg ha^{-1}) resulted in a higher number of fruits per plant, larger fruit diameters and larger

fruit per plant. Heavier resulted in higher fruit production than the treatment without Mutiara NPK fertilizer (n0). The highest fruit production was produced in the 300 kg ha^{-1} (n2) treatment, namely 16.59 tons ha^{-1}, followed by the 400 kg ha^{-1} (n3) and 200 kg ha^{-1} (n1) treatments, namely 15.83 tons ha^{-1} and 14.76 tons ha^{-1}. In contrast, the lowest was produced in the treatment without Mutiara NPK fertilizer (n0), only 10.53 tons ha^{-1}. This is because the nutrient content in the soil is classified as very low, namely 0.09% total N; 6.35 mg/100g P_2O_5 and 0.81 mg 100 g^{-1} K_2O so that by applying Pearl NPK fertilizer it can increase the availability of nutrients N, P, and K and then the plants can give good/high fruit yields. As stated by Darjanto and Satifah (2003) that for the growth/development of fruit, nutrients are needed, especially N, P, and K. Element N is necessary for the formation of protein; element P accelerates the growth of flowers, fruits, and seeds; and element K to facilitate the transport of carbohydrates and affect the appearance and development of fruit. The results of this study are in line with the research report submitted by Hendri, Napitupulu, and Sujalu (2015) that the application of Mutiara NPK fertilizer significantly affected plant height at 30 and 45 days after planting, number of fruits per plant, fruit length, fruit weight per plant, and weight per eggplant plant. The highest fruit weight per plant was obtained at 20 g per plant, namely 1587.78 g per plant, while the lowest was produced in the treatment without Pearl NPK, which was only 825 g per plant.

The results also showed that applying NPK Mutiara fertilizer at a dose of 400 kg ha^{-1} (N3) tended to produce fewer fruits, smaller fruit diameters, lower fruit weight per plant, and lower fruit production than the results achieved, in the treatment of 300 kg ha^{-1}. This is by applying Mutiara NPK fertilizer, causing an imbalance of nutrients in the soil (showing symptoms of excess nutrients). Mulyani Sutejo and Kartasapoetra (2003) explained that the needs of plants for various nutrients during their growth and development are not the same. In other words, according to the activities of the interests of different physiological processes, plants need sufficient nutrients (no deficiencies and no may be redundant).

C. Response of Eggplant Plants to KayaBio Biological Fertilizer

The results of ANOVA showed that the height response of plants aged 14, 28, and 42 days after planting was not significantly different from the KayaBio biological fertilizer treatment. The research results in Table 1 show that applying various doses of KayaBio biological fertilizer tends to produce higher purple eggplant plants than treatment without KayaBio biological fertilizer (k0).

The ANOVA showed that the responses to the number of fruits per plant, fruit length, weight per plant, and fruit production were not significantly different from the KayaBio biological fertilizer treatment. Still, the diameter of the fruit gives a very significantly different response. The research results presented in Table 1 show that the application of various doses of KayaBio biological fertilizer (20, 25, and 30 kg ha^{-1}) tends to produce a higher number of fruits per plant ($\pm$ 17 fruits), more extended fruit sizes (24.48 – 25.09 cm), larger fruit diameter (3.66 – 3.78 cm), higher fruit weight per plant (3.40 – 4.06 kg/plant) and higher fruit production (13, 49 – 16.18 tons/ha) compared to treatment without KayaBio biological fertilizer (k0) with yields namely the number of fruits per plant (14.00 fruits), fruit length (24.02cm), fruit diameter (3.62 cm), fruit weight fruit per plant (3.12 kg $plant^{-1}$) and the lowest fruit production (12.57 tons ha^{-1}). The results of this study are in line with the results of the research reported by Sundari, Rochyat, and Sary (2019); the application of the KayaBio biological fertilizer had no significant effect on all observed parameters of corn plants (plant height at flowering age and dry seed production). The results of another study reported by Harsono, Kuntyastuti, and Sucahyono (2017) found that the effect of using the Kayabio biological fertilizers, Kayabio Plus, and Petrobio on Alfisol soil was not significantly different on the growth and yield of soybeans. Furthermore, the results of the research reported by Kuntyastuti, Sucahyono, and Harsono (2017) on Alfisol soils, Tegal Lamongan land, and Probolinggo paddy fields it turns out that the use of Kayabio biological fertilizers, Kayabio Plus, and Petrobio 50 kg ha^{-1} is not effective in improving the growth and yield of peanuts (the effect is not significantly different on plant height, number of filled pods, the weight of 100 dry seeds and peanut pod production).

