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Application of Combined Manure and Potassium Sulfate on The Vegetative Growth of Rose Apple (*Syzygium aqueum*)

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ABSTRACT
Rose apple is one of the horticultural commodities favored by the Indonesian people. Cultivation using planter bags is popular due to several advantages, such as faster fruiting and shorter plants, making them easier to harvest. Proper care, especially in the use of organic and inorganic fertilizers, greatly influences the results expected by farmers. This study aims to determine the effect of the combination of manure and potassium sulfate on plant height, stem diameter, number of new leaf shoots, and leaf greenness. The research was conducted using quantitative methods with observations every 14 days. The results showed that the combination of fertilizers affected the number of new leaf shoots on rose apple plants (Syzygium aqueum). The best treatment was KH6 (100 grams of potassium sulfate, 200 grams of goat manure, and 200 grams of cow manure), but it was not significantly different from KH2 (150 grams of potassium sulfate, 250 grams of goat manure, and 250 grams of cow manure) and KH8 (150 grams of potassium sulfate, 150 grams of goat manure, and 150 grams of cow manure). The combination of fertilizers also affected leaf greenness at 14 DAT but did not affect it at 28 DAT and 42 DAT. The H2 treatment (200 grams of goat manure and 200 grams of cow manure) produced the greenest leaves compared to all other treatments but was not significantly different from KH3 (100 grams of potassium sulfate, 250 grams of goat manure, and 250 grams of cow manure).

***Keywords**: Rose Apple, Goat Manure, Cow Manure, Potassium Sulfate Fertilizer*

INTRODUCTION
Rose apple (*Syzygium aqueum*) is a highly productive fruit plant capable of bearing fruit throughout the year. It thrives at altitudes between 0-500 meters above sea level, producing 200-360 fruits per tree annually, with each fruit weighing 150-200 g. The fruit is crisp and contains 81.59% rose apple, 12.4˚Brix sugar content, and 210.463 mg/100 g of vitamin C, according to studies. To ensure high-quality fruit, it is essential to perform annual pruning, which involves trimming secondary and tertiary branches and reducing the number of leaves to allow sunlight to reach the flowering parts. Rose apple (*Syzygium aqueum*) is a fruit plant with high productivity and the ability to bear fruit year-round. It has crisp flesh and grows well at altitudes of 0-500 meters above sea level, producing 200-360 fruits per tree annually, with each fruit weighing 150-200 g. Studies show that rose apple contains 81.59% rose apple, 12.4˚Brix sugar content, and 210.463 mg/100 g of vitamin C. To produce high-quality fruit, annual pruning is necessary, including trimming secondary and tertiary branches and reducing leaf count to ensure sunlight reaches the flowering parts (Afidah et al., 2018).

Generally, rose apple plants prefer soil that can be classified as fertile, supported by organic materials, with good drainage and aeration, as well as being loose and friable. Rose apple has become one of the favored fruit horticultural commodities among the Indonesian populace. Its distinctive crisp and fresh texture makes it suitable for consumption at any time. The continuous rise in demand for rose apples has led to an annual increase in production in Indonesia (Nurnimah et al., 2020).

Cultivation using planter bags is widely favored due to several advantages. Rose apple plants grown in bag-shaped containers, known as planter bags, aim to produce fruit more quickly and maintain a manageable height for easy harvesting. Proper care and fertilization greatly influence the expected yield for farmers (Nafi'ah & Royani, 2018).

Organic fertilizers can extend the shelf life of fruit and do not leave chemical residues on them, making them safe for consumption. They also have higher nutritional content and richer flavor. One of the most commonly used organic fertilizers is manure, which can be sourced from various animals such as goats, cows, and others.

Potassium sulfate fertilizer (K2SO4) has the potential to enhance the vegetative growth process and stem quality of rose apple plants. Being highly soluble in rose apple, potassium sulfate aids in the optimal growth of rose apple plants. Despite limited research on the benefits of potassium sulfate for rose apple plants and its limited awareness among the public, ensuring an adequate supply of this element will be crucial for the vegetative growth of rose apple plants (Karamina et al., 2022).

