



The Role of Liquid Biofertilizer on The Growth and Production of Local Red Chili From Lubuk Cuik and Superior Varieties

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ABSTRACT

Red chili (*Capsicum annum* L.) is a spice commodity with high economic value that is increasingly being developed because it not only functions as a cooking spice but also as a functional food due to its bioactive compound content. Improving the growth and production of red chili can be done through the application of liquid biofertilizer on superior and local varieties of red chili from Lubuk Cuik which is a center of red chili production in North Sumatra. This study aims to identify the role of liquid biofertilizer in increasing the growth, and production of red chili from Lubuk Cuik and superior varieties is very important to do. The study was conducted in the field of the Agricultural Training and Mechanization Unit of the Horticultural Food Security Service of North Sumatra Province, using a Factorial Randomized Block Design with two factors and 3 replications. The first factor is the concentration of liquid biofertilizer (0, 10, 20 and 30 ml/L of water), and the second factor is the variety (White Local, Green Local, Dji-tu F1 superior variety, and Laju F1 superior variety). The data was analyzed using analysis of variance, if there was a significant difference then it was continued with Duncan's Multiple Range test at alpha level = 5%. The results showed that 30 ml/L of liquid biofertilizer resulted in improved plant height, branch number, and stem diameter, as well as accelerated flowering and fruit ripening. The Dji-tu F1 variety had higher yields than other varieties, while the Laju F1 variety tended to flower and ripen earlier. Overall, the use of 30 ml/L of liquid biofertilizer on superior varieties improved the growth and yield of red chili.

Keywords: bioactive compound; liquid biofertilizer; red chili; spice; yield

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INTRODUCTION

Red chili (*Capsicum annum* L.) is a high economic value spice commodity which developed massively. Red chili also plays a role as functional food because of its bioactive compound content, such as phenols, carotenoids, alkaloids, flavonoids, and capsaicinoids which has positive correlation with the antioxidant activity, anti-cancer and antimicrobial. The most capsaicinoids compound found in red chili is capsaicin which has anti-cancer activity by inhibiting cancer cell proliferation (Merritt et al, 2022; Zhang et al, 2020; Brown et al, 2023).

Indonesia is the fourth largest country that produced red chili, after China, Mexico, and Turkey. Red chili productivity has been increased in the last 3 years, reaching 1.554.498 tons/year. The production of red chili in North Sumatra Province reaching 217.917 tons/year (Badan Pusat Statistik, 2024). The center of red chili production in North Sumatra Province is in Lubuk Cuik Village, Lima Puluh Pesisir District, Batubara Regency. Although Lubuk Cuik Village has become the center of red chili production, but the potential that can be utilized is still not optimal. Based on the data from Central Agency of Statistics of Batu Bara in 2020, red chili harvest area in Lima Puluh Pesisir District is 1.357 ha, occupying the first place in Batu Bara Regency. The data shown that

the red chili productivity in Lubuk Cuik Village, classified as high (Badan Pusat Statistik, 2020).

The problem in red chili cultivation is the use of chemical fertilizer continuously, excessive, and inappropriate variety. The use of chemical fertilizer excessively without balanced with organic fertilizer will have a negative impact on the soil and the surrounding environment (Pahalvi et al, 2021; Baweja et al, 2020; Rashmi et al, 2020). To minimize the impact of chemical fertilizer, farmer can use liquid biofertilizer which contain microorganism to provide nutrient availability for the plants and environmentally friendly. This is because biofertilizer comes from the results of the decomposition of organic materials, such as plant residue, agro-industrial waste, animal waste, and human waste that contain nutrients, which also contain microbes that can increase soil nutrients (Kumar et al, 2019; Nosheen et al, 2021).

The use of liquid biofertilizer that contain N-fixing microbe, phosphate solvent, and bacteria that produce indole acetic acid (IAA) will give positive impact for the red chili plants growth. Therefore, giving biofertilizer is very important in an attempt to reduce the use of inorganic fertilizers, improve soil health, and provide

a positive contribution to sustainable agricultural, by reduce dependence on chemical fertilizer and support environmentally friendly agricultural program (Rahma et al, 2021; Alouzi et al, 2022; Gonzalez et al, 2023; Guardiola-Márquez et al, 2023).

