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Response of Tomato Varieties and Organic Mulch on Growth and Products of Tomato (*Lycopersicum esculentum* Mill)

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Abstract: Tomato plants are one of the most important vegetables after potatoes, eggplants, and chilies. Tomatoes can be eaten raw, they are also used as a flavoring ingredient in dishes, vegetables or made into soy sauce and sauces. the need for tomato plants is increasing every year. which type of organic mulch and variety is more appropriate for the growth of tomato plants, and how does the response of the three varieties of tomato plants to the type of organic mulch in increasing the growth and yield of tomato plants? Based on the description above, this study aimed to determine the best variety and type of organic mulch suitable for maximum growth and yield of tomato plants, as well as whether there was interaction between the two factors studied. This study used a 3 x 3 factorial Randomized Block Design (RBD) with 3 replications, so there were 27 experimental combinations. There are two factors studied, namely the variety factor (V) and the organic mulch factor (M). The results of this study that the variety of tomatoes has a very significant effect on Plant height (cm), Diameter of stem base (cm), Number of fruits per plant (fruit), Fruit weight per plant (g), Tomato fruit diameter (cm), Fruit weight (g). Organic mulch had no significant effect on Plant height (cm), Diameter of stem base (cm), Number of fruits per plant (fruit), Fruit weight per plant (g), Tomato fruit diameter (cm), and Fruit weight (g). The responses of the three tomato varieties were not significantly different to changes in the type of organic mulch in increasing the growth and yield of tomato plants.

Keywords: Organic mulch; Tomato plants; Variety of tomatoes

Introduction

The tomato plant (*Lycopersicum esculentum* Mill.) is a native plant from the Americas that is spread from Central America to South America. This plant was first cultivated by the Incas and Aztecs in 700 BC. The spread of tomatoes in Indonesia came from the Philippines and other Asian countries, namely in the 18th century. At first, the tomatoes that were planted for the first time still bore little fruit and their productivity was still low. But now, tomatoes produce a weight of up to 60 g per fruit or 5-8 kg of fruit per plant (Agius et al., 2022).

Tomato plants are one the most important vegetables after potatoes, eggplants, and chilies (Mahlangu et al., 2022). Tomatoes can be eaten raw, they are also used as a flavoring ingredient in dishes, vegetables or made into soy sauce and sauces. 100 g of tomatoes contains 94.1% water; energy 19 calories; proteins 1 g; fat 2 g; carbohydrates 4.1 g; fiber 0.8 g; ash 0.6 g; calcium 18 mg; iron 0.8 mg; Sodium 4 mg; potassium 266 mg; vitamin A 735 IU; B vitamins 0.06 mg; vitamin B2 0.04 mg; niacin 0.60 mg; and vitamin C 29 mg.

Varieties are part of a type of plant that is characterized by plant shape, leaf growth, fruit, flowers, and other characteristics that can be distinguished from other varieties of the same plant type (Ievinsh, 2023). In addition, variety is also one of the factors that determine the growth and yield of tomato plants. According to (Dhanaraju et al., 2022), advances in science and technology in agriculture have produced companies in the field of genetics, until finally new varieties have been discovered, not limited only to quantity, but the quality of the yield.

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Several varieties of tomatoes can be cultivated in lowland areas, namely Jelita, Permata, and Rempai varieties. These three varieties are determinate (the stems are erect and sturdy), early maturing, can be harvested at 70 - 80 days after planting, and have a yield potential of 4 kg per plant. In addition, the Jelita F1 variety is sensitive to Fusarium, Verticillium and tolerant to Alternaria. While the Permata F1 variety is tolerant to bacterial wilt and Tomato Mosaic Virus (TMV). The use of superior seeds must be accompanied by improving the environment for plant growth. One effort to improve the environment is to manipulate the environment for growing plants, namely by mulching agricultural land with certain materials (Kader et al., 2017).