MATERIALS AND METHOD

Research Location

This research was conducted from May to July 2023 at the experimental garden of Pondok Pesantren Fathul Ulum, Puton Village, Diwek District, Jombang Regency, East Java, Indonesia.

Research Tools and Materials

The tools used in this research were a meter, hoe, sickle, shovel, bucket, sack, glass, plant scissors, scale, stationery, ruler, label paper, and HP camera. The materials used were rose apple plants under 3 years old, manure including goat and cow dung, Meroke SOP/potassium sulfate fertilizer.

Research Method

The design used in this research was a completely randomized design (RAL) with 15 treatments and 3 replications, conducted on a plot of land measuring 50 × 50 m. Each planter bag was treated with one plant, resulting in a total of 45 rose apple plants. The distance between each replication was 200 cm, and the distance between each treatment was also 200 cm.

Table 1. Sample of Layout

H1 ★ B A	KH5 ★ B A	H1 ★ A
H2 ★ B A	KH1 ★ B A	K3 ★ A
H3 ★ B A	KH4 ★ B A	K2 ★ A
K1 ★ B A	KH3 ★ B A	H3 ★ A
K2 ★ B A	KH2 ★ B A	K1 ★ A
K3 ★ B A	KH9 ★ B A	H2 ★ A
KH1 ★ B A	KH7 ★ B A	KH5 ★ A
KH2 ★ B A	KH6 ★ B A	KH1 ★ A
KH3 ★ B A	KH8 ★ B A	KH4 ★ A
KH4 ★ B	H3 ★ B	KH3 ★

Observations

Were conducted on several parameters as follows:

1. Plant Height (cm) Plant height was measured four times, namely before treatment and after fertilizer treatment at 14 HSP (observation 1), 28 HSP (observation 2), and 42 HSP (observation 3). Measurements were taken from the base of the planter bag to the top of the tallest plant.
2. Stem Diameter (mm) Stem diameter was measured four times, namely before treatment and after fertilizer treatment at 14 HSP (observation 1), 28 HSP (observation 2), and 42 HSP (observation 3). Measurements were made using a caliper to monitor plant growth and development.
3. Number of New Leaf Shoots (Pieces) Observations were made since the fertilizer treatment began.

New leaf shoots were considered to have emerged if there were small protrusions on the surface of the explants pointing upwards.

4. Leaf Green Color Observations of leaf green color were conducted since the fertilizer treatment began. Leaf color was measured using a leaf color chart experiment used in the fertilizer treatment. Color comparison was made with the leaf color chart scale from 14 days after the first treatment until the end of the study.

Data Analysis

The data were analyzed using ANOVA with a significance level of 95% ($\alpha = 0.05$). If there are differences among the fertilizer treatment combinations, post-hoc tests will be conducted. If the calculated F-value is greater than the tabulated F-value, then the Least Significant Difference (LSD) test will be performed at a significance level of 5%. If the calculated F-value is less than the tabulated F-value, there is no need to proceed with the LSD test because there is no influence of fertilizer combination on the vegetative growth of rose apple (Erythrina, 2016).

RESULT AND DISCUSSION

According to the findings from observations made between May and July, four factors were observed: the height of the plants, the diameter of the stems, the number of new leaf buds, and the green color of the leaves. The height of the plants shiwed in the figure below:

Table 1. The Average Height Of Rose Apple Plants Treated With A Combination Of Manure And Potassium Sulfate

Treatment	Plant Height (cm)		
	14 DAT	28 DAT	42 DAT
K1	291,00	296,00	300,00
K2	296,66	298,00	302,33
K3	295,00	296,33	298,66
H1	284,66	287,66	295,33
H2	295,66	298,33	305,33
H3	299,00	301,00	303,66
KH1	304,00	307,00	311,33
KH2	279,66	282,00	287,00
KH3	287,33	288,66	292,33
KH4	282,00	284,00	289,66
KH5	288,00	292,00	294,66
KH6	293,33	295,00	296,33
KH7	300,33	303,00	305,33
KH8	282,00	285,00	290,00
KH9	288,66	291,00	293,33
KK	0,0795	0,0785	0,0755
BNT	TN	TN	TN

