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The Effect of Bio-Fertilizer Concentration and NPK Fertilizer Dosage on the Growth and Yield of Melon (*Cucumis melo* L.) Merlin Variety

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ABSTRACT

Melon (Cucumis melo L.) is a fruit known for its sweet and refreshing taste. Traditionally, melon cultivation has relied on conventional farming methods. The use of biofertilizers offers an alternative to reduce dependency on synthetic fertilizers. This study aimed to enhance the production of healthy, high-yielding melon plants by substituting Mutiara NPK fertilizer with Bioto Grow Gold (BGG) biofertilizer. Conducted in Sukosongo Village, Kembangbau District, Lamongan Regency, East Java, the experiment employed a factorial Completely Randomized Design (CRD).Two factors were tested: BGG fertilizer at four concentrations (0 ml/L [P0], 1 ml/L [P1], 2 ml/L [P2], and 4 ml/L [P3]) and NPK fertilizer at four doses (0 g/plant [N0], 60 g/plant [N1], 70 g/plant [N2], and 80 g/plant [N3]). Results indicated that BGG fertilizer influenced both vegetative and generative growth variables, as did the Mutiara NPK fertilizer doses. The optimal combination was achieved with a BGG concentration of 3 ml/L and an NPK dose of 70 g/plant, which significantly increased the sucrose content in melons.

1. INTRODUCTION

Melon (*Cucumis melo* L.) is a fruit that has a sweet and fresh taste. Melon plants have high nutritional levels, including vitamins, minerals, carotene, and fibers (Lester, 1997; Manchali *et al*., 2021; Mallek-Ayadi *et al*., 2022; Daryono *et al*., 2016). So far, many melon plants have been cultivated conventionally. Excessive use of synthetic fertilizers and pesticides can result in negative impacts (Chittora *et al*., 2023; Tripathi *et al*., 2020), namely chemical residues on fruit, damage to the structure, physical and biological properties of the soil, contamination of water and soil, as well as disrupting the balance of soil microorganisms. This can cause a decrease in soil fertility. Furthermore, a decrease in soil fertility levels will be followed by a decrease in plant production. The use of biological fertilizer is one technique to get around the need for less synthetic fertilizer.

Biofertilizer is a consortium of microorganisms that can stimulate and increase plant growth and yield. Some examples of microorganisms used as biofertilizers include *Azospirillum* sp., *Acinetobacter* sp., *Pseudomonas* sp., *Bacillus* sp., *Escheria* sp., *Actinomycetes* sp., *Azospirillum* sp., *Enterobacter* sp., and *Azotobacter* sp. Biofertilizers are useful as soil conditioners by changing the physical properties of the soil, forming stable aggregates, and increasing the biochemical content of the soil (Ammar *et al*., 2023; Sembiring *et al*., 2020; Bhardwaj *et al*., 2014). The environmental benefits of biofertilizers have also been noted, including reduced environmental pollution, reduced dependence on synthetic fertilizers, and promoting sustainable agricultural ecosystems (Budiman *et al*., 2022; Iskandar *et al*., 2023a; 2023b).

Bioto Grow Gold (BGG) is a type of biological fertilizer containing microorganisms, macro and micro nutrients, as well as ZPT. Microorganisms in BGG fertilizer have many roles, including *Azospirilum* sp. and *Acinetobacter* sp. as a fixer of N for plants by fixing air nitrogen. The microorganisms *Escheria* sp., and *Actinomycetes* sp. as a phosphate solvent. Microorganisms break down bound soil P and naturally formed P through reactions between organic acids and $AlPO_4$, $FePO_4$, and $Ca(PO_4)_2$ which produce organic chelates of Al, Fe, and Ca and dissolve the P so that it is available to plants. *Azospirillum* sp., *Enterobacter* sp., and *Azotobacter* sp. as a producer of IAA it can stimulate growth and yield in plants (Nugraha *et al*., 2019). The application of BGG biofertilizer and NPK fertilizer is expected to influence the growth and yield of melon plants and reduce the use of Mutiara NPK fertilizer with BGG fertilizer as a substitute, which is the aim of this research.