Mulch is a ground cover material used in horticultural farming. Mulch can be grouped into three namely organic mulch, inorganic mulch, and synthetic mulch. Organic mulch comes from agricultural waste materials such as straw and leaves. Inorganic mulch comes from rock materials in various shapes and sizes such as gravel, and synthetic chemical mulch comes from plastic materials such as silver-black plastic mulch (El-Beltagi et al., 2022). According to Mu et al. (2023) the effect of using mulch on the soil environment varies, depending on the type and amount of mulch given. The recommended thickness of the organic mulch layer is between 4 - 10 cm (Wang et al., 2021). Mulch that is too thin will be less effective at controlling weeds (Nwosisi et al., 2019).

The rate of water loss through mulch is slower when compared to exposed soil. This is because evaporation is hindered by the thickness of the mulch that is applied over the soil surface. Mulch functions as an insulator that can reduce heat fluctuations on the soil surface, and suppress weed growth. Giving mulch will also affect the physical and biological properties of the soil (Rahmani et al., 2021). Applying straw and rice husk mulch will provide a good growth environment for plants because it can reduce evaporation, (Garnida et al., 2022) prevent excessive direct sunlight on the soil, and soil moisture can be better maintained so that plants can absorb water and nutrients properly (Iqbal et al., 2020). Based on the description above, this study aimed to determine the best variety and type of organic mulch suitable for maximum growth and yield of tomato plants, as well as whether there was interaction between the two factors studied.

Method

This study used a 3 x 3 factorial Randomized Block Design (RBD) with 3 replications, so there were 27 experimental combinations. There are two factors studied, namely the variety factor (V) and the organic mulch factor (M). The variety factor (V) consists of 3 levels, namely:
V1 = Beautiful
V2 = Gems
V3 = Rempai
The organic mulch factor (M) consists of 3 levels, namely:
M0 = No Mulch
M1 = Rice Straw
M2 = Rice Husk

Observations made are Plant height (cm), Diameter of stem base (cm), Number of fruits per plant (fruit), Fruit weight per plant (g), Tomato fruit diameter (cm), and Fruit weight (g).

Result and Discussion

Effect of Tomato Varieties

The results of the F test on the analysis of variance (Appendix with even numbers 2 to 20) show that the tomato variety factor has a very significant effect on plant height aged 20, 40, and 60 days after planting (DAP), number of fruits per plant, fruit weight per plant, diameter fruit and fruit weight of tomatoes, and had no significant effect on stem diameter at 20, 40 and 60 DAP.

Plant Height (cm)

The average height of tomato plants at the age of 20, 40, and 60 HST with tomato varieties after being tested BNJ0.05 can be seen in Table 2.

Table 1. The Average Height of Plants Aged 20, 40, and 60 DAP with Tomato Varieties

		Plant Height (cm)		
Symbol	Variety	20 DAP	40 DAP	60 DAP
V_1	Jelita	29.11 b	67.53 b	102.06 b
V_2	Permata	26.89 b	73.11 b	98.06 b
V_3	Rempai	19.11 a	52.03 a	70.39 a
	$BNJ_{0.05}$	5.84	8.47	8.62

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% probability level (BNJ test 0.05).

Table 1 shows that the average height of tomato plants at t he ages of 20 and 60 HST was found in the Jelita variety (V1), namely 29.11 cm and 102.06 cm, which were not significantly different from the Permata variety (V2) and significantly different from the Rempai variety (V3). The lowest tomato plants were found in the Rempai variety (V3), namely 19.11 cm and 70.39 cm. Whereas when the plants were 40 HST the Permata variety (V2) had a plant height of 73.11 cm compared to the Rempai (V3) and not significantly different from the Jelita variety (V1). The Rempai variety (V3) had the

lowest plant, namely 52.03 cm. The relationship between plant height at 20, 40, and 60 DAP with the treatment of tomato varieties can be seen in Figure 1.

