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Tomato (*Solanum Lycopersicum*) Growth and Production Response On the Provision of Goat Manure and *Trichoderma*

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Abstract
Chemical fertilizers are commonly used a lot in tomato (Solanum lycopersicum) farming to speed up development and make more fruit. This research looks at how goat dung and the biological agent Trichoderma affect the growth and productivity of tomato plants in an attempt to find more environmentally friendly options. The experiment used a fully randomized factorial design (CRD) with three replications. It tested three levels of goat dung (0, 10, and 20 tons/ha) and three levels of Trichoderma treatment (0, 5, and 10 g/g/ g/plant). The results showed that there was no substantial interaction between the manure and Trichoderma treatments, although each element had an effect on several plant metrics on its own. The 20 tons/ha dosage of goat dung had the most impact on the number of leaves, the weight of the fruit, and the amount of organic carbon in the soil. Trichoderma made a big difference in the number of branches and the weight of the fruit. The most significant changes were seen at 10 g/g/ g/plant. These results show that adding organic matter and living things to tomato plants may help make them healthier and more productive. Using 20 tonnes of goat manure per hectare or 10 grams of Trichoderma per plant is a potential eco-friendly way to minimize reliance on chemical fertilizers while maintaining or even increasing crop output and soil fertility. This study backs the idea of using environmentally friendly farming methods for growing tomatoes.

Keywords— Goat Manure; Organic Fertiliser; Sustainable Agriculture; Tomato; *Trichoderma*.

Introduction

Tomatoes are a vegetable plant that contains many compounds needed by the body, including solanine, saponin, folic acid, malic acid, citric acid, bioflavonoids, protein, fat, vitamins and minerals (Junnaeni & Mahati, 2019). Tomatoes can be used directly, without prior cooking. Tomato cultivation currently uses a lot of chemical fertilizers and pesticides. The use of chemical fertilizers and pesticides can affect the quality of the fruit and soil fertility (Dewi & Afrida, 2022). Ultimately it will affect human health. Therefore, alternative actions are needed to reduce chemical fertilizers and pesticides.

The use of chemical fertilizers can be replaced with organic fertilizers on chili plants (Jaya et al., 2021), sweet corn (Yusworo et al., 2023) and eggplant (Zulkifli et al., 2020). Organic fertilizers have weaknesses in the ability to release nutrients into the soil which is slow compared to chemical fertilizers. Organic fertilizers that are abundant are obtained from agricultural waste, livestock waste and wild grass. The quality of organic fertilisers depends on the quality of the raw materials of organic fertilisers and the organic fertiliser process. The quality of raw materials is influenced by nutrient content, lignin content, and polyphenol content. Raw materials for organic fertilisers that have high nutrient content will have higher quality compared to raw materials that have low nutrient content. Goat manure has a higher potassium nutrient content than cow and chicken manure. Goat manure can increase mustard greens yields compared to chicken manure (Hidayati et al., 2021). Therefore, the quality of manure given to the soil needs to be identified so that it can be used as better fertiliser.

Increasing tomato plant production can also be done by preventing plant diseases. Nowadays, disease eradication is done by using pesticides, which will have an impact on the environment. Diseases that often attack tomato plants are stem rot diseases caused by Fusarium fungi. This disease can be suppressed by using biological pesticides in the form of *Trichoderma*. *Trichoderma* has the ability to inhibit the growth of Fusarium fungi in shallot plants (Syaifudin et al., 2023), banana (Bukhari & Nuryulsen Safridar, 2020) and tomatoes (Lahati & Ladjinga, 2022). *Trichoderma,* in addition to functioning as a disease inhibitor, can also function as a decomposer of organic materials. *Trichoderma*, as a decomposer, can help release nutrients into the soil so that they can be utilised by plants. *Trichoderma* can be used as a banana stem decomposer (Handayani, 2022) and coconut bunches (Sakiah et al., 2024).

The combination of chicken manure and *trichoderma* can increase the growth of land spinach plants (Ramdhan et al., 2022). The combination of cow manure and *trichoderma* can increase the yield of sweet corn plants (Tutik et al., 2022). The combination of white manure and *trichoderma* can increase the growth and yield of shallots.(Septania et al., 2022). A little information about the effect of the combination of goat manure and *trichoderma* on tomato plants. Therefore, the purpose of this study was to provide a study of the combination of goat manure and *trichoderma* on the growth and production of tomato plants. This information is useful for providing an overview of environmentally friendly tomato cultivation alternatives and can improve the quality of tomato fruit).

