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Growth and Yield of Seedless Watermelon Plants in Response to Soil Amendment Application

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ABSTRACT: This research aims to evaluate the effect of soil amendment concentration on the growth and yield of seedless watermelon plants. This research was carried out at the agricultural land that located in Kumendung Village, Muncar District, Banyuwangi Regency, East Java Province, Indonesia. Four soil amendment concentrations (P1: 7.5 ml/liter, P2: 10 ml/liter, P3: 12.5 ml/liter, P4: 15 ml/liter) were tested on 132 watermelon plants in a randomized block experimental design. The results showed that the concentration of soil amendment affected the nutrient content of the soil with the highest concentrations in P1 and P3. Even though soil pH is relatively stable, the concentration of soil amendment affects the nitrogen (N), phosphorus (P) and potassium (K) content in the soil. In terms of plant growth, P3 concentration consistently provide a better plant height at various stages of observation. The fruit yield is also affected by the used of concentration of soil amendment, P3 treatment produces the highest fruit weight and fruit yield of P1 concentration have the highest level of sweetness. Based on the observation results, application of the right soil amendment concentration will increase growth and yield of seedless watermelon, which in this study the best yield obtained with P3 (12.5 ml/liter) application. These results could give an important implication to improving the productivity of seedless watermelon cultivation, especially in areas that have less fertile soil, such as Kumendung Village, Banyuwangi.

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KEYWORDS: humic acid, organic fertilizer, seedless watermelon, soil amendment

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INTRODUCTION

Watermelon is a horticultural plant belonging to the Cucurbitaceae family. Watermelon has great appeal to society and has significant economic value, not only in Indonesia but also throughout the world. Watermelon contains various substances that beneficial for human health, such as lycopene, 6% sugar, 9% water, as well as vitamin B6, vitamin A, vitamin C, electrolytes and phytonutrients (Sujadmiko et al., 2021). These components have the potential to maintain heart health, controls urine secretion, and maintain healthy skin (Kim, 2018).

Some data reports that world market demand for watermelon has reached 1,506,000 tons (Yuriani et al., 2019). However, Indonesia's watermelon export production still tends to be low. This is due to high demand from the domestic market, but on the other hand, watermelon production tends to decline. According to data from the Central Statistics Agency (BPS), watermelon production in Indonesia in the last three years has experienced a significant decline, namely 523,335 tonnes in 2019, 560,317 tonnes in 2020, and 410,754 tonnes in 2021 (Statistik Indonesia 2022, n.d.).

Watermelon planting centers are spread across several regions in Indonesia, such as Central Java (D.I. Yogyakarta, Magelang Regency, and Kulonprogo Regency), West Java (Indramayu, Karawang), East Java (Banyuwangi Regency, Malang), and Lampung (Wahyudi et al., 2016). Banyuwangi Regency, that located in East Java, becomes the largest producer of watermelon in

Indonesia (Mayangsari & Sunartomo, 2021), with Kumendung Village, Muncar District, as one of the villages that produces seedless watermelons.

One of the main obstacles in cultivating watermelon in Kumendung Village, Muncar District, is the low soil fertility. The pH of the soil in the Kumendung Village agricultural land reaches 8.4 (strongly alkaline), while the content of nutrients such as Nitrogen (N), Phosphorus (P), and Potassium (K) is very low, each only around 2.86 kg N. /ha, P 3.74 kg/ha, and K 9.7 kg/ha (Bariyyah et al., 2023).

Therefore, it is necessary to add organic fertilizer as a soil amendment. Soil amendments are materials used to improve the quality of soil, so that the productivity could be increase (Mindari et al., 2022). Some organic materials that can be used as soil amendments are guano compost, rabbit urine, and humic acid. Guano compost contains around 8.32% Nitrogen, 2.06% Phosphorus, and 0.54% Potassium (Hayanti et al., 2014). Liquid organic fertilizer derived from rabbit urine has a fairly high nutrient content, namely around 4% Nitrogen, 2.8% P2O5, and 1.2% K2O (Sembiring et al., 2017). Meanwhile, humic acid is an organic compound that has undergone a humification process and dissolves in alkali. Humic acid can have an indirect effect on improving soil fertility status in terms of physical, chemical and biological soil properties (Tan, 1992). Humic acid contains around 40-80% C elements, 2-4% N elements, 1-2% S elements, and 0-0.3% P elements (Lestari et al., 2020).

Guano organic fertilizer, rabbit urine and humic acid are used as a soil improvement formulation. However, there is still no knowledge about the optimal concentration to support the growth and yield of watermelon plants. Therefore, this study aims to observe and evaluate the effect of soil amendment concentration on the growth and yield of seedless watermelon plants.