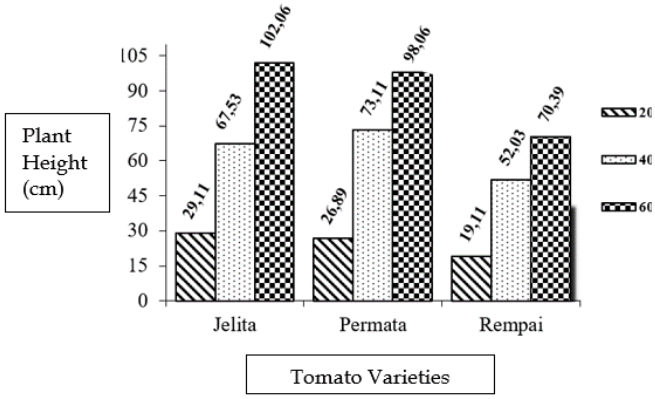

Figure 1. Plant height aged 20, 40, and 60 HST with the treatment of tomato varieties

Stem Diameter (cm)

The average stem diameter at 20, 40, and 60 DAP with the treatment of tomato varieties can be seen in Table 2.

Table 2. Average Stem Diameter at 20, 40, and 60 DAP with the Treatment of Tomato Varieties

		Stem Diameter (cm)		
Symbol	Variety	20 DAP	40 DAP	60 DAP
V_1	Jelita	0.78	1.06	1.17
V_2	Permata	0.74	1.05	1.13
V_3	Rempai	0.66	0.97	1.09

Table 2 shows that the average stem diameter at 20, 40, and 60 DAP tends to be larger for the Jelita (V1) variety, namely 0.78 cm, 1.06 cm, and 1.17 cm compared to the Permata (V2) and Rempai variety (V3). While the Rempai variety (V3) has the smallest diameter at the base of the stem. The relationship between the diameter of the base of the stem at the age of 20, 40, and 60 HST with the treatment of tomato varieties can be seen in Figure 2.

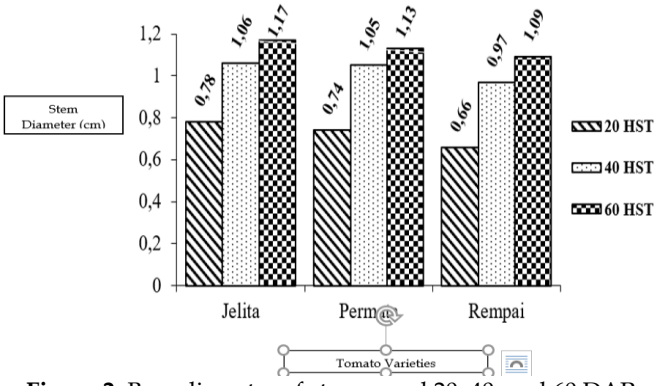

Figure 2. Base diameter of stems aged 20, 40, and 60 DAP with the treatment of tomato varieties

Number of Fruits per Plant (fruit)

Table 3. The Average Number of Fruits per Plant with the Treatment of Tomato Varieties

Symbol	Variety	Number of Fruits Per Plant (fruit)
V_1	Jelita	4.79 a
V_2	Permata	5.91 b
V_3	Rempai	7.47 c
$BNJ_{0.05}$		0.70

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% probability level (BNJ test 0.05).

The average number of fruits per plant with the treatment of tomato varieties after being tested BNJ0.05 can be seen in Table 3. Table 3 shows that the highest average number of tomatoes was in the Rempai variety (V3) which was 7.47 which was significantly different from the Jelita variety (V1) and the Permata variety (V2). The Jelita variety (V1) had the lowest number of fruits, namely 4.79 fruit. The relationship between the number of fruits per plant and the treatment of tomato varieties can be seen in Figure 3 below.

