Effect of Bioculture Fertilizer and Biological Fertilizer on the Growth and Yield f Tomato Plants (*Solanum Lycopersicum L.*), Servo F1 Variety

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Abstract— *The aim of the research was to determine the effect of bioculture and biofertilizers and their interactions on the growth and yield of Servo F1 tomato varieties and to obtain appropriate concentrations of biocultural and biofertilizers for tomato plants.*

The research was conducted from May to July 2022, at the UPTB Agricultural Training Center (BAPELTAN) Jl. Thoyib Hadiwijaya No.36, South Sempaja urban village, North Samarinda sub-District, Samarinda, East Kalimantan Province.

The study used a 4x4 factorial experiment in a completely randomized design with four (4) repetitions. The first factor was the concentration of bioculture fertilizer (B), consisting of 4 levels, namely: no bioculture fertilizer application or control (b_0), 10 ml L^{-1} water (b_1), 20 ml L^{-1} water (b_2), and 30 ml L^{-1} water (b_3). The second factor is biofertilizers (H) consisting of 4 levels, namely: no biofertilizers application of control (h_0), 5 ml L^{-1} water (h_1), 10 ml L^{-1} water (h_2), and 15 ml L^{-1} water (h_3).

The data collected were plant height at 20, 40 and 60 days after planting, plant age at flowering, number of fruits per plant and fruit weight per plant. Data analysis was carried out using analysis of variance and continued with the leasr significant difference test at the 5% level.

The results showed that: (1) application of bioculture fertilizers had a very significant effect on the plant height at 20, 40 and 60 days after planting, and fruit weight per plant. The highest fruit weight per plant was produced in the treatment 30 ml L^{-1} water (b_3) namely 156,25 g $crop^{-1}$, and the lowest was produced in the treatment without bioculture fertilizers (b_0), namely 128,75 g $crop^{-1}$; (2) application of biofertilizers had a significant to very significant effect on the plant height at aged 40 and 60 days after planting, number of fruits per plant and fruit weight per plant. The highest fruit weight per plant was produced in the treatment 15 ml L^{-1} water (h_3) namely 156,25 g $crop^{-1}$, and the lowest was one was produced in the without biofertilizers (h_0), namely 128,75 g $crop^{-1}$; and (3) there is an interaction between the treatment of bioculture fertilizers and biofertilizers on the plant height at the age of 20, 40 and 60 days after planting.

Keywords— Bioculture Fertilizer, Biofertilizer, Tomato Plant.

I. INTRODUCTION

Tomato is a commodity that has high economic value and is cultivated by farmers in their farming activities to meet the needs of consumers and industry. From year to year, market demand for tomatoes is increasing, while tomato productivity has not been able to balance this increase. Tomato productivity needs to be further increased to meet domestic and export needs.

Efforts to increase tomato production through extensification (expansion of the planting area) are carried out not only on potential land but also on marginal land with low soil fertility and are sensitive to erosion. Many things can be done to increase tomato productivity, from technical improvements in tomato cultivation to postharvest treatment. Efforts to improve tomato

cultivation techniques are the availability of sufficient nutrients as plant food to grow and develop thereby affecting the quality and quantity of tomato yields. Therefore, it takes nutrients from outside, such as fertilizer.

Conventional farming systems, including the use of artificial fertilizers, can multiply crop yields. However, the negative impact can cause environmental damage, namely decreasing soil fertility so that agricultural land becomes damaged. The use of artificial fertilizers in large quantities resulted in a decrease environmental quality (Benbrook 1991). The use of artificial chemical fertilizers has a negative impact on the environment which results in damage to ecosystems (Cahyono, 2008). Intensive and continuous use of synthetic fertilizers can lead to hardening of the soil caused by the accumulation of residual artificial fertilizers, making it difficult for the soil to decompose. Hard soil produces several negative impacts including; (1) it becomes more difficult for plants to absorb nutrients, (2) the use of higher doses of fertilizer to get the same yield as the previous crop, and (3) the root system is disrupted so that the root function is not optimal (Notohadiprawiro, 2006).