TN : Not Significant

From the observations, the height of rose apple plants under the treatment of manure concentration and potassium dosage did not significantly affect plant growth. The results indicated no significant difference at 14 days after treatment (DAT). Treatment KH1 (potassium sulfate fertilizer 200 grams, goat manure 250 grams, and cow manure 250 grams) showed the best result with an average of 304.00. Meanwhile, treatments KH4 (potassium sulfate fertilizer 200 grams, goat manure 200 grams, and cow manure 200 grams) and KH8 (potassium sulfate fertilizer 150 grams, goat manure 150 grams, and cow manure 150 grams) had the lowest results with the same average, which is 282.00.

Prolonged drought, temperature, and environmental conditions have a significant impact. High organic matter content in the soil can render fertilizers ineffective (Rahardjo et al., 2020). According to (Islam et al., 2017), fertilizers may not work well due to dry weather conditions and insufficient rose apple, which is crucial for vegetative growth. Rose apple deficiency leads to stunted plant growth.

Table 2. The Average Stem Diameter Of Rose Apple Plants Treated With A Combination Of Manure And Potassium Sulfate

Treatment	Stem Diameter (mm)		
	14 DAT	28 DAT	42 DAT
K1	78,91	78,96	78,96
K2	73,27	73,30	73,30
K3	70,49	70,57	70,57
H1	74,28	74,30	74,30
H2	68,10	68,13	68,13
H3	73,46	73,49	73,49
KH1	78,06	78,08	78,08
KH2	74,18	74,22	74,22
KH3	74,92	74,96	74,96
KH4	77,04	77,07	77,07
KH5	76,54	76,56	76,56
KH6	78,13	78,19	78,19
KH7	77,09	77,12	77,12
KH8	79,34	79,37	79,37
KH9	71,47	71,49	71,49
KK	0,07	0,07	0,07
BNT	TN	TN	TN

TN : Not Significant

From observations of stem diameter under the treatment of manure concentration and potassium fertilizer dosage at 14 DAT, KH8 (150 grams of potassium sulfate fertilizer, 150 grams of goat manure, and 150 grams of cow manure) showed an average of 79.34, but it was not significantly different from K1, KH1, and KH6. The treatment with the lowest result was H2 (200 grams of goat manure and 200 grams of cow manure) with an average of 68.10. At 28 DAT, KH8 still showed the highest average with 79.37, while H2 had the lowest average with 68.13. The same pattern was observed at 42 DAP, where the treatment of manure concentration and potassium sulfate fertilizer dosage yielded similar results and did not differ significantly from previous treatments.

Table 3. The Average Number of New Leaf Shoots of Rose Apple Plants Treated with a Combination of Fertilizer and Potassium Sulfate

Treatment	The Number of New Leaf Shoots		
	14 DAT	28 DAT	42 DAT
K1	9,66	13,66	17,66
K2	13,00	15,00	19,33
K3	13,00	15,00	16,33
H1	12,33	14,66	16,00
H2	17,00	18,66	19,66
H3	9,33	12,66	18,33
KH1	15,66	17,33	19,00
KH2	17,66	20,33	26,33
KH3	15,33	18,00	22,66
KH4	14,66	17,33	23,66
KH5	17,66	19,33	23,66
KH6	15,33	17,66	26,66
KH7	14,33	18,33	20,33
KH8	16,00	18,00	24,66
KH9	13,66	15,33	22,66
KK	0,02	0,02	0,18
BNT	TN	TN	2,86

Observations on rose apple plants showed the highest number of new leaf shoots in the KH6 treatment, averaging 26.67, similar to 26.33 in related treatments. The lowest number, averaging 16.00, was in the H1 treatment. Data was collected 42 days after treatment. Slow shoot growth is due to apical dominance, where the terminal bud inhibits lateral shoot growth. Pruning apical shoots and applying fertilization treatments promote lateral growth and improve overall plant growth.