In general, the results showed that the response to growth and yield of purple eggplant was not significantly different from the application of KayaBio biological fertilizer; this was related to the quality standard of KayaBio biological fertilizer as explained by Simanungkalit, Husen, and Saraswati (2021) that the quality standards for biological fertilizers are quality requirements that must be met by a biological fertilizer so that the microbial functions contained in the biological fertilizer concerned can have a positive effect on the inoculated plants. Some of the microbial characteristics that determine the quality of a biological fertilizer include (1) total population (minimum number of microbial populations that live at the time of production and before expiration, meaning that there is a minimum number of live microbial populations in the inoculant needed to be able to influence plant growth; (2) the effectiveness of microbes in inoculants is the selected (superior) microbes as a result of selection, systematic testing in the laboratory, greenhouse, and the field; (3) the carrier material must be able to provide a suitable living environment for microbes or a mixture of various microbes during production, transportation, and storage before the inoculant is used, and (4) the expiry date, which is related to the age of the inoculant whether it can still be used. If the expiration date passes, the quality (effectiveness) of the inoculant is no longer guaranteed because the number of microbes no longer meets the minimum requirements.

D. Eggplant Plant Response Interaction between Mutiara NPK Fertilizer and KayaBio Biological Fertilizer

The results of ANOVA showed that the response to plant height at 14, 28, and 42 days after planting, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant, and purple eggplant fruit production were not significantly different from the interaction between Mutiara NPK fertilizer and KayaBio biological fertilizer. This situation indicates that the Mutiara NPK fertilizer factor and the KayaBio biological fertilizer factor do not jointly or separately affect the growth and yield of purple eggplant. Steel and Torrie (1991) explain that if the effect of different interactions is not significant, it is concluded that among the treatment factors, they act independently, or the result stands alone.

The results of the research presented in Table 1 show that at multiple levels (doses) of KayaBio biological fertilizer combined with various levels (doses) of Mutiara NPK fertilizer, the growth and yield of purple eggplant fruit were better than the treatment without Mutiara NPK fertilizer. Likewise, at various levels (doses) of Mutiara NPK fertilizer combined with multiple levels (doses) of KayaBio biological fertilizer, it resulted in better growth and yield of purple eggplant fruit than treatment without KayaBio biological fertilizer. Generally, the highest fruit production was produced in the combination of 300 kg ha^{-1} Mutiara NPK fertilizer and 25 kg ha^{-1} Kayabio biological fertilizer (n2k2), namely 19.73 tons ha^{-1}. In contrast, the lowest was produced in the combination without Mutiara NPK fertilizer and without Kayabio biological fertilizer (n0k0), which is 8.85 tons ha^{-1}. This shows that Mutiara NPK fertilizer and KayaBio biological fertilizer can complement each other to meet the nutrient needs of the purple eggplant plant. As Prihmantoro (1999) stated, it is better if nutrients through fertilization are given regularly so plants can grow and give good results.

Furthermore, Setiawati et al. (2020) stated that biological fertilizers contain microbes capable of producing active compounds that break down nutrients in the soil. The activity of microorganisms can increase the ability of soil to store water so that plants more easily absorb nutrients. Hardjowigeno (2015) explained that applying biological fertilizers has a significant influence on improving the chemical and physical properties of the soil, one of which is providing nutrients for plants and helping to increase the soil's ability to hold water. The availability of nutrients can be supplied through fertilization until they reach the ideal for plant growth and will increase the productivity of plants according to their maximum genetic conditions (Wulansari et al., 2022).

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

Based on the results of the research and discussion, conclusions can be drawn, namely as follows:

1. Response of plant height at 14, 28, and 42 days after planting, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant, and fruit production were significantly different to very significantly different from the application of Mutiara NPK fertilizer. The highest fruit production was produced in the 300 kg ha^{-1} (n2) treatment, which was 16.59 tons ha^{-1}, and the lowest was made in the treatment without Pearl NPK fertilizer (n0), which was only 10.53 tons ha-1.
2. The response of plant height at 14, 28, and 42 days after planting, the number of fruits per plant, fruit length, weight per plant, and fruit production were not significantly different. In contrast, the response to fruit diameter was highly different from the application of Kayabio biological fertilizer. The highest fruit production was produced in the 25 kg ha^{-1} (k2) treatment, namely 16.18 tons ha^{-1}, and the lowest was made in the treatment without Kayabio biological fertilizer(k0), which was only 12.57 tons ha^{-1}.
3. The response of plant height aged 14, 28, and 42 days after planting, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant, and fruit production were not significantly different from the interaction between Mutiara NPK fertilizer and Kayabio biological fertilizer.