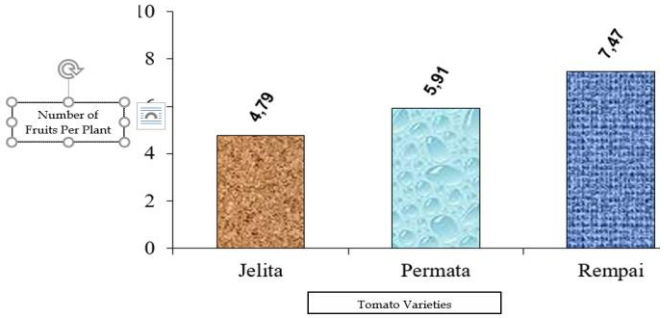

Figure 3. The number of fruits per plant with the treatment of tomato varieties

Fruit Weight per Plant (g)

Table 4. Average Fruit Weight per Plant with the Treatment of Tomato Varieties

Symbol	Variety	Fruit Weight Per plant (g)
V_1	Jelita	834.03 b
V_2	Permata	75.03 b
V_3	Rempai	180.99 a
$BNJ_{0.05}$		122.40

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% probability level (BNJ test 0.05).

The average fruit weight per plant with the treatment of tomato varieties after being tested with BNJ0.05 can be seen in Table 4. Table 4 shows that the fruit weight per tomato plant found in the Jelita variety (V1) reached 834.03 g which was significantly different from the Rempai variety (V3) and not significantly

different from the Permata variety (V2). While the lightest tomato fruit was found in the Rempai variety (V3), which was 180.99 g. The relationship between fruit weight per plant and the treatment of tomato varieties can be seen in Figure 4.

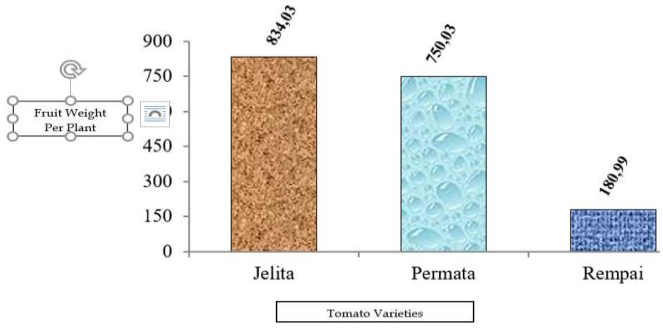

Figure 4. Fruit weight per plant on the treatment of tomato varieties

Fruit Diameter (cm)

Table 5. Average Fruit Diameter by Treating Tomato Varieties

Symbol	Variety	Fruit Diameter (cm)
V_1	Jelita	5.26 c
V_2	Permata	4.30 b
V_3	Rempai	2.67 a
$BNJ_{0.05}$		0.22

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% probability level (BNJ test 0.05).

The average fruit diameter with the treatment of tomato varieties after being tested with BNJ0.05 can be seen in Table 5. From Table 5 it can be seen that the largest average diameter of tomatoes is found in the Jelita variety (V1), which is 5.26 cm, which is significantly different from the Rempai variety (V3) and the Permata variety (V2). While the Rempai variety (V3) has the smallest diameter, which is 2.67 cm. The relationship between fruit diameter and the treatment of tomato varieties can be seen in Figure 5.

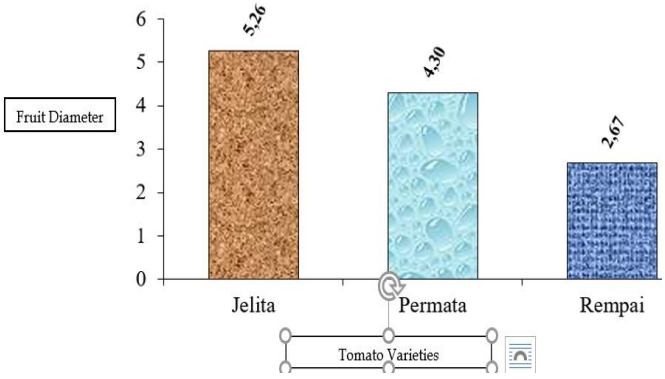

Figure 5. Fruit diameter by treatment of tomato varieties

Fruit Weight (g)

Table 6. Average Fruit Weight in the Treatment of Tomato Varieties Conclusion

Symbol	Variety	Fruit Weight Per plant (g)
V_1	Jelita	834.03 b
V_2	Permata	75.03 b
V_3	Rempai	180.99 a
$BNJ_{0.05}$		122.40

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% probability level (BNJ test 0.05).