The use of appropriate red chili seeds is the supporting factors for agricultural land productivity. It is very important to choose a variety that is suitable for the agricultural land where it will be planted. Red chili planting material that farmer generally used in Lubuk Cuik Village is *Lokal Hijau* and *Lokal Putih* variety, and there are two superior variety, namely *Laju* and *Djitu*.

Strategy that can be used related to the problem faced is liquid biofertilizer usage and appropriate red chili variety. Liquid biofertilizer contain many microbes that are beneficial to the soil which can optimize availability of nutrients that can be absorbed by plants and can help red chili plants to improve the production optimally.

Previous research stated that liquid biofertilizer contain useful microbes to improve nutrient absorption by reducing the use of inorganic fertilizer. Rahma et al. stated that the application of organic fertilizer and NPK increased the average weight of chili per fruit by 8.8 grams. Makmur (2018) stated that the application of 50ml/L of liquid biofertilizer have a real impact on productive branches and flowering age in chili plants and provides the highest average number of fruits and fruit weight. Hanafiah et al (2024) stated that based on dendrogram similarity coefficient of 0,4 for all red chili genotype that is analyzed and divided into two groups. Based on phylogenetic analysis, there is the kinship relationship between local cultivars (*Hijau Putih*) and hybrid varieties (*Djitu* and *Laju*) in one group. This research provides valuable insights about genetic diversity and disease resistance of local chili varieties, that is important for breeding and conservation in the future. Diverse morphological characteristics among local chili accessions of Lubuk Cuik. Some of morphological characteristics obtained can be useful as a genetic diversity sources. SSR analysis revealing monomorphic bands with CAMS-390 (547–569 bp), ASSR-281 (731–758 bp), and EPMS-335 (587625 bp). All the accessions showed the resistance towards anthracnose, with five genotypes also showing resistance towards fusarium. The dendrogram shows a similarity coefficient of 0.4 for all chili genotypes that is analyzed and divided into two groups. Based on phylogenetic analysis, there is kinship relationship between local cultivars and hybrid varieties from one group.

Haryati et al (2024) report that the red chili seeds harvested on third and fourth week is the best quality seeds because has a weight of 100 seeds, maximum growth power, highest vigor index, and fastest germination power. Maulana et al (2024) report that local chili varieties from Lubuk Cuik, namely *Lokal Hijau* and *Lokal Putih* that have superior characteristics and potential to be developed. Local chili varieties has a wide phenotypic diversity in plant height, number of seeds per fruit, crown width, weight per fruit and harvest age.

To date, there is still a lack of information regarding growth response, production and phytochemical content of several varieties of red chili plants to liquid biofertilizer. Therefore, this research aim is to identify the role of liquid

biofertilizer towards the growth improvement and the production of red chili from Lubuk Cuik and superior varieties very important to do.

MATERIALS AND METHODS

This research was conducted on land belonging to the Agricultural Training and Mechanization Technical Implementation Unit of the North Sumatra Province Food Security and Horticulture Agency at an altitude of 32 meters above sea level. The materials used in this research were: liquid biofertilizer, dolomite, compost, urea fertilizer, ZA, SP-36, KCl, Furadan 3G, red chili seeds of the *lokal putih* variety, *lokal hijau* variety, F1 fast variety, and *Dji-tu* F1 variety, 10 cm x 5 cm polybags as seedling growing media containers, silver plastic black mulch, stakes as plant supports, water as a supply for plant water needs, *Trichoderma* sp., acetone, capsaicin standards, and carotenoids. The tools used in this study were a hoe, measuring tape, ruler, analytical scale, camera, notebook and writing instruments, spectrophotometer, UV absorbance detector, and vial bottles.