(Qowiyah Ula et al., 2018) stated that pruning can stimulate vegetative growth in rose apple plants (*Syzygium aqueum*) when accompanied by fertilizers that promote generative growth. Nutrients in fertilizers have a positive effect on the growth and development of rose apple plants, especially on new leaf shoots. The fertilizer levels have already shown a beneficial impact on the number of new leaf shoots, and manure contains higher nutrients, resulting in a higher average number of leaves with manure treatment (Suryani & Rubianti, 2023). Potassium sulfate also plays an important role in the vegetative growth of rose apple; about 25% is found in the rose apple seeds after harvest, and then in the stems. Additionally, potassium sulfate fertilizer contains sulfur, which is needed by plants as a macronutrient to enhance vegetative growth (Aziz et al., 2014). According to (Raksun et al., 2019), the use of organic fertilizers can increase nutrient content and improve soil structure by stimulating the development of soil microorganisms.

On day 42 after treatment, significant differences were observed between treatments KH6 and KH8 compared to KH9, KH7, H3, and H1. The combination of potassium sulfate and manure significantly affected the number of new leaf shoots in rose apple plants, which in turn influenced potassium sulfate absorption. Treatments with smaller amounts of manure had the lowest absorption, while KH6 (100g potassium sulfate, 200g goat manure, 200g cow manure) showed the highest average, though not significantly different from KH2 (150g potassium sulfate, 250g goat manure, 250g cow manure).

Plants absorb potassium sulfate in amounts exceeding their needs. The absorption of potassium sulfate from soil solution by plants is influenced by several factors, including soil texture, soil moisture and temperature, soil pH, and the availability of oxygen in the soil (Mengel and Kirkby, 1980 The (Ernawati, 2015)). The growth of new leaf shoots is influenced by the availability of sufficient soil nutrients. Adequate nutrients lead to more new shoots, suggesting genetic factors are more influential than environmental ones. Thus, providing optimal nutrient levels can enhance photosynthesis and plant growth.

Table 4. Summary of ANOVA for the Number of New Leaf Shoots at 42 DAT

SK	DB	JK	KT	Fhit	Ftab		Ket
					0,05	0,01	
Treatment	14	502,53	35,90	2,62	2,31	2,74	**
Galat/Residual	30	410,67	13,69				
Total	44	913,20					

** : Significantly Different

The ANOVA analysis results show that the calculated F value for the treatment (2.62) is greater than the F table value at 0.05 (2.31), indicating that the concentration of manure and the dose of potassium sulfate significantly affect the number of new leaf shoots in the vegetative growth of rose apple plants at 42 DAT. The nutrients in the fertilizer have a positive effect on growth and development, especially on the new leaf shoots of rose apple plants. The fertilizer concentration has shown a beneficial impact on the number of new leaf shoots, with manure having higher nutrient content, resulting in a higher average number of leaf shoots.

Potassium sulfate plays an important role in the vegetative growth of rose apple. About 25% of the potassium sulfate is contained in the seeds of the rose apple after harvest, then it spreads to the stems. Additionally, potassium sulfate fertilizer also contains sulfur, which is needed by plants as a macronutrient to enhance vegetative growth. The use of organic fertilizer can increase nutrient content and improve soil structure by stimulating the development of microorganisms in the soil. The treatment of manure concentration and potassium dosage on the vegetative growth of rose apple at 42 DAT significantly affects the number of leaf shoots and is further tested with BNT notation.

Table 5. The Average Number of New Leaf Shoots of Rose Apple Due to Manure and Potassium Sulfate Dosage Treatment

Treatment	Average	Treatment + BNT	Notatios
H1	16,00	18,86	a
K3	16,33		a
K1	17,67		a
H3	18,33	21,19	ab
KH1	19,00		b
K2	19,33		b
H2	19,67		b
KH7	20,33	23,19	bc
KH3	22,67		c
KH9	22,67	25,52	cd
KH4	23,67		d
KH5	23,67		d
KH8	24,67	27,52	de
KH2	26,33		e
KH6	26,67		e

Based on the BNT test results on day 42, significant differences were found between treatments KH6 and KH8 compared to KH9, KH7, H3, and H1. The combination of potassium sulfate fertilizer and manure significantly affected the number of new leaf shoots on water guava plants. Treatments with lower amounts of goat and cow manure resulted in the lowest fertilizer absorption. Conversely, the KH6 treatment (100 grams potassium fertilizer, 200 grams goat manure, and 200 grams cow manure) showed the highest average, though not significantly different from KH2 (150 grams potassium sulfate, 250 grams goat manure, and 250 grams cow manure).