2. MATERIALS AND METHODS

2.1. Research Location

The research will be carried out in March – May 2024, in Sukosongo Village, Kembangbau District, Lamongan Regency, East Java. The research location has an altitude of 5.17 meters above sea level, a temperature of 24-33°C, and average rainfall in March of 201-300 mm (BMKG, 2023).

2.2. Material and Tool

The equipment used included a camera, stationery, hoe, refractometer, ball of thread, 40 x 40 cm polybag, 1 liter measuring cup, scissors, bucket, gembor, seedling tray and measuring tape. The materials included melon seeds (Merlin variety), manure, soil, sand, Bioto Grow Gold fertilizer, NPK Mutiara fertilizer (16:16:16), and pesticides.

2.3. Experimental Method

A factorial Completely Randomized Design (CRD) was chosen in this study. There were 2 factors, the first factor Bioto Grow Gold (BGG) fertilizer with 4 doses: 0 ml/L (P0), 2 ml/L (P1), 3 ml/L (P2), and 4 ml/L (P3). Meanwhile, the second factor was NPK fertilizer with 4 doses: 0 g/plant (N0), 60 g/plant (N1), 70 g/plant (N2), and 80 g/plant (N3). Sixteen treatment combinations were obtained and all were executed with 3 replications.

2.4. Observation Variables

The observation variables included number of leaves, plant length (cm), flowering age (DAT), fruit circumference (cm), fruit weight (kg), fruit volume (cm^3), fruit flesh thickness (cm), and sweetness level (°Bx).

2.5. Implementation

The research began with preparing the planting media. Melon seeds were transplanted into polybags at the age of 10 days. Melon maintenance was carried out by watering, installing stakes, pest control, land sanitation, pruning, fertilizing, pollination and fruit selection. Harvesting was conducted when the melon was 65 DAT.

2.6. Analysis

Data analysis was carried out from the experimental results using analysis of variance in accordance with the design used, namely a Completely Randomized Design (CRD) (Susilawati, 2015).

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \quad (1)$$

where Y_{ijk} is observation on the k^{th} replication that received treatment with the i^{th} level of BGG biofertilizer factor and the j^{th} level of NPK fertilizer factor, μ is general average, α_i is influence of BGG biofertilizer factor i level, β_j is influence of the NPK fertilizer factor at the j^{th} level, $(\alpha\beta)_{ij}$ is interaction effect of the i-level BGG biological fertilizer factor and j-level NPK fertilizer factor, and ε_{ijk} is error component by biofertilizer factor BGG level i, factor j^{th} level of NPK fertilizer and kth repetition. The obtained data was analyzed using analysis of variance (ANOVA), and the treatment had a significant effect if the calculated F (F-count) is greater than the F-table at confidence level of 95%

and if it was smaller or equal to the F table of 5% it meant there was no significant effect. Next, the HSD (Honesty Significant Difference) test was carried out with a level of α = 5% (Susilawati, 2015; Gomez & Gomez, 1995):

$$HSD(\alpha) = q(p,v) \times \sqrt{\frac{MSE}{r}} \quad (2)$$

where *MSE* is mean square error, *r* is repetition, and *q*(p,v) is tabular *q*-value from Tukey table at α = 5%.

3. RESULTS AND DISCUSSION

The combination treatment between the concentration of BGG biological fertilizer and the dose of Mutiara NPK fertilizer gave a significant interaction on the sweetness level of the melon fruit alone, but there was no interaction on the parameters of number of leaves, plant length, female flowering age, fruit circumference, fruit volume, thickness of fruit flesh, and weight of fruit. The treatment between the combination of P2N2 biofertilizer concentration, namely BGG 3 ml/l, with a Mutiara NPK fertilizer dose of 70 g/plant, produced a sweetness level of 10.0 °Bx, which was significantly different from the treatment combination of P0N1 BGG biofertilizer concentration, 0 ml/l, and Mutiara 60 NPK fertilizer dose. g/plant (7.0 °Bx) and a combination treatment of P0N2 BGG biological fertilizer concentration of 0 ml/l with a dose of Mutiara NPK fertilizer 70 g/plant (7.3 °Bx), but not significantly different from other treatment combinations.

