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Increasing Plant Growth and Yield of Tomatoes (*Solanum lycopersicum* L.) by Providing Chicken Manure and Hormonics

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ABSTRACT

Tomato cultivation in alluvial land requires treatments to increase productivity. The research aimed to determine the effect of interaction between chicken manure and hormonal fertilizer application on the growth and yield of tomato plants in alluvial soil. This research was conducted at the greenhouse of the Faculty of Agriculture, Science, and Technology, Panca Bhakti University from April to July 2023. A Completely Randomized Design (CRD) with a factorial pattern was employed. The treatments consisted of 2 factors. The first factor was chicken manure with 3 levels: a1= 20 g/polybag, a2= 40 g/polybag, a3= 60 g/polybag. The second factor was hormonal fertilizer with 3 levels: h1= 2 ml/l, h2= 3 ml/l, h3= 4 ml/l. The results showed that there was no interaction effect between the application of chicken manure and hormonal fertilizer on all observed variables, as well as the application of chicken manure alone. The application of hormonal fertilizer significantly affected all observed variables including plant height, number of branches, number of fruits, and fruit weight. The treatment level h2 (3 ml/l) yielded the highest result in plant height at 113.26 cm. The highest number of branches, number of fruits, and fruit weight were observed at the h3 level (4 ml/l) with values of 3.39 branches, 2.57 fruits, and a fruit weight of 86.10 grams, respectively. The treatment level h1 (2 ml/l) yielded the lowest result.

1. INTRODUCTION

The tomato plant (Solanum lycopersicum L.) is a popular horticultural commodity with significant nutritional value and high demand (Fajri *et al*., 2022; Ceri & Anggorowati, 2023). One type of soil suitable for tomato cultivation is alluvial soil. This soil has a high water retention capacity (Rusydi *et al*., 2019) but has drawbacks such as being dense, sticky, and high in clay content (Yatno *et al*., 2016). These conditions can lead to the formation of compacted soil, high bulk density (BD), and low soil pore space (Masulili & Paiman, 2023). Additionally, alluvial soil lacks certain nutrients, hindering optimal plant growth (Hidayah *et al*., 2022).

To boost the productivity of alluvial soil, organic fertilizer treatment is necessary to enhance its physical and chemical properties. Organic fertilizer has been shown to increase soil fertility, reduce dependence on chemical fertilizers, and improve overall soil health (Roy & Kashem, 2014). Chicken manure is one type of organic fertilizer that can be used. Applying it at a rate of 10 tons per hectare can enhance the growth and yield of shallots in tidal swamp areas (Susilawati *et al*., 2022). Several studies have shown that chicken manure fertilizer, when combined with Rhizobium and NPK, improves the yield of groundnuts (Chuong, 2023), enhances phosphorus uptake in maize plants (Deryqe *et al*., 2016), and increases electrical conductivity (EC), N and K content (Aboutayeb *et al*., 2014), pH, and organic C (Roy & Kashem, 2014). Therefore, using chicken manure fertilizer has the potential to boost the growth and yield of tomato plants in alluvial soil.

In addition to nutrients from fertilizers, plant growth is also influenced by hormones. Hormone is substances containing growth regulators that play a role in rooting, flowering, and fruiting to achieve optimal harvest. Growth regulators are non-nutrient organic compounds that, even in small amounts, can stimulate, inhibit, or modify plant growth and development, enhancing root and shoot growth as well as germination processes. Un *et al*. (2018) found that growth regulators affect the germination of sandalwood seeds (*Santalum album* Linn.) and enhance the growth of tea plants (*Camellia sinensis* (L.) O. Kuntze) clone GMB 7 (Saefas *et al*., 2017).

While there has been extensive research on the use of chicken manure fertilizer to increase crop productivity in alluvial soil, the combined application of chicken manure fertilizer with hormones for tomato plants in alluvial soil has not been explored. Hence, this study was carried out to examine the combined effects of chicken manure fertilizer and hormones on the growth and yield of tomato plants in alluvial soil.

2. MATERIALS AND METHODS

The research took place in the greenhouse and laboratory of the Faculty of Agriculture, Science, and Technology at the University of Panca Bhakti, Pontianak, from February to May 2023. The research site was located one meter above sea level, with an average air temperature of 27.6°C and an average humidity of 82.8%, at the latitude of 2º05' N–3º 05' S and longitude of 108º30'–144º10' E. The materials used in the study included Servo F1 variety tomato seeds (*Solanum lycopersicum* L.), alluvial soil composited from the Kakap River, West Kalimantan, dolomite lime, chicken manure fertilizer, and hormonics. The equipment used in this research consisted of polybags measuring 40 x 50 cm, hoes, machetes, buckets, tape measures, scales, raffia rope, writing materials, documentation equipment, a pH meter, thermometer, hygrometer, hand sprayer, and other supporting tools.