To overcome this, technology is needed that can save on the use of agrochemicals including artificial fertilizers, maintain soil fertility, improve product quality, use seeds from superior varieties as well as proper and balanced fertilization, and increase farmers' income (Rosliani et al. 2004).

At present it is known that there is a new agricultural technology, namely enzymatic technology in an effort to increase agricultural production. This enzymatic technology focuses on improving the physical, chemical and biological properties of the soil. One type of product of this enzymatic technology is bioculture which is made from a mixture of biological enzyme substrates, complex biological chelates, vitamins, and electrolyte salts and is added to water and then aerated for 1 week. Bioculture can change the soil to be more friable, increase soil pH, and beneficial microbes can develop properly, while soil pathogens can be suppressed (Setiono Hadi 2005).

Biological fertilizer (biofertilizer) is a fertilizer made from microbes that have the ability to provide nutrients and hormones for plant growth. Microbes contained in biological fertilizers applied to plants are able to bind nitrogen from the air, dissolve bound phosphates in the soil, break down complex organic compounds into simpler compounds, and stimulate plant growth (Suwahyono, 2011).

The aim of the study was to determine the effect of bioculture fertilizers and biofertilizers and their interactions on the growth and yield of Servo F1 variety tomatoes and to obtain concentrations of bioculture fertilizers and biofertilizers suitable for tomato plants.

II. RESEARCH METHODS

2.1 Place and time of research

The research was conducted from May to July 2022, at the UPTB Agricultural Training Center (BAPELTAN) Jl. Thoyib Hadiwijaya No.36, South Sempaja, North Samarinda sub-District.

2.2 Materials and Research Tools

The research materials were: tomato seeds (the Servo F1 variety), liquid bioculture fertilizers, biofertilizers, topsoil, polybags measuring 25 x 30 cm. Tools used include: hoe, tape measure, camera, notebook, label to mark treatment, bucket, hand spayer, and ruler.

2.3 Research design

The study used a completely randomized design with 4 x 4 factorial analysis with four (4) replications. The first factor was the concentration of bioculture fertilizer (B), consisting of 4 levels, namely: no bioculture fertilizers application or control (b_0), 10 ml L^{-1} water (b_1), 20 ml L^{-1} water (b_2), dan 30 ml L^{-1} water (b_3). The second factor is biofertilizers (H) consisting of 4 levels, namely: no biofertilizers application or control (h_0), 5 ml L^{-1} water (h_1), 10 ml L^{-1} water (h_2), dan 15 ml L^{-1} water (h_3).

2.4 Research Activities

The research activities carried out are as follows: preparation of planting media; sowing seeds, transferring seedlings and planting, applying bioculture fertilizers and biofertilizers, maintaining plants (watering, loosening the soil, setting stakes, controlling pests and diseases), harvesting, data collection and analysis, reporting.

2.5 Data collection

The data collected were plant height at 20, 40 and 60 days after planting, plant age at flowering, number of fruits per plant and fruit weight per plant.

2.6 Data analysis

Data analysis was carried out using analysis of variance and continued with the least significant difference test of 5%.

III. RESULTS AND DISCUSSION

3.1 Bioculture Fertilizer

The results of the analysis of variance showed that bioculture fertilizers had a significant to very significant effect on the plant height at aged 20, 40 and 60 days after planting, and fruit weight per plant, but had no significant effect on plant age at flowering and number of fruits per plant. The results of the research on the effect of bioculture fertilizers on the growth and yield of Servo F1 tomato variety are presented in Table 1.