The average fruit weight with the treatment of tomato varieties after being tested with BNJ0.05 can be seen in Table 6. Table 6 shows that the average fruit weight of the tomatoes found in the Jelita variety (V1) reached 60.99 g which was significantly different from the Permata variety (V2) and the Rempai variety (V3). While the Rempai variety (V3) had the lowest weight, namely 12.09 g. The relationship between fruit weight and the treatment of tomato varieties can be seen in Figure 6.

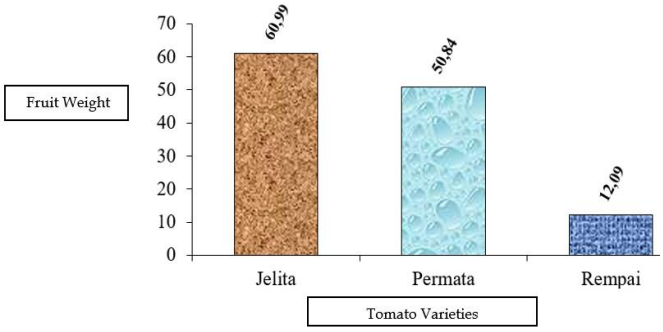

Figure 6. Fruit weight by treatment of tomato varieties

Effects of Organic Mulch

The results of the F test on the analysis of variance (Appendix with even numbers 2 to 20) showed that the use of organic mulch had no significant effect on plant height aged 20, 40, and 60 DAP, stem diameter at 20, 40 and 60 DAP, number of fruits per plant, weight fruit per plant, fruit diameter and fruit weight of tomatoes. Plant Height (cm). The average height of tomato plants aged 20, 40, and 60 DAP with organic mulch can be seen in Table 7.

Table 7. The average height of tomato plants aged 20, 40, and 60 DAP with organic mulch.

		Plant Height (cm)		
Symbol	Mulsa	20 DAP	40 DAP	60 DAP
M_0	No Mulch	24.19	64.81	88.86
M_1	Straw	25.33	62.64	89.56
M_2	Rice Husk	25.58	65.22	92.08

Table 8 shows that the average height of tomato plants aged 20, 40, and 60 DAP tends to be higher in the use of rice husk (M2) than in the use of straw mulch (M1) and without mulch (M0).

Stem Diameter (cm)

The average diameter of the base of the stems aged 20, 40, and 60 DAP with organic mulch can be seen in Table 8.

Table 8. The Average Diameter of Tomato Stem Base at 20, 40, and 60 DAP with Organic Mulch

		Stem Diameter (cm)		
Symbol	Mulsa	20 DAP	40 DAP	60 DAP
M_0	No Mulch	0.65	0.99	1.10
M_1	Straw	0.71	1.05	1.13
M_2	Rice Husk	0.80	1.06	1.16

Table 8 shows that the diameter of the base of the stems aged 20, 40, and 60 DAP tends to be greater when using Rice Husk (M2) mulch compared to using Without Mulch (M0) and Straw (M1).

Number of Fruits per Plant (Fruit)

The average number of fruits per tomato plant with organic mulch can be seen in Table 9.

Table 9. The Average Number of Fruits per Tomato Plant with Organic Mulch

Symbol	Mulsa	Number of Fruits Per Plant (fruit)
M_0	No Mulch	6.17
M_1	Straw	5.66
M_2	Rice Husk	6.33
$BNJ_{0.05}$		6.17

Table 9 shows that the number of fruits per tomato plant tends to be higher with the use of Rice Husk (M2) reaching 6.33 fruits compared to the use of Without Mulch (M0) and Straw (M1). While the use of Straw mulch (M1) has a small number of pieces, namely 5.66 pieces.