Table 6. The Average Green Color of Leaves in Rose Apple Plants Treated with a Combination of Fertilizer and Potassium Sulfate

Treatment	Leaf Color (BWD)		
	14 DAT	28 DAT	42 DAT
K1	3,50	3,50	4,50
K2	3,33	3,67	4,33
K3	4,00	4,33	4,33
H1	4,17	4,67	4,50
H2	4,83	4,83	5,00
H3	2,83	3,83	4,17
KH1	3,33	3,50	4,17
KH2	2,67	3,67	4,00
KH3	4,67	4,33	4,83
KH4	4,00	4,50	4,50
KH5	3,00	3,67	4,50
KH6	2,67	3,83	4,00
KH7	2,83	3,33	3,67
KH8	4,33	3,67	4,33
KH9	4,33	4,33	4,67
KK	0,15	0,01	0,01
BNT	0,55	TN	TN

TN : Not Significant

Observations of the rose apple leaf color indicated that varying fertilizer concentrations and doses significantly impacted the green color of the leaves at 14 DAT. Data analysis showed that the H2 treatment had an average color rating of 4.83, which was not significantly different from KH3 with an average of 4.67, but was significantly different from KH8 and KH9, each with an average of 4.33. Meanwhile, the treatments with the lowest manure concentration and potassium dose were KH2 and KH6, both with an average of 2.67. No significant differences were observed at 28 and 42 days after treatment.

This indicates that different treatments in terms of manure concentration and potassium dosage significantly affect the green color of rose apple leaves at 14 DAT. This is due to the involvement of potassium sulfate in vegetative growth, which aids in the formation of green leaf color and increases protein and vitamin content in the harvest, crucial for sugar production. Potassium sulfate also plays a key role in reducing rose apple evaporation, thereby enhancing the plant's resistance to drought and disease infection (Nurcahyani et al., 2020).

The combination of manure with potassium sulfate fertilizer in KH8 (150 grams of potassium sulfate, 150 grams of goat manure, and 150 grams of cow manure) and KH9 (100 grams of potassium sulfate, 150 grams of goat manure, and 150 grams of cow manure) effectively provides the necessary nutrients for the plants, resulting in a change in leaf green color. The combination of manure and potassium sulfate can provide the necessary nutrients for plant growth (Suhaeni & Sutaiman, 2022). Similarly, the daily average temperature in Jombang ranges from 28 to 39 ºC. The findings of this study align with those reported by Santi et al. in 2023, which stated that light intensity significantly affects.

The findings of this study align with (Qowiyah Ula et al., 2018), who stated that when plants have adequate nutrients such as nitrogen (N), phosphorus (P), and potassium (K) from goat and cow manure, the leaves become greener and the protein levels in plant tissues improve. The addition of potassium sulfate enhances the plant's ability to absorb nutrients, which in turn accelerates plant growth. With sufficient potassium sulfate, plant roots grow deeper, allowing them to extract rose apple from deeper soil layers.

Table 7. Summary of ANOVA for the Number of Green Leaves at 14 DAT

SK	DB	JK	KT	Fhit	Ftab		Ket
					0,05	0,01	
Treatment	14	23,37	1,67	6,01	2,04	2,74	*
Galat/Residual	30	8,33	0,28				
Total	44	31,70					

* : Significantly Different

The results of the Anova analysis indicate that the F-value for treatment (2.62) exceeds the critical F-value at the 0.05 significance level (2.31), indicating a significant influence of variation in manure concentration and potassium dosage on the green leaf color of rose apple plants at 14 DAT. The involvement of potassium sulfate in the vegetative growth of plants aids in the formation of green leaf color, increases protein and vitamin content in the harvest, and reduces rose apple evaporation, thereby enhancing plant resilience to drought and disease.