Literature Review

Tomato (Solanum lycopersicum) is a horticulture crop that is both good for your health and good for business, but its output is still limited by unsustainable farming techniques, especially the overuse of chemical fertilisers and pesticides (Dewi & Afrida, 2022). Researchers have been looking more and more into organic options that improve soil health and plant strength in response to these health and environmental concerns. Goat dung is better than chicken or cow manure at helping plants develop, especially mustard greens and tomato crops (Hidayati et al., 2021; Santi et al., 2023). This is because it is full of important elements including potassium, nitrogen, and phosphorus. Sundari et al. (2023) and Irawan et al. (2023) both found that higher amounts of organic manure are directly linked to better tomato yields and soil quality. At the same time, Trichoderma spp., a kind of filamentous fungus, have become powerful biological agents because they can act as both biofertilizers and biocontrol agents. Trichoderma breaks down organic materials to free up nutrients and makes phytohormones like auxins that help plants develop (Syuherman & Novita, 2022). In addition, it has been well proven that they may stop diseases like Fusarium spp., which makes tomatoes wilt in their vascular system (Lahati & Ladjinga, 2022; Khodijah et al., 2023). Trichoderma has been shown to work well in a wide range of agricultural systems, including shallots (Syaifudin et al., 2023), bananas (Bukhari & Safridar, 2020), and coconut bunch composting (Sakiah et al., 2024).

Prior investigations have explored the combined effects of animal manure and Trichoderma on different crops. For example, Ramdhan et al. (2022) showed that chicken manure paired with Trichoderma enhanced spinach growth, while Tutik et al. (2022) demonstrated similar outcomes for sweet corn using cow manure. Additionally, Septania et al. (2022) reported improved shallot yields from white manure and Trichoderma combinations. However, little scholarly attention has

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been devoted to understanding the specific interactions between goat manure and Trichoderma on tomato plants—a gap this study aims to fill.

This study is grounded in the theory of integrated nutrient management, which postulates that the synergistic use of organic inputs and biological agents can optimize crop productivity while maintaining ecological balance. Although previous studies validate the individual benefits of goat manure and Trichoderma, the interactive effects between the two on tomato growth and soil health have not been systematically examined. By addressing this void, the present research contributes to developing sustainable, eco-friendly agricultural practices. It empirically tests the hypothesis that combining goat manure with Trichoderma will result in enhanced growth parameters and yield of tomato plants, compared to their separate application or chemical alternatives. This approach not only aligns with the principles of sustainable agriculture but also offers practical implications for organic farming in tropical agroecosystems

Research Method

The study was performed in the greenhouse of the Agrotechnology department at the Faculty of Science and Technology, Darussalam Gontor University, Ponorogo. The study was done from August to December 2024. Sample analysis was conducted at the laboratory of the Agrotechnology Study Program, Faculty of Science and Technology, Darussalam Gontor University, Ponorogo. This research utilises soil, 35x35 cm polybags, tomato seedlings, bamboo stakes, plastic ropes, Tricho plus fertiliser, goat manure, insecticides, fungicides, potassium dichromate, distilled water, sulphuric acid, glucose, and envelope paper. The instruments used include analytical balances, meters, spectrophotometers, and pH meters.

This research used a factorial fully randomised design (CRD) with two components, replicated three times. The first component is the dosage of goat manure, comprising three treatment levels, whereas the subsequent factor is the dosage of trichoderma, also consisting of three treatment levels. The first element of goat manure application has three treatment levels: L0 = Control, L1 = 10 tons/ha, L2 = 20 tons/ha. The second component is the trichoderma dosage, including three levels: A0 = Control, A1 = 5 g per plant, A2 = 10 g per plant. The observation parameters include plant height, leaf count, branch count, fruit count, fruit weight, soil pH, and soil organic carbon content.

The study implementation include seed sowing, land preparation, planting, fertilisation, irrigation, weeding, pest and disease management, harvesting, and laboratory analysis. Data gathering is conducted according to the parameters mentioned in the study.
The observational data were analysed by Analysis of Variance (ANOVA) using SPSS version 29 to assess the impact of goat manure and trichoderma dosages on tomato growth and yield. In the event of a significant impact, a least significant difference (LSD) analysis is used to ascertain the differences across treatments.