TABLE 1
RECAPITULATION OF RESEARCH DATA EFFECT OF BIOCULTURE FERTILIZERS ON THE GROWTH AND YIELD OF TOMATO, SERVO F1 VARIETY

Treatment Factor Bioculture Fertilizers (B)	Plant height (cm)			Age of Flowering Plants (days)	Number of Fruits/ Plants (fruits)	Weight of Fruit / Plant (g)
	20 HST	40 HST	60 HST			
Analysis of Variance	**	**	**	tn	tn	**
No bioculture fertilizers (b0)	7,07c	42,71c	82,43d	22,13	10,50	111,00d
10 ml l^{-1} water (b1)	8,91b	42,38c	84,33c	23,36	11,73	133,25c
20 ml l^{-1} water (b2)	9,09b	46,55b	86,83b	23.31	11,19	143,25b
30 ml l^{-1} water (b3)	9,51a	47,50a	88,28a	23,44	11,06	170,75a

Remark : The average number in each column followed by the same letter is not significantly different based on the results of the LSD test at the 5% level. HST = days after planting.

Based on the results of the research presented in Table 1, it shows that the application of various concentrations of bioculture fertilizers 10 ml L^{-1} water (b1), 20 ml L^{-1} water (b2), and 30 ml L^{-1} water (b3) produced higher tomato plants, higher number of fruits per plant, and higher fruit weight per plant compared to the treatment without bioculture fertilizers (b0). The highest fruit weight per plant was produced in the treatment 30 ml L^{-1} water (b3) namely 170,75 g $crop^{-1}$, followed by treatment 20 ml L^{-1} water (b2) and 10 ml L^{-1} water (b1) that is, censecutively 143,25 g $crop^{-1}$ and 133,25 g $crop^{-1}$, and the lowest was produced in the treatment without bioculture fertilizers (b0) namely 111,00 g $crop^{-1}$. The results of this study are in line with those reported by Setiono Hadi (2005) on rice plants, the use of bioculture can increase average rice yields up to 10 tons ha^{-1}, then the yield of hybrid corn with the application of bioculture fertilizers reached 20-25 ton ha^{-1} harvested dry corn kernels while the average yield was only 9-10 ton ha^{-1}. Nurtika, Sofiari, and Sopha (2008) reported that the highest yield of potato tubers was achieved by using inorganic fertilizers recommended by Balitsa. + bioculture 2.000 L ha^{-1} namely 15,30 kg $plot^{-1}$ (14,57 ton ha^{-1}), whereas without bioculture the results are only 13,06 kg $plot^{-1}$ (12,43 ton ha^{-1}); further reported by Lasmini et al. (2018) that application of bioculture fertilizers with as many doses 750 L ha^{-1} had a better effect on plant height, plant fresh weight, tuber excretion weight, tuber dry weight, tuber diameter, tuber moisture content and shallot bulb yield compared to other treatments. The highest yield of shallot bulbs was obtained by giving as much bioculture fertilizers 750 L ha^{-1} namely 9.27 ton ha^{-1}. This situation indicates that the application of bioculture fertilizers can improve the physical, chemical and biological properties of the soil, and can further increase the availability and uptake of nutrients by plants. As stated by Sumiarti and Soetiarso (2003) that liquid bioculture complementary fertilizers can improve soil physical properties, increase soil biological activity and increase the availability of nutrients for plants.

3.2 Biofertilizer

The results of variance showed that biofertilizers had a significant to very significant effect on the plant height at aged 20, 40 and 60 days after planting, number of fruits per plant and fruit weight per plant, but had no significant effect on plant age at flowering. The results of the research on the effect of biofertilizers on the growth and yield of the tomato (Servo F1 variety) are presented in Table 2.

TABLE 2
RECAPITULATION OF RESEARCH DATA EFFECT OF BIOFERTILIZERS ON GROWTH AND YIELD OF TOMATOES. SERVO F1 VARIETY

Treatment Factor Biofertilizers (H)	Plant height (cm)			Age of Flowering Plants (hari)	Number of Fruits / Plants (fruit)	Weight of Fruit / Plant (g)
	20 HST	40 HST	60 HST			
Analysis of Variance	tn	**	**	tn	*	**
No biofertilizers (h0)	8,51	44,10c	83,70d	22,81	9,12 b	128,75c
5 ml l^{-1} water (h1)	8,52	44,46bc	84,58c	23,25	11,56 a	133,75bc
10 ml l^{-1} water (h2)	8,72	44,80b	86,18b	23,19	11,44 a	139,50b
15 ml l^{-1} water (h3)	8,47	45,78a	87,40a	23,00	11,75 a	156,25a

Remark : The average number in each column followed by the same letter is not significantly different based on the results of the LSD test at the 5% level.
HST = days after planting.