This research used a factorial randomized block design with three replicates. Factor I was liquid biofertilizer (C) and factor II was variety (V), as follows: Factor I: Liquid Biofertilizer with 4 levels, namely: No Treatment, 10 ml/l, 20 ml/l, and 30 ml/l. Factor II: Red Chili Varieties consisting of 4 varieties, namely: *Lokal Putih* Variety, *Lokal Hijau* Variety, *Dji-tu* F1 Variety, and *Laju* F1 Variety. If the analysis of variance shows that the treatment has a significant effect, then it is followed by a mean difference test based on the Duncan Multiple Range Test (DMRT) at a level of $\alpha = 5\%$.

The liquid biofertilizer used contains nitrogen-fixing bacteria $\geq 10^8$; phosphorus-solubilizing bacteria $\geq 10^8$; IAA-producing bacteria $\geq 10^8$; auxin hormone composition ≥ 65 ppm; gibberellin ≥ 82 ppm; cytokinin ≥ 34 ppm; organic carbon content $\geq 17\%$; organic carbon $\geq 0.17\%$; total nitrogen $\geq 0.12\%$; $P_2O_5 \geq 0.006\%$; $K_2O \geq 0.022\%$; iron ≥ 24.18 ppm; copper ≥ 0.51 ppm; zinc ≥ 0.62 ppm; boron ≥ 13.71 ppm.

The research began with land preparation by clearing the land of plant debris, rocks, and weeds in all research areas measuring 11 m x 20 m. The soil was tilled using a tractor and 2 tons/ha of dolomite was applied.

The plots were made to fit the size of the chart, which was 90 cm x 180 cm, with a distance of 50 cm between plots, and silver plastic mulch was placed on each plot that had been formed. Next, the seeds are soaked in warm water for 1 hour, then drained and sown in 10 cm x 5 cm polybags containing soil under shade. The seedlings are ready to be transferred to the field at 25-30 days after sowing with the criteria of healthy and uniform-sized plants that have 4-6 leaves.

Selected seeds are planted in mulch with holes 3-5 cm deep, with a planting distance of 50 cm x 40 cm. Maintenance includes activities such as watering twice a day in the morning and afternoon. Weeding around the plants is done manually. Replanting is done if there are dead plants. Staking is done using bamboo sticks after 1 month.

Basic fertilizer uses 20 tons/ha of compost fertilizer applied 2 weeks before planting and 300 kg/ha of inorganic urea fertilizer, ZA 150 kg/ha, SP-36 600 kg/ha

and KCl 300 kg/ha and insecticide with active ingredient carbofuran 20 kg/ha applied 5 days before planting by spreading, then watering and covering with mulch.

Liquid biofertilizer is applied 14 days after transplanting at regular intervals. Follow-up fertilization is carried out after the red chillies are 50 days old. This is intended to stimulate flower and fruit growth, as well as to improve unsatisfactory growth. Urea fertilizer (100 kg/ha), ZA (300 kg/ha), and KCL (150 kg/ha) are applied at 3, 6, and 9 WAT, respectively, at 1/3 of the dose. Pest control is carried out in two ways: mechanically and chemically. Mechanical control involves picking pests from the plants. Chemical control uses *Tricoderma* sp. at a dose of 25 g/plant, applied at planting time.

Harvesting is carried out in the morning by picking chili that are ripe and red in color. Red chili are harvested after 80 days, when the fruit is red in color. Harvesting is carried out gradually according to the harvest criteria.

Observation parameters included plant height (cm), number of branches, stem diameter (mm), flowering age, fruit ripening age, length of chili per sample plant (cm), and weight of chili per sample plant (g).

RESULT AND DISCUSSION

RESULT

Plant Height

Treatment with 30 ml/L liquid biofertilizer increased plant height by 8-10 cm compared to other biofertilizer treatments. The *Lokal Putih*, *Lokal Hijau*, and superior *Dji-tu* varieties had plant heights that were 8–10 WAT significantly higher than the *Laju F1* variety. However, although the difference was not significant, there was a tendency for the combination of 10 mL/L liquid biofertilizer treatment with the *Lokal Putih* variety to have a higher plant height than all other treatment combinations (Table 1).