Fruit Weight per Plant (g)

The average fruit weight per tomato plant with organic mulch can be seen in Table 10.

Table 10. Average Fruit Weight per Tomato Plant with Organic Mulch

Symbol	Mulsa	Fruit Weight Per plant (g)
M_0	No Mulch	592.09
M_1	Straw	566.82
M_2	Rice Husk	606.14

Table 10 shows that the fruit weight per tomato plant tends to be greater with the use of rice husk mulch (M2) reaching 606.14 g compared to the use without mulch (M0) and straw (M1). The lightest fruit is found in the use of straw (M1), which is 566.82 g.

Fruit Diameter (cm)

The average diameter of tomatoes with organic mulch can be seen in Table 11.

Table 11. The Average Diameter of Tomatoes with Organic Mulch

Symbol	Mulsa	Fruit Diameter (cm)
M_0	No Mulch	4.05
M_1	Straw	4.03
M_2	Rice Husk	4.16

Table 11 shows that the diameter of the tomatoes tends to be larger with the use of Rice Husk (M2) mulch, which is 4.16 cm compared to the use of Without Mulch (M0) and Straw (M1). The use of straw mulch (M1) is the smallest fruit diameter of 4.03 cm.

Fruit Weight (g)

The average weight of tomatoes with organic mulch can be seen in Table 12.

Table 12. Average Fruit Weight of Tomatoes with Organic Mulch

Symbol	Mulsa	Fruit Weight Per plant (g)
M_0	No Mulch	41.20
M_1	Straw	42.48
M_2	Rice Husk	40.24

Table 12 shows that the weight of tomatoes tends to be greater with the use of straw (M1) reaching 42.48 g compared to the use without mulch (M2) and rice husk (M2). The use of rice husk (M2) was the lowest fruit weight, namely 40.24 g.

Interaction

The results of the F test on analysis of variance (Appendix even-numbered 2 to 20) showed that there was no significant interaction between the tested tomato varieties and various types of organic mulch on all observed growth and yield variables of tomato plants (Raksun et al., 2020). The results of this study indicate that differences in the response of tomato plants due to different varieties do not depend on the various types of organic mulch used, and vice versa.

Effect of Tomato Varieties on Growth and Yield of Tomato Plants

The results showed that the treatment of tomato varieties had a very significant effect on plant height at

20, 40, and 60 DAP, number of fruits per plant, fruit weight per plant, fruit diameter, and tomato fruit weight, and had no significant effect on stem diameter at 20, 40 and 60 HST. Furthermore, from the results of the study, it can also be concluded that the Jelita variety (V1) tomatoes gave superior growth and yield when compared to the Permata (V2) and Rempai (V3) varieties. The Jelita variety (V1) and the Permata variety (V2) are superior varieties that have higher morphological forms and high yields, unlike the Rempai variety (V3). The Rempai variety (V3) is a local variety that has a lower morphological shape and a high number of fruits. The Jelita variety has a superior morphology compared to other varieties. This is because these varieties have a maximum fruit weight per plant (Asare-Addo et al., 2022).

From the research results it can be seen that the Jelita variety (V1) has the highest production, this is the opinion that states that the use of seeds and farming methods and the right land can affect production, both in quality and quantity (Nabuuma et al., 2022). According to Das et al. (2022) differences in growing power between different varieties are determined by genetic factors. Furthermore, Latifah et al. (2021) also added that different plant varieties have different growth even though they are planted in the same soil. This difference is closely related to the genetic characteristics of the plant itself. By the opinion of (Jáquez-Gutiérrez et al., 2019) states that varieties consist of several different genotypes and each genotype can adapt to the environment. Gladkov et al. (2023) also stated that growth is the result of interactions between various internal factors stimulating growth, namely in genetic control and elements of climate, soil, and biology of the environment. The use of seeds and the right way of farming can affect the production to be achieved both in quantity and quality. Furthermore Bihon et al. (2022) states that the high production of a variety can adapt to its growing environment. Although genetically other varieties have good production potential, because they are still in adaptation, their production is lower than it should be (Zabel et al., 2021).