MATERIALS AND METHODS

Place and Time of Activity

This article is based on the results of experiments carried out on agricultural land in Kumendung Village, Muncar District, Banyuwangi Regency, East Java Province, Indonesia, with the height of 33 meters above sea level. Research activities had been conducted from the beginning of August to the end of November 2022. By that time, the average daily temperature is in the range of 26 - 26.85 °C, with the average humidity of the planting environment is 80.21%, rainfall is 7.19 mm, duration of sunlight 6.05 hours/day, and wind speed 1.89 m/s. Soil amendments were made in the field laboratory at the University of 17 August 1945 Banyuwangi.

Preparation for Making Soil Improvement

The soil amendment formulation used consists of guano compost, liquid organic fertilizer from rabbit urine, and humic acid in a ratio of 1:1:1 respectively. The process of making the soil amendment thorough out of several stages, namely preparation of the soil amendment, mixing the soil amendment, and fermentation for two weeks.

Tools and materials

The tools used in this study were the hand tractors, hoes, sickles, sprinkler, buckets, measuring cups, spray tanks, mulch punches, seedling trays, rulers, digital scales, automation tools for measuring soil N, P, K instrument (Agrooscan) (Bariyyah et al., 2023), scissors, and hand refractometer. The materials used in this research were seedless watermelon seeds aged 20 days after planting, and soil amendment solution.

Research design

The study was carried out using a randomized block design (RBD) with a single factor, namely variations in soil amendment concentration and consisting of four level of soil amendment concentration treatments, as shown below:

P1: Soil improver concentration of 7.5 ml/liter;
P2: Soil improver concentration of 10 ml/liter;
P3: Soil improver concentration of 12.5 ml/liter;
P4: Concentration of soil improver is 15 ml/liter.

Each treatment level consisted of 11 plant samples with three replications and so the total population for sampling is 132 plants. The soil amendment concentration treatment is carried out once a week by watering 500 ml/plant. The parameters observed were the soil fertility, include measurements of soil pH, and concentrations of N, P and K in the soil. These obersevation carried out after the second applications of soil amendment. Observation of plant growth was carried out by measuring plant height at 7 days after planting (DAP), 14 DAP, and 21 DAP. Observations on the yield and quality of watermelon include measuring the weight of the fruit and the sugar content at it harvest time as well.

Data analysis

The data obtained were then analyzed using analysis of variance (Anova), using the (F test) at a significance level of 5%. Data showing a significant effect were further tested using Duncan's Multiple Rang Test (DMRT) at 5% level.

Research Implementation

Research was carried out through several stages of activities, namely: land preparation by clean the land from any pollutants and intruders, making beds and installing mulch, and then followed by setting a planting distance of 250 x 60 cm (Sumarni, 2019), which is also followed by the application of basic fertilizer (NPK). Then, watermelon plants are planted at a distance of 250 cm x 60 cm. Maintanance stage of the plant is carried out by watering the plants twice, in the morning and evening. Plant embroidery is carried out at 5 – 7 days after planting (DAP), then continue with pruning lateral branches, fruit selection (1 fruit maintained per plant), pest and disease control, and then keep maintaining the health conditions of plant until it harvesting time, which is when the plants are 70 days after planting (dap).

RESULTS AND DISCUSSION

Soil Fertility

Organic material is a good alternative for improving soil quality because it is able to add macro and micro elements needed by plants while improving soil structure. Basic organic materials can be used as fertilizer or soil conditioner which can affect soil pH and the availability of nutrients in the soil (Husen et al., 2022). Nutrient availability in one period will affect production the following year in response to soil nutrient content. The availability of nutrients in the soil is influenced by the acidity (pH value) of the soil. Soil nutrients are optimally available at neutral pH (6.5-7.5) condition (Azurianti et al., 2022). Results of this study about the effect of soil amendment concentration on soil fertility (pH, availability of N, P, K elements) are presented in Table 1.

Table 1. Effect of Soil Amendment Concentration to Soil Fertility (soil pH, N, P, K value)

Soil Amendment Concentration	pH	N (ppm)	P (ppm)	K (ppm)
P1	6,7 a	2,0 a	1,7 a	4,1 a
P2	6,3 a	1,5 b	1,6 a	3,7 b
P3	6,6 a	1,5 b	1,7 a	4,4 a
P4	6,7 a	1,3 b	1,4 b	3,8 b

Note: Numbers accompanied by the same letters in the column and the same observation parameters in each treatment are not significantly different based on the DMRT test at 5% level. P1: soil amendment concentration of 7.5 ml/liter; P2: soil amendment concentration of 10 ml/liter; P3: soil amendment concentration of 12.5 ml/liter; P4: soil amendment concentration of 15 ml/liter.