Results and Discussion

Result

The results of the analysis of variance showed that there was no interaction between manure and trichoderma treatments on plant height. Manure and *trichoderma* treatments did not significantly affect plant height (Table 1). The average plant height was 90.26 cm. The highest plant height was in the A3B1 treatment of 104.33 cm, and the lowest was in the A1B2 treatment of 77.67 cm (Table 2).

Table 1. Results of analysis of variance of plant height, number of leaves and number of branches

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Treatment	Plant height	
Manure 0 ton/ha + Trichoderma 0 g/tan	90.33±3.05	a
Manure 0 ton/ha + Trichoderma 5 g/tan	77.67±11.02	a
Manure 0 ton/ha + Trichoderma 100 g/tan	92.00±8.66	a
Manure 10 ton/ha + Trichoderma 0 g/tan	90.00±11.26	a
Manure 10 ton/ha + Trichoderma 5 g/tan	82.00±16.09	a
Manure 10 ton/ha + Trichoderma 10 g/tan	86.67±13.57	a
Manure 20 ton/ha + Trichoderma 0 g/tan	104.33±16.77	a
Manure 20 ton/ha + Trichoderma 5 g/tan	107.33±6.66	a
Manure 20 ton/ha + Trichoderma 10 g/tan	82.00±18.35	a

Parameter	*Plant height*	*Number of leaves*	*Number of branches*
	F	F	F
Manure	2.46	4.09*	2.71*
Trichoderma	0.97	0.19	4.10*
Manure dan Trichoderma	2.04	0.58	0.69

Table 2. Average plant height

Note: Numbers accompanied by the same letters in the same column and row show no significant difference based on the BNT test.

The analysis of variance data indicated no interaction between manure and trichoderma treatments on the number of leaves. The treatment of manure significantly influenced the leaf count. The application of Trichoderma therapy did not significantly influence the leaf count (Table 1). In the manure treatment, the highest leaf length was recorded in the A3 treatment at 29.44 cm, while the lowest was in the A1 treatment at 21.89 cm. Treatment A1 shown no significant difference from A2, although demonstrated a substantial difference from A3 (Table 3). The Trichoderma therapy resulted in an average leaf count of 24.88.
The analysis of variance data indicated no interaction between the manure and trichoderma treatments for the number of branches. The manure treatment did not significantly influence the quantity of branches. The trichoderma therapy significantly influenced the quantity of branches (Table 1). In the trichoderma therapy, the highest number of branches was seen in the B3 treatment with 6.00 branches, while the lowest was in the B1 treatment with 3.67 branches. The B3 therapy did not vary substantially from B2, although it was considerably different from B1 (Table 3). The manure treatment resulted in an average of 5.07 branches. The analysis of variance data indicated

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no interaction between the manure and trichoderma treatments for tomato fruit weight.

The manure application considerably altered tomato fruit weight. Using trichoderma considerably reduced tomato fruit weight (Table 4). In the manure treatment, A3 had the biggest tomato fruit weight at 639.22 g/plant and A2 the smallest at 567.55. Table 5 shows that A3 differed from A2 but not A1. Trichoderma treatment B3 had the maximum tomato fruit weight at 736.44 g/plant, whereas B1 had the smallest at 559.33. Treatment B3 differed considerably from B1 and B2 (Table 5).

Table 4. Results of variance analysis of fruit weight and number of fruits

	Number of leaves		Number of branches	
Manure				
Manure 0 tons/ha	21.89±3.06	a	4.00±0.87	a
Manure 10 tons/ha	23.33±5.05	a	6.00±2.74	a
Manure 20 tons/ha	29.44±7.54	b	5.22±1.99	a
Trichoderma				
Trichoderma 0 g/plant	24.44±7.68	a	3.67±0.67	a
Trichoderma 5 g/plant	24.33±5.61	a	5.56±2.51	b
Trichoderma 10 g/plant	25.88±5.97	a	6.00±2.00	**b**

Parameter	Fruit weight fruit weight	Number of fruits number of fruits
	F	F
Manure	4.21*	1.52
Trichoderma	9.05**	1.03
Manure*Trichoderma	1.33	1.25

Table 5. Average fruit weight per plant

	Fruit weight	
Manure		
Manure 0 tons/ha	637.56±108.13	ab
Manure 10 tons/ha	567.55±139.74	a
Manure 20 tons/ha	693.22±112.71	b
BNT Value		
Trichoderma		
Trichoderma 0 g/plant	559.33±88.43	a
Trichoderma 5 g/plant	602.56±106.45	a
Trichoderma 10 g/plant	736.44±120.51	b
BNT Value		

Note: Numbers accompanied by the same letters in the same column and row show no significant difference based on the BNT test.