Table 1. Plant height of several varieties of red chili with the application of liquid biofertilizer

WAT	Liquid Biofertilizer (ml/L)	Varieties				Mean
		V1 (Lokal Putih)	V2 (Lokal Hijau)	V3 (Dji-tu F1)	V4 (Laju F1)	
	cm.....				
4	C0 (0)	38.38 ± 0.96	38.71 ± 0.82	38.93 ± 0.54	39.43 ± 0.39	38.86 ^b ± 0.44
	C1 (10)	40.58 ± 1.09	40.18 ± 0.87	40.66 ± 0.84	40.26 ± 0.99	40.42 ^a ± 0.23
	C2 (20)	40.48 ± 1.16	40.76 ± 0.51	41.26 ± 0.86	41.08 ± 0.18	40.89 ^a ± 0.35
	C3 (30)	42.15 ± 0.43	41.43 ± 1.39	41.88 ± 0.87	41.88 ± 0.45	41.84 ^a ± 0.30
	Mean	40.40 ± 1.54	40.27 ± 1.16	40.68 ± 1.27	40.66 ± 1.05	
6	C0 (0)	58.62 ± 2.06	59.41 ± 2.34	58.79 ± 2.57	59.74 ± 2.18	59.14 ^b ± 0.53
	C1 (10)	62.38 ± 2.49	62.13 ± 1.20	61.58 ± 0.85	61.06 ± 1.23	61.79 ^{ab} ± 0.59
	C2 (20)	62.66 ± 1.43	63.09 ± 1.37	63.43 ± 1.21	62.66 ± 0.67	62.95 ^a ± 0.39
	C3 (30)	64.60 ± 0.82	64.68 ± 0.13	63.37 ± 0.15	64.46 ± 0.47	64.28 ^a ± 0.61
	Mean	62.06 ± 2.50	62.32 ± 2.21	61.79 ± 2.17	61.96 ± 2.03	
8	C0 (0)	72.10 ± 0.58	73.10 ± 4.07	72.79 ± 2.57	70.44 ± 3.75	72.11 ^{bc} ± 1.19
	C1 (10)	79.59 ± 2.45	75.40 ± 2.31	72.33 ± 2.29	70.87 ± 3.09	74.55 ^{ab} ± 3.87
	C2 (20)	73.03 ± 4.70	73.68 ± 2.25	72.18 ± 1.19	68.73 ± 1.03	71.91 ^c ± 2.21
	C3 (30)	78.70 ± 3.41	78.63 ± 3.21	76.78 ± 4.98	73.83 ± 2.19	76.99 ^a ± 2.83
	Mean	75.86 ^a ± 3.84	75.20 ^a ± 0.48	73.62 ^a ± 2.19	70.97 ^b ± 2.12	-
10	C0 (0)	73.21 ± 0.62	74.36 ± 3.96	73.52 ± 2.57	71.19 ± 3.75	73.07 ^b ± 1.34
	C1 (10)	80.42 ± 2.45	76.67 ± 2.31	74.28 ± 2.29	72.50 ± 3.09	75.94 ^{ab} ± 3.38
	C2 (20)	75.71 ± 4.69	76.01 ± 2.25	74.96 ± 1.19	73.43 ± 1.03	75.03 ^{ab} ± 1.15
	C3 (30)	78.78 ± 3.41	79.76 ± 2.39	79.15 ± 3.00	75.87 ± 1.24	78.39 ^a ± 1.73
	Mean	77.00 ^a ± 3.17	76.70 ^a ± 2.26	75.48 ^{ab} ± 2.52	73.24 ^b ± 1.97	

Description: Numbers followed by different letters at the same observation time indicate significant differences according to Duncan's Multiple Range Test at α= 5%. WAT = weeks after transplanting

Total Branches

Based on Table 2, it can be seen that each variety tested had a different number of branches of 4-10 WAT that was not significant. The application of 30 ml/L liquid biofertilizer produced the highest number of branches that was significantly different from the other treatments. There was no significant effect or interaction between the liquid biofertilizer treatment and the red chili variety, but there was a tendency for the combination of 30 mL/L liquid biofertilizer treatment with the local white variety to produce the highest number of branches at 8 WAT compared to the other treatment combinations.