2.1. Experimental Design

This research utilized a Completely Randomized Design (CRD) involving two treatment factors. The first factor involved applying chicken manure fertilizer at three different levels, while the second factor concerned the application of hormonic fertilizer, also at three different levels. Consequently, there were nine treatment combinations in total. Each treatment combination consisted of three plants and was replicated three times, resulting in a total of 81 research units, each housed in individual polybags. Table presents the specific treatments used in this study.

Table 1. Details of treatments in the research

Material amount	Treatment combination								
	a_1h_1	a_1h_2	a_1h_3	a_2h_1	a_2h_2	a_2h_3	a_3h_1	a_3h_2	a_3h_3
Chicken manure (g/polybag)	20	20	20	40	40	40	60	60	60
Hormonic (ml/l)	2	3	4	2	3	4	2	3	4

2.2. Research Procedure

2.2.1. Seed and Growing Medium Preparation

Seed preparation was carried out to select high-quality and viable seeds. The chosen seeds were of the tomato variety Servo F1. The selection process involved soaking the seeds in water for 1 hour. Seeds that sank were deemed suitable for sowing. To prepare the planting medium, soil was collected in a composite manner to a depth of 20 cm using a hoe. The soil was air-dried for 24 hours and then sifted through a sieve with openings larger than 20 mm. The sieved soil was placed into 40 x 50 cm polybags, each containing 8 kg of soil. Dolomite lime was applied 2 weeks before planting at a rate of 7.7 g per polybag.

2.2.2. Planting and Treatment Application

Each polybag in the research unit was planted with a 1-2 week old tomato seedling after germination. The application of chicken manure fertilizer was carried out one week before planting, in accordance with the treatment levels, by

mixing it with the planting medium. The application of hormonic, as per the treatment levels, was done three times, specifically at 2, 4, and 6 weeks after planting (WAP), by spraying it on the plants in the morning.

2.2.3. Plant Maintenance

The maintenance activities included watering was conducted twice daily, in the morning and evening, based on the moisture conditions of the medium. This regular watering schedule was crucial for maintaining the appropriate soil moisture level for the tomato plants. To prevent the plants from falling over, staking was performed using bamboo placed about 5 cm away from each plant. This method provided the necessary support for the growing plants, especially as they began to bear fruit. Weed and pest control were carried out mechanically. This approach likely aimed to avoid the use of chemicals, thereby maintaining the integrity of the experiment and the health of the plants. The tomatoes were harvested after they reached physiological maturity, indicated by the fruit's skin changing from light green to pink and eventually to dark red. Harvesting was conducted in the morning and carried out four times over a period of two weeks.

Observed Variables and Data Analysis

The measured variables in the study included: plant height was measured from the base of the stem to the tip of the tallest leaf, the total number of branches formed on each plant was counted, the number of fruits was counted over four harvests, and the weight of the fruits was measured using a scale. Furthermore, to determine the effect of the treatments, either individually or in combination, on the data from each variable obtained, an analysis of variance (ANOVA) was performed at the 5% level. If there was a significant effect from the treatments, a Least Significant Difference (LSD) test was conducted at the 5% significance level ($\alpha = 0.05$).

3. RESULTS AND DISCUSSION

3.1. Effect of Treatments on the Growth and Yield of Tomatoes

The research results shown in Table 2 indicate that the treatments of chicken manure fertilizer (a) and hormonic (h) did not have a significant interaction effect on all observed variables, including plant height, number of branches, number of fruits, and fruit weight. From this analysis, it means that each treatment factor did not directly complement each other in influencing the growth and yield of tomatoes but had individual effects. Chicken manure fertilizer influenced the improvement of soil properties (Mayele & Abu, 2023; Biratu *et al*., 2018; Aboutayeb *et al*., 2014), and hormonic influence physiological processes that either promote or inhibit plant growth and development (Puspitasari *et al*., 2023). Furthermore, Puspitasari *et al*. (2023) found that the combined treatment of NPK and growth regulators triggered plant growth and development in tomatoes, resulting in an increase in the number and weight of fruits.

The single-factor effect of chicken manure (a), as shown in Table 2, had no significant impact on all observed variables. This indicates that the given dose levels of chicken manure had a relatively similar influence on all observation variables, presumably due to the dose intervals between levels not being significantly different. In relation to this, several studies have shown that the optimal dose range for chicken manure is between 10 tons/ha and 15 tons/ha (Priyadi *et al*., 2023; Susilawati *et al*., 2022). Chicken manure is an excellent source of both macro and micro mineral elements for soil fertility. It acts as a soil conditioner and helps to raise soil pH (Mayele & Abu, 2023), as well as enhancing soil productivity and plant production (Dikinya & Mufwanzala, 2010). As a source of organic matter, chicken manure helps to loosen the soil and enhance nutrient availability.