Based on the results of the research presented in Table 2, it shows that the application of various concentrations of biofertilizers, namely 5 ml L^{-1} water (h_1), 10 ml L^{-1} water (h_2), and 15 ml L^{-1} water (h_3) produced higher tomato plants, higher number of fruits per plant, and higher fruit weight per plant compared to the treatment without biological fertilizers (h_0). The highest fruit weight per plant was produced in the treatment 15 ml L^{-1} water (h_3) namely 156,25 g $crop^{-1}$, followed by treatment 10 ml L^{-1} water (h_2) and 5 ml L^{-1} air (h_1) that is, consecutively 139,50 g $crop^{-1}$ dan 133,75 g crop $^{-1}$, and the lowest was produced in the treatment without biofertilizers (h_0) namely only 128,75 g crop $^{-1}$. The results of this study are in line with the results of research reported by Kaya et al (2020) that the application of Kesta biofertilizer combined with organic fertilizer and NPK fertilizer resulted in plant height aged 35 days after planting, fresh weight and dry weight of tomato plants in the nursery compared to the treatment without Kesta biofertilizer. The results of another study reported by Nazimah et al (2020) stated that the application of biofertilizers at doses 6 g $plot^{-1}$ gave a very good effect on the growth and yield of tomato plant varieties compared to other treatments including treatment without biofertilizers. The increase in plant growth and yield from the application of biofertilizers is due to the fact that biofertilizers are fertilizers made from microbes that have the ability to provide nutrients and hormones for plant growth. Microbes contained in biofertilizers applied to plants are able to bind nitrogen from the air, dissolve bound phosphates in the soil, break down complex organic compounds into simpler compounds, and stimulate plant growth (Suwahyono, 2011).

3.3 Interaction of Bioculture Fertilizers and Biofertilizers

The results of variance showed that the interaction between bioculture fertilizers and biofertilizers had a significant to very significant effect on the plant height at aged 20, 40 and 60 days after planting, but it had no significant effect on the plant age at flowering, number of fruits per plant and fruit weight per plant. This situation indicates that the dosage factor of bioculture fertilizers and biofertilizers concentration factor did not jointly or individually affect the growth and yield of tomato plants. As stated by Steel and Torrie (1991), that if the effect of different interactions is not significant, then it is concluded that the treatment factors act independently of each other.

The results of the research on the effect of the interaction between bioculture fertilizers and biofertilizers on the growth and yield of tomatoes (Servo F1 variety) are presented in Table 3.

TABLE 3
INTERACTION EFFECT RESEARCH RESULTS

Interaction (B×H)	Plant height (cm)			Age of Flowering Plants (days)	Number of Fruits / Plants (fruit)	Weight of Fruit / Plant (g)
	20 HST	40 HST	60 HST			
Analysis of Variance	*	**	**	tn	tn	tn
b0h0	7,05ef	40,20h	80,50k	21,25	8,25	100,00
boh1	7,30e	43,05e	81,20j	23.25	11,25	113,00
b0h2	6,70f	43,10e	83,40h	21,00	10,75	111,00
boh3	7,22ef	44,50d	84,60g	21,50	11,75	120,00
b1h0	8,33d	42,20fg	82,60i	23,00	10,25	120,00
b1h1	8,85bcd	41,10g	82,90hi	24,00	11,25	122,00
b1h2	8,65cd	42,90ef	85,60f	22,75	11,00	126,00
b1h3	8,40d	43,30f	86,20e	22,75	12,00	165,00
b2h0	9,03bc	46,40c	84,50g	23,50	8,75	138,00
b2h1	8,78cd	46,90bc	86,70de	23,75	11,75	141,00
b2h2	9,68a	45,70d	87,50c	23,75	12,25	139,00
b2h3	8,85bcd	47,20bc	88,60b	22,25	12,00	155,00
b3h0	9,68a	47,60ab	87,20cd	23,50	9,25	157,00
b3h1	9,13b	46,80b	87,50c	22,00	12,00	159,00
b3h2	9,83a	47,50ab	88,20b	23,75	11,75	182,00
b3h3	9,38ab	48,10a	90,20a	24,50	11,25	185,00