The analysis of variance of tomato fruit number indicated no interaction between manure and trichoderma. Manure and trichoderma did not alter plant height (Table 5). An average of 28.07 fruits were produced. The A3B3 treatment had 34.00 fruits, whereas the A1B2 treatment had 23.33 (Table 6).

Table 6. Average number of fruits per plant

Treatment	Number of fruits

Manure 0 tons/ha + Trichoderma 0 g/plant	25.67±1.15	a
Manure 0 tons/ha + Trichoderma 5 g/plant	23.33±1.53	a
Manure 0 tons/ha + Trichoderma 100 g/plant	29.67±6.51	a
Manure 10 tons/ha + Trichoderma 0 g/plant	28.33±2.31	a
Manure 10 tons/ha + Trichoderma 5 g/plant	27.67±5.51	a
Manure 10 tons/ha + Trichoderma 10 g/plant	26.33±10.2	a
Manure 20 tons/ha + Trichoderma 0 g/plant	25.00±7.21	a
Manure 20 tons/ha + Trichoderma 5 g/plant	32.67±3.06	a
Manure 20 tons/ha + Trichoderma 10 g/plant	34.00±4.36	a
BNT Value		

Note: Numbers accompanied by the same letters indicate no significant difference based on the BNT test.

The results of the analysis of variance of soil organic C showed that there was no interaction between manure and trichoderma treatments on soil organic C. Manure treatment had a significant effect on soil organic C. Trichoderma treatment did not have a significant effect on soil organic C (Table 1). In the manure treatment, the largest soil organic C was in treatment A3 of 2.42% and the lowest in treatment A1 of 1.89%. Treatment A3 was not significantly different from A2 but was significantly different from A1 (Table 8). Trichoderma treatment gave an average organic C of 2.23%.

Table 7. Results of the analysis of variance of soil pH and organic C

Parameter Treatment	pH	Organic C
	F	F
Manure	2.05	3.98
Trichoderma	0.19	2.40
Manure*Trichoderma	0.46	0.84

Table 8. Soil organic C

Treatment	Organic C	
Manure		
Manure 0 tons/ha	1.89±0.23	a
Manure 10 tons/ha	2.39±0.65	b
Manure 20 tons/ha	2.42±0.41	b
BNT Value		
Trichoderma		
Trichoderma 0 g/plant	1.99±0.39	a
Trichoderma 5 g/plant	2.27±0.51	a
Trichoderma 10 g/plant	2.44±0.56	a
BNT Value		

Note: Numbers accompanied by the same letters in the same column and row show no significant difference based on the BNT test.

The results of the analysis of variance of soil pH showed that there was no interaction between manure and trichoderma treatments on soil pH. Manure and trichoderma treatments did not significantly affect soil pH (Table 7). The average soil pH was 7.04. The highest pH was in the A1B1 treatment of 7.34 and the lowest was in the A3B1 treatment of 6.54 (Table 9).

Table 9. pH of soil

Treatment	*pH*

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Manure 0 tons/ha + Trichoderma 0 g/plant	7.34±0.40	a
Manure 0 tons/ha + Trichoderma 5 g/plant	7.20±0.19	a
Manure 0 tons/ha + Trichoderma 100 g/plant	7.20±0.22	a
Manure 10 tons/ha + Trichoderma 0 g/plant	7.34±1.29	a
Manure 10 tons/ha + Trichoderma 5 g/plant	6.98±0.72	a
Manure 10 tons/ha + Trichoderma 10 g/plant	7.07±0.28	a
Manure 20 tons/ha + Trichoderma 0 g/plant	6.54±0.32	a
Manure 20 tons/ha + Trichoderma 5 g/plant	6.68±0.13	a
Manure 20 tons/ha + Trichoderma 10 g/plant	7.04±0.03	a
BNT Value		

Note: Numbers accompanied by the same letters indicate no significant difference based on the BNT test.