Based on the results of analysis of variance in the vegetative phase (Table 1). The concentration treatment of BGG biological fertilizer on melon plants had a significant effect on the parameters of leaf number 21-35 HST and plant length 21-28 DAP. The BGG biofertilizer treatment with a concentration of 3 ml/l on the number of leaves 21-35 DAP was significantly different from the control but not significantly different from the treatment with concentrations of 2 ml/L and 4 ml/L. The BGG biofertilizer treatment at a concentration of 3 ml/L was significantly different from the control but not significantly different from the treatment at concentrations of 2 ml/L and 4 ml/L for plant length parameters 21-28 DAP.

Based on the results of analysis of variance in the generative phase (Table 2). Treatment of Bioto Grow Gold (BGG) biological fertilizer concentration on melon plants had a significant effect on the parameters of fruit circumference, fruit volume, fruit weight and sweetness level. The BGG biofertilizer concentration treatment of 3 ml/L was significantly different from the control, but was not significantly different in the 2 ml/L and 4 ml/L treatments in the parameters of fruit circumference, fruit volume, fruit weight, and sweetness level.

The treatment dose of Mutiara NPK fertilizer had a significant effect on the parameters of leaf number 21-35 HST and plant length 21-35 DAT (Table 1), as well as on the parameters of fruit circumference, fruit volume and fruit weight (Table 2). The NPK Mutiara fertilizer treatment at a dose of 70 g/plant was significantly different from the control but not significantly different from the treatment at a dose of 60 g/plant and 80 g/plant at the number of leaves 21-35 HST. The Mutiara NPK fertilizer treatment at a dose of 70 g/plant was significantly different from the control but not significantly different from the treatment at a dose of 60 g/plant and 80 g/plant at plant length 21-35 HST. The treatment dose of Mutiara NPK fertilizer of 70 g/plant was significantly different from the control, but not significantly different from the treatment of 60 g/plant and 80 g/plant in terms of fruit circumference, fruit volume and fruit weight.

Application of a combination treatment of BGG biofertilizer concentration and optimal dosage of Mutiara NPK fertilizer can increase the level of sweetness (Bx) in melons and can reduce the use of Mutiara NPK fertilizer by 10 g from the recommended dosage of 80 g/plant. This is due to an increase in sucrose synthesis. Sucrose is produced by the sucrose synthase enzyme in the (SuSy) pathway. In this pathway trise phosphate (triose-P) requires the elements N, P, and K which are produced from NPK fertilizer and BGG biofertilizer through the role of microorganisms, as well as micro nutrients, especially the Mg element contained in BGG biofertilizer as an ingredient in the catalyst process to produce fructose 1,6-bisphosphate molecule (Ruan, 2014). One of the raw materials for sucrose is carbon resulting from photosynthesis. Meanwhile, the photosynthesis process requires macro and micro nutrients, so the supply of macro and micro nutrients in NPK Mutiara fertilizer and BGG life fertilizer will contribute to the level of sweetness of melon fruit.

Treatment with a BGG biofertilizer concentration of 3 ml/l gave the highest results in terms of growth in number of leaves and plant length. This is because the microorganism *Azotobacter* sp. and *Azospirillum* sp. plays a good role in fixing nitrogen. The N element has an important role in increasing the chlorophyll content. An increase in chlorophyll content will be followed by an increase in photosynthate yield in the form of carbohydrates and glucose. Apart from that, the microorganisms *Pseudomonas* sp., *Bacillus* sp., *Escheria* sp., and *Actinomycetes* sp. As a phosphate solvent, it can provide P elements for plants. One of the P elements is useful in dividing and elongating the tips of roots and plants. Microorganisms *Bacillus* sp., *Pseudomonas* sp., *Azospirillum* sp., *Streptomycetes* sp., and *Azotobacter* sp. contained in BGG biological fertilizer plays an active role in dissolving potassium. Element K can increase photosynthate translocation. At the beginning of growth, the photosynthate will be used by the plant in the formation of new leaves, elongation of stems, and elongation of roots. However, in the generative phase, the photosynthate translocation process will focus on the process of fruit formation, fruit enlargement, and increasing sucrose levels in the fruit. This is in accordance with the opinion of Ikhwan *et al*., (2015) that the bacteria *Azospirillum* sp. has a role as a fixer of free nitrogen elements from the air, so it is useful for productivity and plant growth.