Remark: The average number in each column followed by the same letter is not significantly different based on the results of the LSD test at the 5% level.
HST = days after planting

In general, the results of the research presented in Table 3 show that the combined treatment of various concentrations of bioculture fertilizers with various concentrations of biofertilizers, as well as the combined treatment of various concentrations of biofertilizers with various concentrations of bioculture fertilizers tend to produce higher plants, the number of fruits per plant is higher more and the weight per plant is heavier than the combination without bioculture fertilizers and without biofertilizers. The highest fruit weight per plant was produced in the combination 30 ml L^{-1} water bioculture fertilizers and 15 ml L^{-1} water biofertilizers (b_3h_3) namely 185,00 g $crop^{-1}$, while the lowest was produced in a combination without bioculture fertilizers and without biofertilizers (b_oh_o), namely 100,00 g $crop^{-1}$. This is because the application of both fertilizers can improve the physical, chemical and biological properties of the soil. As stated by Barus (2011) that the addition of organic matter is necessary so that the ability of the soil can be maintained or even increased to support efforts to increase plant productivity through the efficient use of inorganic/chemical fertilizers. Then stated by Muklis (2020) biofertilizers contain microbes that function and are able to break down complex organic compounds found in the soil into simpler compounds and form other compounds so that they are easier for plants to use. Another function of biofertilizers is as a soil enhancer because they can change the physical condition of the soil so that it makes the soil a stable aggregate.

On the parameter of plant age at flowering, both bioculture fertilizer and biofertilizer treatment and their interactions had no significant effect, this is because the age of plants at flowering is largely determined by the plant's own genetic factors. As stated by Darjanto and Satifah (2002) that the transition from the vegetative period to the generative period (marked by the appearance of flowers) is partly determined by the genotype or internal factors and partly determined by external factors such as temperature, light, water, nutrients and so on other.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

Based on the results of the research and discussion, it can be concluded as follows:

1. Application of bioculture fertilizers had a very significant effect on the plant height at aged 20, 40 and 60 days after planting, and fruit weight per plant, but had no significant effect on the plant age at flowering and number of fruits per plant. The highest fruit weight per plant was produced in the treatment 30 ml L^{-1} water (b_3) namely 170,75 g $crop^{-1}$, and the lowest was produced in the treatment without bioculture fertilizers (b_0), namely only 111,00 g $crop^{-1}$.
2. Application of biofertilizers had a significant to very significant effect on the plant height at aged 40 and 60 days after planting, number of fruits per plant and fruit weight per plant, but had no significant effect on plant height 20 days after planting and plant age at flowering. The highest fruit weight per plant was produced in the treatment 15 ml L^{-1} water (h_3) namely 156,25 g $crop^{-1}$, and the lowest was produced in the treatment without biofertilizers (h_0), namely only 128,75 g $crop^{-1}$.
3. There is an interaction between the treatment of bioculture fertilizers and biofertilizers on the plant height at the age of 20, 40 and 60 days after planting.

4.2 Suggestion

For the cultivation of tomato plants in polybags, can be suggested using 30 ml L^{-1} water bioculture fertilizers and 15 ml L^{-1} biofertilizers.

Similar research can be carried out in various conditions in the field.

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