Soil pH

Table 1. contains the results of the Duncan Multiple Range Test (DMRT) at a significance level of 5%, shows that the organic soil amendment concentration treatment of between 7.5 ml/liter – 15 ml/liter on watermelon seedless cultivation land had no significant effect on the soil acidity. Soil pH tends to be stable in all treatments, that is between 6.3 and 6.7. Organic matter tends to have a high buffer capacity, so that when soil contains enough of this component, then the soil pH is relatively stable (Nuryani et al., 2003).

Soil acidity, which usually be measured from pH value, can be used as an indicator of soil fertility, because it can reflect the availability of nutrients in the soil (Hanafiah, 2013). In general, the availability of soil nutrients (N, P, K) reaches its maximum number in the pH range 6-7. Meanwhile, the optimum pH for the growth of most plants ranges from pH 6-6.5, including watermelon plants (Agustina, 2004).

Nitrogen (N)

The results (Table 1), showed that the soil amendment concentration treatment showed significant number in soil N availability. P1 treatment had the highest N concentration (2.0 ppm), while P4 had the lowest N concentration (1.3 ppm). This indicates that the higher concentration of soil amendment can lead to decreasing nitrogen levels in the soil.

Organic matter being the main source of N in soil. Mixing organic materials (guano compost, rabbit urine and humic acid) as a soil amendment and increasing the concentration of it application could increasing the N element release, thereby causing a decrease in soil N availability. This process can occur through the nitrification process. Nitrification is a gradual process, which the nitritation process were carried out by Nitrosomonas bacteria to produce nitrite. This process immediately followed by the next oxidation to become nitrate, that carried out by Nitrobacter bacteria and called as nitratation process. Nitrates are the result of the

mineralization process that absorbed by most cultivated plants. However, this nitrate is easily leached through drainage water and evaporates into the atmosphere in gas form (in poor drainage and limited aeration) (Killham, 1994) in (Atmojo, 2003).

Phosphorus (P)

This study also showed that the soil amendment concentration treatment gave a significant values for the P element in the soil as well. The soil amendment concentration treatments of 7.5 ml/liter (P1), 10 ml/liter (P2), and 12.5 ml/liter (P3) gave results that were not significantly different between each treatments but were significantly different from treatment P4 (15 ml/liter). This indicates that the concentration of soil amendment can affected the phosphorus content in the soil. In this study, the result obtained is that P3 and P1 treatments are more effective in increasing phosphorus availability for plants.

Soil amendments derived from organic materials can increase the availability of phosphorus in the soil and make the availability of phosphorus increases. Soil amendment made from a mixture of guano compost, rabbit urine provides soil P elements while humic acid can form P-Humic which is more easily absorbed by plants (Jumin, 2012).

Potassium (K)

Results showed that the soil amendment concentration treatment also affected the potassium (K) content in the soil, by the treatments of P1 and P3 which shows the results of the K value are quite high, where 4.1 ppm for P1 and 4.4 ppm for P3. On the other hand, P2 treatment had the lowest K concentration (3.7 ppm). This suggests that soil amendments can influence the availability of potassium in the soil, with P1 and P3 providing a more positive effect.

In this study, it can be concluded that the concentration of soil amendment has no significant effect on soil pH in each concentrations that observed. However, the concentration of soil amendment had a significant impact on the availability of nitrogen (N), phosphorus (P), and potassium (K) in the soil, with the highest concentrations obtained in P1 and P3 treatment. This can happen because the combination of application, that using rabbit urine and guano compost providing the macro elements N, P, and K (Muryanto & Lidar, 2020; Indabo & Abubakar, 2020) and apart from that the addition of humic acid in soil amendments can be used as an organic substance that can increase the availability of soil nutrients as well (Khan et al., 2013).

Plant Growth

Table 2. Effect of Soil Amendment Concentration on Watermelon Plant Height

Soil Amendment Concentration	Plant Height (cm)		
	7 dap	14 dap	21 dap
P1	21.77 a	73.53 a	153.40 a
P2	16.53 b	59.20 b	122.87 a
P3	23.07 a	68.73 a	147.33 b
P4	20.47 a	65.93 a	123.20 b

Note: Numbers accompanied by the same letters in the column and the same observation parameters in each treatment are not significantly different based on the DMRT test at the 5% level. P1: soil amendment concentration of 7.5 ml/liter; P2: soil amendment concentration of 10 ml/liter; P3: soil amendment concentration of 12.5 ml/liter; P4: soil amendment concentration of 15 ml/liter.