Discussion

The effect of manure on tomato growth and yield

Manure has a role in increasing plant growth through the provision of nutrients for plants, provision of groundwater and the development of microbes that are beneficial to plants. The effectiveness of manure depends on the dose of manure, the type of manure and the maturity of the manure. In this study, it was found that manure can increase the number of leaves, fruit weight and soil organic C. Manure with a dose of 20 tons/ha causes the highest number of leaves, fruit weight and organic C. This study differs from Sujana's (2024) opinión which states that manure has no significant effect on tomato yields. Manure given to the soil will undergo a decomposition process that will release nutrients, organic acids and humus. The nutrients contained in manure include Nitrogen, Phosphorus, Potassium and micro nutrients. Goat manure has a higher potassium content than other manures. The nutrients released from manure are directly proportional to the amount of manure given to the soil. Increasing the dose of cow manure can increase tomato plant yields(Sundari et al., 2023). Increasing the dose of chicken manure can increase the yield of tomato plants (Irawan et al., 2023). Increasing the dose to 20 tons/ha can increase tomato crop yields (Santi et al., 2023)

The nutrients N, P and K will be more available when given in higher doses. Nutrients will be absorbed by tomato plants and translocated to the leaves to form organic compounds such as carbohydrates, proteins, fats and vitamins. The increased availability of nutrients will increase the results of photosynthesis which will be translocated to all parts of the plant, including the formation of leaves and fruits. Manure can increase the levels of organic C in the soil through the organic C content in manure. In addition, manure can stimulate the growth of microorganisms. Dead microorganisms will release organic C in the soil.

Effect of trichoderma on tomato growth and yield

The activity of microorganisms in the soil might affect tomato plant development and output. According to the results of this investigation, adding trichoderma may make tomato fruit heavier and have more branches. Trichoderma breaks down the organic materials in the soil. Decomposed organic matter will release nutrients that are either bound by the soil or contained in organic matter. Hormones released by Trichoderma have the ability to promote plant development. Trichoderma produces a number of hormones, including auxin. This hormone has the ability to accelerate plant development by stimulating cell proliferation. According to Khodijah et al. (2023), Trichoderma may prevent tomato plants from developing wilt disease. Trichoderma has the ability to regulate soil bacterial growth (Soesanto et al., 2022).

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The weight of tomato plant fruit increases in tandem with an increase in trichoderma dosage. Tomato yields may rise in response to an increase in trichoderma.(Novita & Suherman, 2022). This suggests that there is still insufficient trichoderma in the soil, since there is no effect on tomato fruit weight when trichoderma is added in modest quantities. Since Trichoderma is a heterotrophic fungus, the quantity of organic matter in the soil affects how much it grows. Trichoderma will not grow in soil with low levels of organic matter. Trichoderma has not operated at its best, which makes it less capable of increasing tomato plant yields, as shown by the treatment without manure.

Conclusion

This research offers a valuable contribution to scientific knowledge in the field of sustainable agriculture, particularly in the optimization of tomato cultivation practices through organic and biological inputs. By investigating the effects of goat manure and *Trichoderma* on the growth and productivity of tomato plants, the study provides empirical support for reducing reliance on chemical fertilizers and pesticides, which are known to negatively impact soil health and the environment. The findings demonstrate that goat manure, especially at a dose of 20 tons per hectare, significantly enhances tomato leaf development, fruit weight, and soil organic carbon levels. This highlights its potential as a superior organic fertilizer due to its rich nutrient profile, particularly in potassium, compared to other animal manures.

Furthermore, the application of *Trichoderma* at 10 grams per plant was shown to effectively increase the number of branches and fruit weight of tomato plants, reinforcing its role not only as a biological growth promoter but also as a natural agent for disease suppression and organic matter decomposition. These results substantiate the growing body of research that supports *Trichoderma*'s efficacy in promoting healthier plant growth and improving soil nutrient availability. Interestingly, the study found no significant interaction between the effects of goat manure and *Trichoderma*, suggesting that while both inputs individually benefit plant growth and yield, their combined application does not result in synergistic effects under the tested conditions. This nuance adds depth to existing knowledge by indicating that the co-application of organic and biological amendments may not always produce enhanced results and should be evaluated on a case-by-case basis.

Additionally, the research enriches our understanding of how organic amendments influence soil quality parameters such as organic carbon and pH, providing critical insight into the long-term implications of such practices on soil fertility. By presenting dosage-specific outcomes and identifying optimal treatment levels, this study also offers practical guidelines for farmers and agricultural policymakers seeking to implement more sustainable, eco-friendly cultivation methods. Overall, this research advances scientific discourse by integrating agronomic data with ecological considerations, promoting a more resilient and environmentally conscious approach to horticultural production.

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