Leaf color change serves as a crucial indicator of plant health and quality, reflecting optimal nutrient absorption and suitable environmental conditions. Variations in manure concentration and potassium dosage also significantly impact the number of new leaf shoots at 14 DAT, as confirmed by further post-hoc testing with notation.

The combination of manure and potassium sulfate has been proven to provide optimal nutrition for plant growth, as mentioned by (Suhaeni & Sutaiman, 2022). Additionally, it is worth noting that the average daily temperature in the Jombang area ranges from 28 to 39 ºC. This finding indicates that the climate conditions in the area tend to be hot, which can affect the growth and development of plants. Previous research by Santi and her team in 2023 affirmed that light intensity has a significant impact on several plant growth parameters, including stem diameter, leaf greenness, and the number of new leaf shoots. This suggests that environmental factors such as light also play a crucial role in regulating plant growth in regions with high temperatures like Jombang.

Table 8. The Average Green Leaf Color of Rose Apple After Treatment with Manure Concentration and Potassium Sulfate Dosage

Treatment	Average	Treatment + BNT	Notatios
KH2	2,666666667	3,07	a
KH6	2,666666667		a
H3	2,833333333		a
KH7	2,833333333		a
KH5	3	3,41	ab
K2	3,333333333		b
KH1	3,333333333	3,74	bc
K1	3,5	3,91	c
K3	4	4,41	d
KH4	4		d
H1	4,166666667		d
KH8	4,333333333		d
KH9	4,333333333	4,74	de
KH3	4,666666667	5,07	ef
H2	4,833333333		f

The combination of manure along with the dosage of potassium sulfate in KH8 (150 grams of potassium sulfate fertilizer, 150 grams of goat manure, and 150 grams of cow manure) and KH9 (100 grams of potassium sulfate fertilizer, 150 grams of goat manure, and 150 grams of cow manure) can provide the necessary nutrients for plants, which affects the change in leaf greenness.

Various applications of treatments and combinations show better results than relying solely on one type of fertilization treatment or minor variations in treatment combinations. The intensity of the fertilizer concentration's effect on leaf color increases, which also has a positive impact on the plant's photosynthesis process and ultimately affects fruit production. Although plants can grow normally, their success depends on the availability of the right nutrients in optimal and balanced amounts in the soil.

This finding is supported by a study conducted by (Sedo et al., 2019), which suggests that the nitrogen content in manure can enhance leaf greenness. This is consistent with the assertion of Setyanti et al. (2013), who state that nitrogen plays a role in chlorophyll formation, resulting in green leaves. Plants deficient in nitrogen tend to experience chlorosis, or pale yellow leaves, while those with excess nitrogen will have dark green leaves. Furthermore, (Firmansyah et al., 2022) also assert that the vegetative growth of plants can be improved by the application of fertilizers containing phosphorus and potassium sulfate.

CONCLUSIONS

The combination of fertilizers did not affect the height and stem diameter of rose apple plants (*Syzygium aqueum*) in any of the treatments. However, the combination of fertilizers did affect the number of new leaf shoots, with the best treatment being KH6 (100 grams of potassium sulfate, 200 grams of goat manure, and 200 grams of cow manure), although it was not significantly different from KH2 (150 grams of potassium sulfate, 250 grams of goat manure, and 250 grams of cow manure) and KH8 (150 grams of potassium sulfate, 150 grams of goat manure, and 150 grams of cow manure). The combination of fertilizers influenced the green leaf color at 14 DAT, but not at 28 and 42 DAT. The H2 treatment (200 grams of goat manure and 200 grams of cow manure) produced the greenest leaves compared to other treatments, although it was not significantly different from KH3 (100 grams of potassium sulfate, 250 grams of goat manure, and 250 grams of cow manure).

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