The Effect of Organic Mulch on the Growth and Yield of Tomato Plants

The results showed that the type of organic mulch did not significantly affect plant height, stem diameter at 20, 40, and 60 DAP, number of fruits per plant, fruit weight per plant, fruit diameter, and tomato fruit weight. Furthermore, the best type of organic mulch was found with the use of rice husk mulch (M2) compared to the use without mulch (M0) and straw (M1). In general, the growth and yield of tomato plants tended to be better in the Rice Husk treatment (M2), except for good tomato fruit weight found in the Straw mulch treatment (M1). This is because straw mulch and rice husk mulch can decompose with the soil to produce the nutrients needed for plant growth (Cao et al., 2021). In terms of cultivation, the use of mulch can provide benefits, including saving water use with evaporation rates from the land surface, inhibiting the growth rate of weeds, being able to absorb water and nutrients properly (Oluwasegun Olamide et al., 2023)

The high growth and yield of tomato plants by giving rice husk mulch is because the mulch can maintain soil moisture from the beginning of growth to harvest. Okeng (Du et al., 2022) state that the use of mulch will provide a better soil structure due to moist conditions under the mulch so it can increase the activity of microorganisms in the soil. The existence of a stable soil structure and increased availability of nutrients will further support weed growth and reduce the intensity of light reaching the soil surface (Alhammad et al., 2023). Rice husk as an agricultural waste has the opportunity to be used as mulch for horticultural crops. According to (Sharma et al., 2023), in horticultural crops, the use of husks as a cover on the soil surface is useful for good plant growth and makes the root system more developed.

According to Pavlů et al. (2021) the difference in the thickness of the mulch applied to the soil surface will have a different effect on plant growth. The recommended thickness of organic mulch is between 4–8 cm. In addition, rainfall greatly affects plant growth. Because it will inhibit the growth of tomato plants and increase pest and disease attacks so that the yield of tomato plants is low (Panno et al., 2021). Juhos et al. (2023) states that plant productivity is largely determined by genetic and environmental factors because superior plants will give maximum results when supported by a favorable environment, so the use of mulch in plants serves to maintain moisture, reduce excessive water loss, and maintain temperature land.

Interaction

The results of the F test on the analysis of variance (Appendix even-numbered 2 to 20) show that there is no significant interaction between tomato varieties and the type of organic mulch on the growth of plant height and stem diameter and fruit yield such as number of fruits per plant, fruit weight per plant, diameter fruit and fruit weight of tomatoes. This shows that the differences in the responses of all variables observed due to differences in varieties do not depend on the use of organic mulch or vice versa (Blanco-Pérez et al., 2022).

Conclusion

Tomato variety had a very significant effect on plant height at 20, 40, and 60 DAP, number of fruits per

plant, fruit weight per plant, fruit diameter, and fruit weight of tomatoes, and had no significant effect on stem diameter at 20, 40, and 60 DAP. The best variety found was the Jelita variety. Organic mulch had no significant effect on plant height, stem diameter at 20, 40, and 60 DAP, number of fruits per plant, fruit weight per plant, fruit diameter, and tomato fruit weight. The mulch that tends to increase the growth and yield of tomato plants is Rice Husk. The responses of the three tomato varieties were not significantly different to changes in the type of organic mulch in increasing the growth and yield of tomato plants.

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Author Contributions
Conceptualization, D. Y., A. R.; methodology, D. Y.; validation, A. R and D. Y.; formal analysis, A. R.; investigation, A. R and D. Y.; formal analysis, A. R.; investigation, D. Y and A. R.; resources, D. Y and A. R.; data curation, D. Y.: writing—original draft preparation, A. R and D. Y.; writing—review and editing, A. R.: visualization, A. R and D. Y.; supervision, A. R.; project administration, D. Y.; funding acquisition, A. R and D. Y. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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