Table 2 shows that at 7 day after planting (dap), it was seen that P3 (12.5 ml/liter) had a significantly higher plant height compared to P1 (7.5 ml/liter) and P2 (10 ml/liter), but not significantly different with P4 (15 ml/liter). At 14 dap, P1 (7.5 ml/liter) and P3 (12.5 ml/liter) had significantly higher plant height compared to P2 (10 ml/liter) and P4 (15 ml/liter). At 21 dap, P3 (12.5 ml/liter) still had a significantly higher plant height compared to P1 (7.5 ml/liter) and P2 (10 ml/liter), while P4 (15 ml/liter) did not. significantly different from the three.

Basically, organic fertilizers that use urine help increase soil aeration, nitrification and dominate N_2O production. This is because the contents of urine can evaporate after application, so it will form cavities in the soil and improve soil aeration. Good aeration will help improve the quality of growth, especially in this case is the plant height parameter. Rabbit urine contains many important nutrients for plant growth, such as nitrogen, potassium, phosphate, as well as several other organic components (Indabo & Abubakar, 2020). The element nitrogen is an important element that build up the protein. The increase in plant height is also influenced by the presence of amino acid synthesis process that are going well, where sufficient nitrogen elements as constituent molecules have been fulfilled (Abdissa et al., 2011). Fulfillment of adequate nitrogen elements can be obtained not only from the use of urine but also the composition of guano and humic acid. The use of humic acid also plays a role in increasing metabolic processes in plants, one of which is increasing the rate of photosynthesis which is related to providing an energy source for cells to carry out their functions, including the function of cell differentiation or elongation (Puspitasari & Lukito, 2021). With an increase

in the rate of photosynthesis, the process of cell elongation and growth also increases. One of the cells that experiences elongation is stem cells, which is expressed as an increase in plant height.

Table 2. Effect of Soil Amendment Concentration on Seedless Watermelon Plant Yield

Soil Amendment Concentration	Fruit Weight (kg)	Fruit sweetness (brix)
P1	4.59 a	12.32 a
P2	4.46 a	11.35 b
P3	5.17 a	12.29 a
P4	4.13 b	12.10 a

Note: Numbers accompanied by the same letters in the column and the same observation parameters in each treatment are not significantly different based on the DMRT test at the 5% level. P1: soil amendment concentration of 7.5 ml/liter; P2: soil amendment concentration of 10 ml/liter; P3: soil amendment concentration of 12.5 ml/liter; P4: soil amendment concentration of 15 ml/liter.

Fruit Weight

The results showed that the concentration of soil amendment had a significant effect on the weight of Seedless watermelon. The soil amendment concentration treatment of 15 ml/liter (P4) had the lowest fruit weight (4.13 kg). Meanwhile, a concentration of 12.5 ml/liter (P3) had the highest fruit weight (5.17 kg). This shows.

The soil amendment concentration treatment of 12.5 (P) showed the highest fruit weight. This is closely related to the availability of P and K elements in the soil due to soil amendment concentration treatment. The availability of P and K nutrients is very important in increasing production yields (Hakim et al., 2018). P plays a role in improving the quality of fruit weight and K plays a role in accelerating the reaction rate of photosynthesis and translocation in increasing fruit weight (Nursuyuti, 2022).

Fruit Sweetness Level

The level of sweetness of seedless watermelon also varies depending on the concentration of soil amendment. The soil amendment concentration treatments of 7.5 ml/liter (P1) and 12.5% (P3) had the highest fruit sweetness with an average of 12.32 Brix and 12.29 Brix, while the P2 concentration (10 ml/liter) had the lowest fruit sweetness with an average -average 11.35 Brix. This shows that the concentration of soil amendment also has a significant effect on the sweetness of the fruit. The sweetness level of the fruit seems to be connected to the availability of potassium in the soil. The P3 treatment showed that the K concentration in the soil was higher than the other treatments so that the fruit produced was sweeter than the other treatments. Increasing the nutrient potassium by plants can help increase sugar levels in plants (Firmansyah, 2018).

CONCLUSION

The concentration of soil amendment affects the nutrient content in the soil, plant growth, and yield of Seedless watermelon. The P3 concentration (12.5 ml/liter) consistently gave better results in terms of soil N, P, K availability, plant height, fruit weight, and fruit sweetness.

SUGGESTION

Further research needs to be carried out to better understand the effect of soil amendment concentration on the population growth of microorganisms in the soil as well as the uptake of N, P, K elements by plants.

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