The number of leaves and plant length will have an impact on melon production. The maximum number of leaves and plant length will increase the rate of photosynthesis, so that the amount of photosynthesis will increase. When entering the generative phase, the photosynthate results will be allocated for fruit formation, fruit enlargement, and increasing sucrose levels in the fruit. Apart from that, the micronutrients contained in BGG biofertilizer also act as building blocks of plant tissue, catalysts, and influence plant oxidation and reduction processes. This is in accordance with the significant difference in the BGG biofertilizer concentration treatment of 3 ml/l versus the control, but there is no significant difference in the 2ml/l and 4 ml/l treatments for the parameters of fruit circumference, fruit volume, fruit weight, and sweetness level. With research by Aritonang & Surtinah, (2018) that the use of BBG fertilizer has a real influence on vegetative and generative growth parameters, such as plant length, leaf width, stem diameter, fruit circumference, fruit weight, flesh thickness fruit, and sucrose content (Bx). Treatment 3 ml/l is the best treatment.

Table 1. Effect of combination of BGG biofertilizer concentration and Mutiara NPK fertilizer dosage on sweetness level of melon.

BGG Concentration (ml/l)	Sweetness Level (Bx)			
	NPK 0	NPK 60	NPK 70	NPK 80
0	8.0 ab	7.0 a	7.3 a	9.0 ab
2	8.2 ab	8.7 ab	8.7 ab	8.3 ab
3	8.3 ab	9.2 b	10.0 b	8.5 b
4	7.3 ab	9.8 b	8.7 ab	8.8 ab
HSD 5%			2.04	

Note: The average value followed by the same letter in the combination treatment is not significantly different in the 5% HSD test.

Table 2. Average vegetative growth treatment of BGG fertilizer concentration and Mutiara NPK fertilizer dosage

Level of Factor	Number of Leaves (pieces)			Plant Length (cm)		
	21 DAP	28 DAP	35 DAP	21 DAP	28 DAP	35 DAP
BGG concentration (ml/L)						
0	11.83 a	21.00 a	29.21 a	80.29 a	123.92 a	168.17
2	12.13 ab	21.92 a	28.79 a	82.21 ab	130.63 ab	162.5
3	14.38 b	23.96 b	31.79 b	89.92 b	137.92 b	176.08
4	13.50 b	22.75 ab	30.50 ab	87.87 ab	133.83 ab	172.17
HSD 5%	1.48	2.58	2.86	8.55	10.04	tn
Mutiara NPK Fertilizer Dosage (g/plant)						
0	12.13 a	21.00 a	25.75 a	80.54 a	126.95 a	147.50 a
60	12.54 ab	22.13 ab	31.17 b	83.46 ab	126.92 a	173.67 b
70	13.96 b	24.21 b	32.92 b	89.42 b	138.71 b	184.04 b
80	13.20 ab	22.29 ab	30.46 b	86.88 ab	133.71 ab	173.71 b
HSD 5%	1.48	2.58	2.86	8.55	10.04	15.28

Note: The average value followed by the same letter in the same column indicates not significantly different in the 5% HSD test. tn: not significant.

Table 3. Average generative growth treatment of BGG fertilizer concentration and Mutiara NPK fertilizer dosage

BGG concentration (ml/L)	Flowering Age (DAP)	Fruit Circumference (cm)	Fruit Volume (cm^3)	Fruit Flesh Thickness (cm)	Fruit Weight (kg)	Sweetness Level ($Brix^o$)
0	24.25	40.94 a	1054.58 a	3.52	1.10 a	7.8 a
2	24.13	42.94 ab	1230.87 ab	3.54	1.30 ab	8.5 ab
3	24.13	47.87 b	1692.43 b	4.05	1.70 b	9.0 b
4	24.04	44.13 ab	1263.68 ab	3.37	1.40 ab	8.7 ab
HSD 5%	TN	5.82	557.83	TN	0.49	1.02
Mutiara NPK Fertilizer Dosage (g/plant)						
0	24.13	38.78 a	900.86 a	3.19	0.94 a	8
60	24.21	44.27 ab	1269.37 ab	3.63	1.40 ab	8.7
70	23.88	46.73 b	1586.42 b	3.79	1.59 b	8.7
80	24.33	46.11 b	1484.91 b	3.88	1.58 b	8.7
HSD 5%	TN	5.82	557.83	TN	0.49	TN

Note: The average value followed by the same letter in the same number indicates that the value is not significantly different in the 5% HSD test and the average value followed by a different letter in the same number indicates that the value is significantly different in HSD test 5%; tn: not real.