Stem Diameter

Based on Table 3, the treatment with 30 ml/L liquid biofertilizer resulted in a larger stem diameter compared

to other treatments, although the stem diameter at 10 WAT was not significantly different from the 20 ml/L dose. The *Dji-tu F1* variety tended to have a wider stem diameter than other varieties. The combination of liquid biofertilizer treatment at 30 mL/L with the *Dji-tu F1* variety resulted in a higher stem diameter at 4–10 WAT compared to other treatment combinations.

Flowering Age

Based on Table 4, It can be seen that increasing the treatment of liquid biofertilizer from 0-30 mL/L slows down the flowering time. The *Lokal Putih* variety flowers faster than other varieties. The combination of 10 mL/L liquid biofertilizer treatment with the *Lokal Putih* variety tends to flower the fastest compared to other combinations.

Table 2. Number of branches of severa varieties of red chili with the application of liquid biofertilizer

WAT	Liquid Biofertilizer (ml/L)	Varieties				Mean
		V1 (Lokal putih)	V2 (Lokal hijau)	V3 (Dji-tu F1)	V4 (Laju F1)	
	branches.....				
4	C0 (0)	2.25 ± 0.66	2.25 ± 0.66	2.25 ± 0.66	2.25 ± 0.66	2.25 ^c ± 0.66
	C1 (10)	2.75 ± 0.66	2.75 ± 0.66	2.75 ± 0.66	2.75 ± 0.66	2.75 ^b ± 0.66
	C2 (20)	3.08 ± 0.38	3.08 ± 0.38	3.08 ± 0.38	3.08 ± 0.38	3.08 ^b ± 0.38
	C3 (30)	3.92 ± 0.28	3.92 ± 0.28	3.92 ± 0.28	3.92 ± 0.28	3.92 ^a ± 0.28
	Mean	3.00 ± 0.70	3.00 ± 0.70	3.00 ± 0.70	3.00 ± 0.70	
6	C0 (0)	3.33 ± 0.14	3.58 ± 0.28	3.67 ± 0.38	3.67 ± 0.62	3.56 ^c ± 0.15
	C1 (10)	4.08 ± 0.52	4.08 ± 0.14	3.83 ± 0.28	3.92 ± 0.80	3.98 ^b ± 0.12
	C2 (20)	5.17 ± 0.14	4.67 ± 0.14	5.00 ± 0.75	5.08 ± 0.14	4.98 ^a ± 0.21
	C3 (30)	2.33 ± 0.14	5.08 ± 0.38	5.25 ± 0.25	5.50 ± 0.00	5.29 ^a ± 0.17
	Mean	4.48 ± 0.94	4.35 ± 0.65	4.44 ± 0.80	4.54 ± 0.88	
8	C0 (0)	4.58 ± 0.28	4.50 ± 0.25	4.75 ± 0.50	5.00 ± 0.43	4.70 ^c ± 0.22
	C1 (10)	5.33 ± 0.52	5.33 ± 0.28	5.42 ± 0.38	5.50 ± 0.43	5.39 ^b ± 0.07
	C2 (20)	5.83 ± 0.52	6.08 ± 0.62	5.67 ± 0.38	5.92 ± 0.52	5.87 ^b ± 0.17
	C3 (30)	6.58 ± 0.57	6.42 ± 0.38	6.25 ± 0.25	6.17 ± 0.52	6.35 ^a ± 0.18
	Mean	5.58 ± 0.84	5.58 ± 0.85	5.52 ± 0.62	5.64 ± 0.51	

Description: Numbers followed by different letters in the same row or column indicate significant differences according to Duncan's Multiple Range Test at the 5% level.