Table 2 shows that the single-factor effect of Hormonic (h) had a significant impact on all observed variables, namely plant height, branch number, fruit number, and fruit weight. This indicates a difference in effect between the levels of Hormonic concentration. Hormonic, being a plant hormone, contains organic growth regulators like auxins, gibberellins, and cytokinins (Meidina & Sutejo, 2020). Applying growth regulators at a dose of 4 ml/l can enhance plant height, accelerate flowering and fruiting stages, increase pod length, and boost the weight of baby bean pods (Wuriesyliane & Sawaluddin, 2022). Treatment with a concentration of 3 ml/l auxin combined with 1 g/l leaf fertilizer can increase the yield of pakcoy plants by up to 54.55% (Dewanti *et al*., 2021). Therefore, hormonic at specific

concentration levels have the potential to improve the growth and yield of tomato plants. To assess the differences between each level of hormonic treatment, the results were analyzed using the LSD (Least Significant Difference) analysis at 5% are presented in Table 3.

Table 2. Effect of chicken manure fertilizer (a) and hormonic (h) treatments on the height of plants, number of branches, number of fruits, and fruit weight of tomato plants

Observed Variables	Treatments	F count	F Table 1 %	F Table 5 %
Plant height	Chicken Manure Fertilizer (a)	0.38^{tn}	3.55	6.01
	Hormonic (h)	4.18^{*}	3.55	6.01
	Interaction a × h	2.78^{tn}	2.93	4.58
Total number of branches	Chicken Manure Fertilizer (a)	2.44^{tn}	3.55	3.55
	Hormonic (h)	9.12^{*}	3.55	3.55
	Interaction a × h	2.69^{tn}	2.93	3.93
Number of fruits	Chicken Manure Fertilizer (a)	0.42^{tn}	3.55	3.55
	Hormonic (h)	5.98^{*}	3.55	3.55
	Interaction a × h	1.93^{tn}	2.93	3.93
Weight of the fruits	Chicken Manure Fertilizer (a)	2.20^{tn}	3.55	3.55
	Hormonic (h)	5.52^{*}	3.55	3.55
	Interaction a × h	1.99^{tn}	2.93	3.93

Note : (*) Significant; (ns) Not significant

Table 3. The influence of hormonic on the average height of plants, number of branches, number of fruits, and fruit weight of tomato plants

Hormonic	Average			
	Plant height (cm)	Number of branches	Number of fruits (fruits)	Weight of fruits (g)
h_1= 2 ml/l	98.15 a	2.52 a	1.98 a	74.93 a
h_2=3 ml/l	113.26 b	3.24 b	2.38 ab	75.78 a
h_3=4 ml/l	97.61 a	3.39 b	2.57 b	86.10 b
LSD 5%	3.61	0.56	0.56	0.56

Note: Numbers followed by the same letter in a different column are not significantly different at the 5% least significant difference.

Table 3 shows that the tallest tomato plants were achieved in the h2 hormonic treatment, reaching 113.26 cm, significantly different from h1 and h3. The highest number of branches was observed in the h3 treatment, with 3.39, significantly different from h1, but not significantly different from h2. The highest fruit count was obtained in the h3 treatment, with 2.57, significantly different from h1 but not significantly different from h2. The highest fruit weight, recorded at 86.10 g, was achieved with the h3 treatment, which was significantly different from the h1 and h2 treatments. This data shows that the effects of the hormonal concentrations on tomato growth and yield varied. The best treatment was observed at the h3 concentration of 4 ml/l. This is attributed to the growth regulators present in hormonic, which exert physiological effects on plant growth, promoting cell division, elongation, and the growth and maturation of reproductive plant organs (Sun *et al*., 2023). This is consistent with Supriyanto & Yulianto (2022) where application of auxin growth regulators at different concentrations had varying effects on the growth of avocado seedlings.

In the displayed image, it shows the influence of the combination of manure fertilizer (a) and hormonic (h) on the observed variables, where at each same dosage of manure fertilizer, there is a phenomenon of increased value when the concentration of hormonic is increased, except for the variable of plant height (Figure 1). For the variables of the number of branches (Figure 2), the number of fruits (Figure 3), and fruit weight (Figure 4), at each dose of chicken manure fertilizer, there was an increase in values with the increasing concentration of Hormonic. In line with these findings, Desta & Amare (2021) suggested that growth regulators play a role in hormonal balance and lead to physiological enhancement in plants. Mubarok *et al*. (2022) also found that growth regulators had a significant impact on the growth, yield, and quality of sweet corn during the dry season.