B. Suggestion

1. To cultivate purple eggplant, it is recommended to apply Mutiara NPK fertilizer at 300 kg ha^{-1} and the Kayabio biological fertilizer at 25 kg ha^{-1}.
2. It is necessary to conduct similar research in other locations/fields accompanied by observations of plant nutrient uptake.

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Table 1. Summary of Research Results Response to Growth and Yield of Purple Eggplant Yufita F1 Varieties to Application of Mutiara NPK Fertilizer and Kayabio Biological Fertilizer and Their Interactions

Treatment Factors	Plant Height (cm)			Number of Fruits (Fruits)	Length of Fruits (cm)	Diameter of Fruits (cm)	Fruit Weight/ crops (kg)	Yield of Fruit (ton ha^{-1})
	14 HST	28 HST	42 HST					
Mutiara NPK Fertilizer (N)	*	**	**	**	tn	*	*	*
Without Mutiara NPK(n0)	7,93 c	17,03 b	41,90 b	11,17 b	24,43	3,65 b	2,63 b	10,53 b
200 kg ha^{-1} (n1)	8,49 bc	25,52 a	61,25 a	15,08 ab	24,67	3,66 b	3,69 a	14,76 a
300 kg ha^{-1} (n2)	8,98 ab	29,42 a	65,04 a	18,92 a	24,32	3,78 a	4,15 a	16,59 a
400 kg ha^{-1} (n3)	9,08 a	29,61 a	67,23 a	17,00 a	24,70	3,72 ab	3,98 a	15,83 a
Kayabio Biofertilizer(K)	tn	tn	tn	tn	tn	**	tn	tn
Without Kayabio (k0)	8,46	23,41	56,27	14,00	24,02	3,62 c	3,12	12,57
20 kg ha^{-1} (k1)	8,48	25,36	59,65	17,25	24,48	3,66 bc	3,86	15,46
25 kg ha^{-1} (k2)	8,79	26,05	62,65	17,59	25,09	3,74 ab	4,06	16,18
30 kg ha^{-1} (k3)	8,74	26,65	61,85	13,33	24,51	3,78 a	3,40	13,49
Interaction (N x K)	tn	tn	tn	tn	tn	tn	tn	tn
n0k0	8,42	18,04	39,50	10,67	22,71	3,63	2,21	8,85

n0k1	7,85	16,67	43,17	11,00	24,84	3,66	2,36	9,44
n0k2	7,33	13,83	49,92	13,67	24,39	3,74	3,23	12,92
n0k3	8,13	19,58	55,00	9,33	25,76	3,59	2,72	10,89
n1k0	8,38	22,42	65,25	16,33	25,14	3,61	3,88	15,79
n1k1	8,25	27,71	56,75	17,00	24,42	3,62	4,17	16,63
n1k2	8,96	25,96	66,50	17,00	25,94	3,65	3,95	15,53
n1k3	8,38	25,58	56,50	10,00	23,17	3,77	2,77	11,08
n2k0	8,42	29,93	57,25	16,33	23,67	3,55	3,49	13,97
n2k1	9,19	28,63	68,08	20,13	24,29	3,78	4,34	17,38
n2k2	9,29	28,92	66,42	22,00	25,05	3,87	4,93	19,73
n2k3	9,00	30,21	68,41	17,00	24,26	3,91	3,82	15,27
n3k0	8,63	23,25	63,08	12,67	24,61	3,70	2,77	11,09
n3k1	8,63	28,42	70,58	20,67	24,35	3,60	4,79	18,98
n3k2	9,59	35,50	67,75	17,67	25,01	3,70	4,14	16,54
n3k3	9,46	31,25	67,50	17,00	24,83	3,88	4,27	16,71

Description: tn = no significant different response; * = significantly different response; ** = very significantly different response; and HST = days after planting