Table 1. Stem diameter of several varieties of red chili with the application of liquid biofertilizer

WAT	Liquid Biofertilizer (ml/L)	Varieties				Average
		V1 (Lokal Putih)	V2 (Lokal Hijau)	V3 (Dji-tu F1)	V4 (Laju F1)	
	mm.....				
4	C0 (0)	3.27 ± 0.16	3.52 ± 0.36	3.42 ± 0.29	4.35 ± 0.98	3.64 ^b ± 0.48
	C1 (10)	4.30 ± 0.42	4.05 ± 0.06	4.70 ± 0.75	5.47 ± 0.59	4.63 ^a ± 0.61
	C2 (20)	3.90 ± 0.59	4.04 ± 0.54	5.10 ± 0.55	4.58 ± 0.69	4.41 ^a ± 0.54
	C3 (30)	4.40 ± 0.45	3.99 ± 0.44	5.37 ± 0.33	5.08 ± 0.29	4.71 ^a ± 0.62
	Average	3.97 ± 0.51	3.90 ± 0.25	4.65 ± 0.86	4.87 ± 0.50	
6	C0 (0)	6.12 ± 0.25	5.90 ± 0.47	6.98 ± 0.95	6.54 ± 1.22	6.39 ^b ± 0.47
	C1 (10)	6.73 ± 0.48	6.60 ± 0.02	6.55 ± 0.37	7.08 ± 0.61	6.74 ^a ± 0.24
	C2 (20)	6.28 ± 0.70	5.80 ± 0.45	6.10 ± 0.98	5.90 ± 0.81	6.10 ^c ± 0.29
	C3 (30)	6.81 ± 0.47	6.66 ± 0.19	7.39 ± 0.20	6.78 ± 0.48	6.91 ^a ± 0.32
	Average	6.48 ± 0.33	6.24 ± 0.45	6.83 ± 0.44	6.58 ± 0.50	
8	C0 (0)	7.23 ± 0.22	7.22 ± 0.50	7.91 ± 0.68	7.83 ± 1.29	7.55 ^c ± 0.37
	C1 (10)	9.53 ± 0.70	9.49 ± 0.33	9.38 ± 0.65	10.03 ± 0.73	9.61 ^b ± 0.28
	C2 (20)	9.21 ± 0.82	8.99 ± 0.50	9.77 ± 1.52	9.23 ± 1.19	9.30 ^{ab} ± 0.33
	C3 (30)	10.18 ± 0.13	9.88 ± 0.20	10.66 ± 0.18	10.40 ± 0.31	10.28 ^a ± 0.32
	Average	9.04 ± 1.26	8.90 ± 1.17	9.43 ± 1.14	9.37 ± 1.13	
10	C0 (0)	7.43 ± 0.41	7.42 ± 0.41	8.47 ± 0.57	8.28 ± 1.46	7.90 ^c ± 0.55
	C1 (10)	10.00 ± 0.91	10.02 ± 0.56	9.89 ± 0.63	10.53 ± 0.70	10.11 ^b ± 0.28
	C2 (20)	10.64 ± 1.34	10.47 ± 1.22	11.13 ± 1.78	10.66 ± 1.66	10.73 ^{ab} ± 0.28
	C3 (30)	11.43 ± 0.64	11.23 ± 0.54	11.93 ± 0.73	11.63 ± 0.76	11.55 ^a ± 0.29
	Average	9.88 ± 1.73	9.78 ± 1.65	10.35 ± 1.51	10.28 ± 1.41	

Description: Numbers followed by different letters in the same row or column indicate significant differences according to Duncan's Multiple Range Test at the 5% level.

Table 4. The flowering age of several varieties of red chili with the application of liquid biofertilizer

Liquid Biofertilizer (ml/L)	Varieties				Mean
	V1 (Lokal Putih)	V2 (Lokal Hijau)	V3 (Dji-tu F1)	V4 (Laju F1)	
 the day after transplanting.....				
C0 (0)	28.25 ± 0.75	25.67 ± 0.38	27.08 ± 1.04	28.00 ± 1.14	27.25 ^a ± 1.16
C1 (10)	29.58 ± 1.04	29.67 ± 1.04	29.75 ± 0.25	31.25 ± 1.08	30.06 ^b ± 0.79
C2 (20)	30.42 ± 1.42	30.58 ± 0.94	30.00 ± 0.43	31.00 ± 1.14	30.05 ^b ± 0.41
C3 (30)	30.67 ± 0.14	30.25 ± 0.75	30.42 ± 0.52	30.92 ± 0.14	30.56 ^b ± 0.29
Mean	29.73 ^a ± 1.08	29.04 ^a ± 2.28	29.31 ^a ± 1.51	30.29 ^b ± 1.53	

Description: Numbers followed by different letters in the same row or column indicate significant differences according to Duncan's Multiple Range Test at the 5% level.