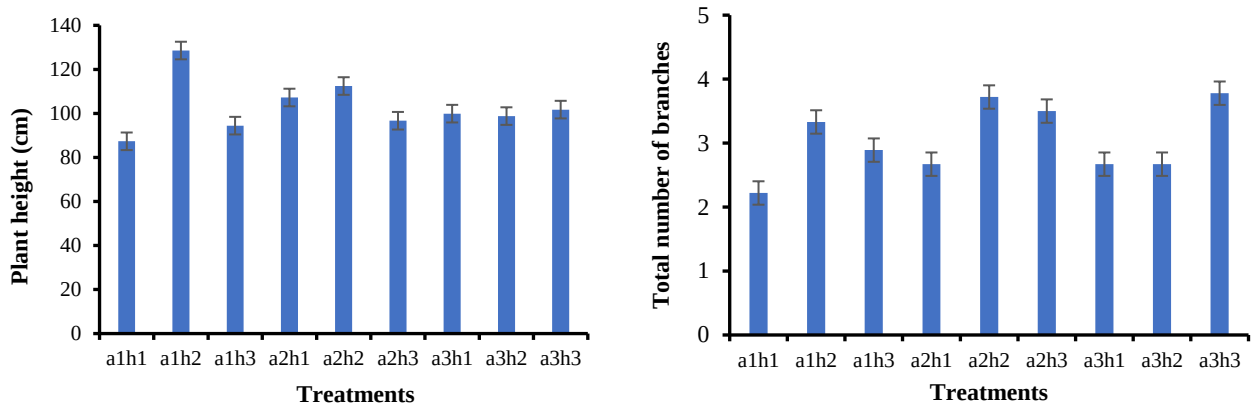

Figure 1. The effect of the interaction of chicken manure fertilizer (a) and Hormonic (h) on the plant height (left), and total branch of tomato plants (right)

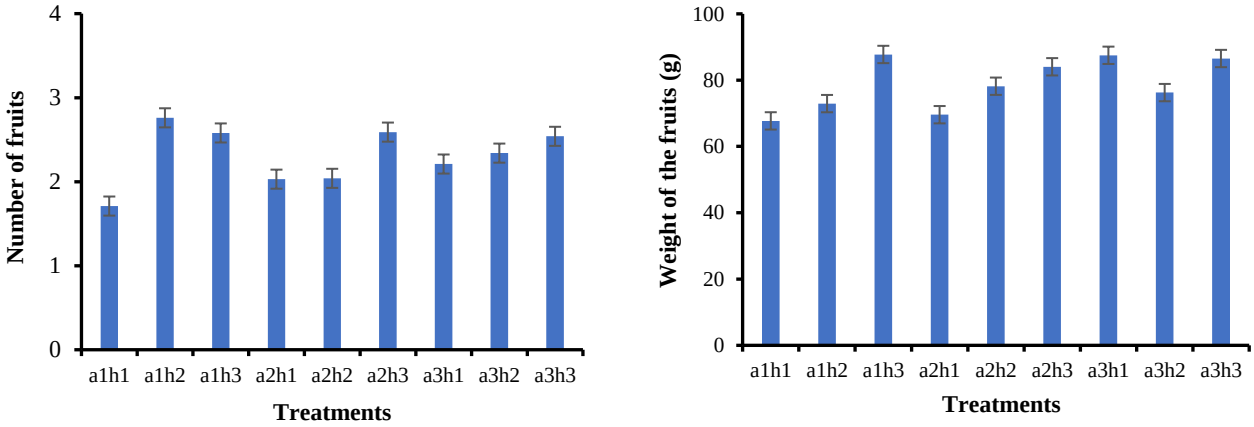

Figure 2. The effect of the interaction of chicken manure fertilizer (a) and Hormonic (h) on the number of fruits (left), and weight of tomato plants (right)

4. CONCLUSION

The treatment involving chicken manure fertilizer and Hormonic did not show any significant interaction effect on all observed variables, namely plant height, number of branches, number of fruits, and fruit weight; this was also true for the treatment with chicken manure fertilizer alone. However, the individual treatment with Hormonic had a significant effect. The h2 treatment level (3 ml/l) produced the highest result in plant height, reaching 113.26 cm. For the number of branches, number of fruits, and the highest fruit weight, the best results were obtained with the h3 treatment level, which resulted in 3.39 branches, 2.57 fruits, and a fruit weight of 86.10 grams. The h1 treatment level yielded the lowest results across all observed variables.

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