Providing NPK Mutiara fertilizer has a real influence in the vegetative phase, namely on the parameters of number of leaves and plant length. This is because the N content in Mutiara NPK fertilizer helps the formation of vegetative organs such as roots, stems and leaves. The N element also has an important role in the formation of chlorophyll in plants, chlorophyll levels will influence the photosynthesis process and the amount of assimilate produced so that it can support plant growth in the vegetative phase (Suharno *et al*., 2007).

The application of Mutiara NPK fertilizer also had a real influence on melon production, namely on the parameters of fruit circumference, fruit volume and fruit weight. The P element in Mutiara NPK fertilizer plays an important role in meristem tissue cell division. Good root formation will be followed by greater nutrient uptake. A lot of absorption will stimulate a lot of photosynthate. The availability of K elements will increase the translocation of photosynthate results in growing melons, so that production will increase. In accordance with the opinion of Nursayuti *et al*., (2019) that nutrients play a role in metabolic processes in plants, so that the formation of starch, protein and carbohydrates can increase as food reserves for plants.

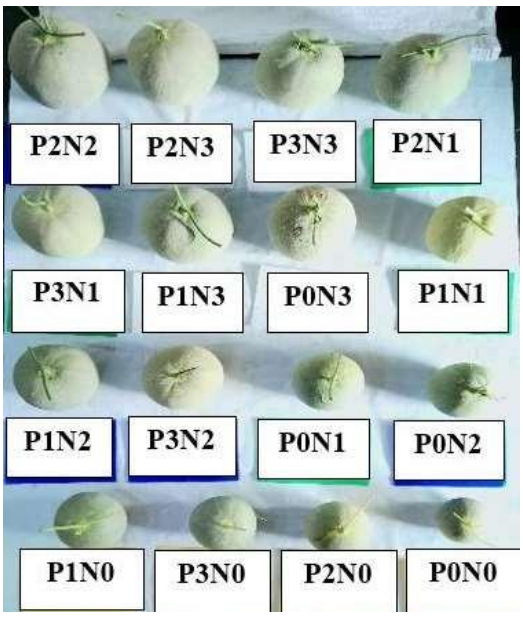

Figure 1. Melon fruit from all treatments

Figure 1 shows that the best melon fruit was in the P2N2 treatment, namely a BGG biofertilizer concentration of 3 ml/L with a Mutiara NPK fertilizer dose of 70 g/plant (1.70 kg). This combination is the best dose compared to other treatment combinations. The use of BGG biofertilizer can reduce the use of Mutiara NPK fertilizer by 10 g from the recommended dose of 80 g/plant. This reduction in dosage provides benefits for farmers both from an economic and land perspective. Considering the price of non-subsidized chemical fertilizers is so expensive. According to research by Palmasari *et al*. (2022), the treatment with NPK fertilizer had a significant effect on the parameters of plant length, number of leaves, weight of fruit per plant, and fruit sweetness (Bx). The best treatment is to use NPK at a dose of 80 g/plant.

4. CONCLUSION

Treatment with Bioto Grow Gold (BGG) biological fertilizer concentration of 3 ml/l on melon plants gave the highest results on the parameters of number of leaves, plant length, fruit circumference, fruit volume, fruit weight and sweetness level. Treatment with a NPK Mutiara fertilizer dose of 70 g/plant on melon plants gave the highest results on the parameters of number of leaves, plant length, fruit circumference, fruit volume and fruit weight. The results of this research suggest using a concentration of Bioto Grow Gold (BGG) biological fertilizer of 3 ml/plant and a dose of NPK Mutiara fertilizer of 70 g/plant to increase plant growth and yield. And can reduce the use of Mutiara NPK fertilizer by 10 g from the recommended dose of 80 g/plant.

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