Fruit Ripening Age

The application of 30 ml/L liquid biofertilizer significantly accelerated fruit ripening compared to other treatments (Table 5). The *Laju F1* variety tended to enter

the fruit ripening phase faster than other varieties. The combination of 30 ml/L liquid biofertilizer treatment with the *Lokal Putih* variety tended to produce the fastest fruit ripening compared to other treatment combinations.

Fruit Length

Varieties of red chili have a significant effect on fruit length, while liquid biofertilizer and the interaction between liquid biofertilizer and variety have no significant effect on fruit length (Table 6). The *Dji-tu F1*, Lokal Putih, and Lokal Hijau varieties have significantly longer fruit length compared to the *Laju F1* variety. The application of liquid biofertilizer without treatment produces longer fruit compared to other doses of liquid biofertilizer.

Total Weight of Chilli Per Sample

Based on Table 7, the treatment with 30 ml/L liquid biofertilizer (C3) produced a higher total fruit weight per sample compared to the control (C0), and was not significantly different from the 10 ml/L (C1) and 20 ml/L (C2) treatments. The *Dji-tu F1* variety (V3) showed a heavier total fruit weight per sample compared to other varieties. The interaction between treatment C1 and the *Laju F1* variety (V4) resulted in the highest total fruit weight per sample compared to other treatment combinations.

Table 5. Fruit Ripening Age of several varieties of red chili with the application of liquid biofertilizer

Liquid Biofertilizer (ml/L)	Varieties				Mean
	V1 (Lokal Putih)	V2 (Lokal Hijau)	V3 (<i>Dji-tu F1</i>)	V4 (<i>Laju F1</i>)	
 the day after transplanting.....				
C0 (0)	76.33 ± 0.57	76.33 ± 0.57	75.67 ± 1.15	76.33 ± 1.15	76.17 ^d ± 0.33
C1 (10)	75.33 ± 0.57	75.00 ± 1.73	75.00 ± 1.00	75.33 ± 1.52	75.17 ^c ± 0.19
C2 (20)	73.67 ± 1.15	73.67 ± 1.15	74.33 ± 0.57	72.33 ± 1.52	73.50 ^b ± 0.83
C3 (30)	71.67 ± 0.57	72.00 ± 1.00	72.33 ± 0.57	72.00 ± 0.00	72.00 ^a ± 0.27
Mean	74.25 ± 2.04	74.25 ± 1.85	74.33 ± 1.44	74.00 ± 2.16	

Description: Numbers followed by different letters in the same row or column indicate significant differences according to Duncan's Multiple Range Test at the 5% level.

Table 6. Fruit length of several varieties of red chili with the application of liquid biofertilizer

Liquid Biofertilizer (ml/L)	Varieties				Mean
	V1 (Lokal Putih)	V2 (Lokal Hijau)	V3 (<i>Dji-tu F1</i>)	V4 (<i>Laju F1</i>)	
cm.....				
C0 (0)	15.38 ± 1.63	17.08 ± 2.57	17.79 ± 2.27	14.98 ± 1.96	16.31 ± 1.34
C1 (10)	15.15 ± 1.85	17.33 ± 0.90	17.33 ± 1.01	12.46 ± 1.88	15.57 ± 2.31
C2 (20)	14.63 ± 1.92	15.52 ± 1.79	17.03 ± 2.88	13.38 ± 0.45	15.14 ± 1.53
C3 (30)	17.10 ± 3.16	16.81 ± 1.35	14.96 ± 1.68	14.33 ± 0.50	15.80 ± 1.36
Mean	15.56 ^a ± 1.07	16.69 ^a ± 0.80	16.78 ^a ± 1.25	13.79 ^b ± 1.10	

Description: Numbers followed by different letters indicate significant differences according to Duncan's Multiple Range Test at the 5% level.

Table 7. Total weight of several varieties of red chili with the application of liquid biofertilizer

Liquid Biofertilizer (ml/L)	Varieties				Mean
	V1 (Lokal Putih)	V2 (Lokal Hijau)	V3 (<i>Dji-tu F1</i>)	V4 (<i>Laju F1</i>)	
g.....				
C0 (0)	409.41 ± 33.01	435.42 ± 31.19	566.06 ± 27.63	408.32 ± 25.22	454.80 ^b ± 75.22
C1 (10)	494.98 ± 55.83	448.02 ± 18.09	590.27 ± 26.08	606.14 ± 72.82	534.85 ^a ± 75.90
C2 (20)	490.06 ± 74.52	423.66 ± 48.09	587.59 ± 77.63	440.56 ± 61.30	485.47 ^{ab} ± 73.68
C3 (30)	573.52 ± 42.43	530.52 ± 64.08	572.22 ± 19.44	545.71 ± 157.08	555.49 ^a ± 21.00
Mean	491.99 ^b ± 67.03	459.40 ^b ± 48.44	579.03 ^a ± 11.75	500.18 ^b ± 91.82	

Description: Numbers followed by different letters in the same column and row indicate significant differences according to Duncan's Multiple Range Test at the α = 5% level.

DISCUSSION

The vegetative growth of chili plants, as indicated by plant height, number of branches, and stem diameter, increased with the application of liquid biofertilizer, especially at a dose of 30 ml/L. This indicates that the microorganisms contained in biofertilizers play an active role in improving the availability of nutrients in the soil, both through nitrogen fixation, phosphate solubilization, and the production of growth-regulating compounds such as IAA. These conditions allow plants to utilize nutrients more optimally, resulting in better vegetative growth. This finding is in line with the research by Pakpahan et al. (2022), which states that the application of biofertilizer can improve the growth of horticultural plants because it supports more efficient nutrient absorption.

The acceleration of the generative phase is also influenced by the application of liquid biofertilizer. A concentration of 10 ml/L of liquid biofertilizer accelerates flowering, while a concentration of 30 ml/L accelerates fruit harvest. This mechanism can be

attributed to the role of microorganisms that produce growth-regulating compounds, thereby accelerating flower initiation, while better nutrient availability supports the process of fruit formation and filling. Similar results were reported by Makmur (2018), who found that the use of liquid organic fertilizer accelerated flowering and fruit ripening in chili plants. Yield components such as fruit length and fruit weight per plant showed a significant increase with liquid biofertilizer treatment. The *Laju F1* variety showed the highest potential, especially in combination with 10 ml/L liquid biofertilizer, producing the highest total red chili yield per sample at 606 g. This phenomenon proves that, in addition to fertilization factors, the genetic potential of the variety also greatly determines productivity. Rahma et al. (2024) also found that the use of biofertilizer can significantly increase chili fruit weight, indicating that the presence of beneficial microbes contributes to increased yield. In addition to supporting growth and yield, liquid biofertilizer also affects the bioactive quality of the fruit, namely the content of capsaicin and carotenoids.

Overall, the use of liquid biofertilizer has been proven to provide tangible benefits, both in terms of vegetative growth, acceleration of the generative phase, and increased red chili yield. The response between varieties shows an interaction between genetic factors and fertilization treatment. The *Dji-tu F1* variety tends to be more responsive to yield increases, while the *Laju F1* variety excels in terms of branch number and harvest acceleration. Therefore, selecting varieties that are compatible with optimal liquid organic fertilizer doses (30 ml/L) can be a strategy to enhance both productivity and quality of red chili in sustainable agricultural systems.

CONCLUSION

Liquid biofertilizer affects the growth and yield of red chili. A concentration of 30 ml/L of liquid biofertilizer results in better growth in terms of plant height, number of branches, stem diameter, and accelerates flowering and fruit ripening. The *Dji-tu F1* variety produces higher yields than other varieties, while the *Laju F1 (V4)* variety tends to flower and ripen fruit more quickly. Overall, the use of liquid biofertilizer at 30 ml/L on high-yielding varieties can enhance the growth and yield of red chili.

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