IJASST
International Journal of
Applied Sciences and Smart Technologies
p-ISSN 2655-8564, e-ISSN 2685-943, pp. 113-124, 2024

Volume 06
Issue 01

Evaluation of Impact of Biofertilizer and Mulch Types on Growth and Production of Tomato Cultivar Gustavi F1 in Lowland Areas

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(Received 23-10-2023; Revised 19-01-2024; Accepted 25-04-2024)

Abstract

Tomato plants are expected to have an ideal growing environment to optimize their growth and production. Therefore, this study aimed to investigate the effect of various concentrations of biofertilizer, mulch types, and their interactions on growth and production of the Gustavi F1 tomato cultivar. A randomized group design (RGD) arranged factorially was used for the analysis, with the first factor consisting of no mulch (M0), straw mulch (M1), and plastic mulch (M2). The second factor was five biofertilizer concentrations, including 0 $ml.l^{-1}$ (L0), 5 $ml.l^{-1}$ (L1), 10 $ml.l^{-1}$ (L2) 15 $ml.l^{-1}$ (L3), and 20 $ml.l^{-1}$ (L4). Data were analyzed using the F test (analysis of variance), and in cases of significant differences, the analysis proceeded with Duncan Multiple Range Test (DMRT) at an α level of 5%. Growth parameters observed in the experiments included plant height at 1 and 3 weeks after planting, while production parameters comprised fruit diameter, the number of fruits per plant, the percentage of fruits experiencing Blossom End-Rot (BER), and fruit weight per plot. The results showed that the use of plastic mulch significantly increased the number of fruits per plant, while the 0 $ml.l^{-1}$ biofertilizer concentration showed the most effective reduction in the percentage of fruits experiencing BER. Moreover, an interaction between mulch and biofertilizer treatments was observed, particularly in relation to plant height 1 week after planting, the number of fruits per plant, and the percentage of fruits experiencing BER.

Keywords— generative, microbes, ground cover, vegetative

1 Introduction

Tomato is a horticultural commodity with significant economic potential, widely recognized and valued within the community. In Lampung Province, the production of this commodity expresses fluctuations over the period spanning from 2018 to 2022. In

2018, tomato production reached 19,604 tons, followed by 18,669 tons in 2019, 19,096 tons in 2020, 15,934 tons in 2021, and 16,190 tons in 2022 [1].

According to [2], lowland tomato cultivation in this region faces numerous challenges, including high temperatures, low soil fertility, high soil acidity, and pest infestations. The application of biological fertilizers become one of the potential solutions to mitigate these problems. Based on the study of [3], biofertilizer were fertilizers containing a single microorganism or a combination of several microorganisms (consortium) that acted as plant growth promoters, nitrogen fixers, phosphate solvents, and inhibitors of plant disease development. [4] further reported that biofertilizer dose of 4 $l.ha^{-1}$ significantly affected the number of primary branches and flowers in tomato plants. In addition to biological fertilizers, another strategy to enhance tomato cultivation is the use of mulch.

Mulch, the ground cover material placed around plants, comes in two primary types, including organic and inorganic. According to [5], organic mulch is plant residues such as rice debris, sawdust, corn stalks, and prunings from hedges, leaves, and plant twigs that can improve soil fertility, structure, and water retention capacity. Inorganic mulch, on the other hand, includes all materials derived from rocks, plastics, or other chemicals. [6] showed that providing straw mulch with a thickness of 1.5 cm resulted in a total of 9.00 fruits tan^{-1}, with a fresh weight of 0.62 kg tan^{-1} in tomato plants. Additionally, [7] reported that black silver plastic mulch outperformed both no mulch and plastic mulch in terms of plant height and total leaf count in red chili plants.

The application of biofertilizer to tomatoes has never been applied and it is hoped the addition of several types of mulch will affect the effectiveness of the microorganism consortium in biofertilizer. Based on research by [8], the use of straw as mulch in the short term, although only able to increase the consortia of certain soil microorganisms, is still able to increase the production of unstable C and N components and accelerate the C and N cycle in cultivated land. This study aims to assess the effect of diverse concentrations of biological fertilizers, mulch types, and their interaction on growth and production of tomato plants.

2 Material and Methods

The study was conducted from September to December 2022 in the experimental garden of Lampung State Polytechnic. Various tools were used for the experiment, including hoes, meters, measuring cups, seedling containers, hand sprayers, knapsack sprayers, bamboo stakes, buckets, digital scales, and a hallway. The materials used were Gustavi F1 cultivar tomato seeds, Liquid Organic Biofertilizer (LOB) produced by PT Great Giant Pineapple, containing *Bacillus sp., Meyerozyma sp.,* and *Saccharomyces sp*. which facilitated phosphate dissolution and production of plant growth hormones (IAA/Auxin, Giberalin, Kinetin, and Zeatin), plastic mulch, straw mulch, chemical insecticides, NPK Mutiara fertilizer, seedling plastic, subsoil, cow dung organic fertilizer, and raffia rope.

The study began with the sowing of tomato seeds, which were nurtured for 7 days after sowing (DAS) in seedling containers. Subsequently, the seedlings were transplanted into 1x1 m beds using plastic mulch and kept for 14 days. Two weeks after planting (WAP), the seedlings were transferred to the field, spaced at 60 x 50 cm on previously prepared soil enriched with 20 tons.ha^{-1} of cow dung organic fertilizer and 5 kg.ha^{-1} of dolomite. Maintenance comprised three applications of NPK Mutiara fertilizer, with the first applied 4 days after planting (DAP) at a dose of 5 g.plant^{-1}, and the second and third applications given at 18 DAP and 39 DAP, respectively, at 20 g.plant^{-1}. Furthermore, regular chemical insecticide spraying was carried out in the experiment. Hilling, bud pruning, and weeding were performed as part of routine plant care, with plant staking conducted at 14 DAP. Biofertilizer was applied 4 times, precisely at 1, 2, 3, and 4 weeks after planting, with a predetermined concentration. Mulch was installed after soil preparation by using mulch types corresponding to each treatment within the experimental plots. Additionally, harvesting occurred regularly between 7 to 11 weeks after planting.

The parameters observed in this study included plant height at 1 and 3 weeks after planting, fruit diameter, number of fruits per plant, the percentage of fruits experiencing Blossom End-Rot (BER), and fruit weight per plot. Plant height measurements were taken at 1 and 3 weeks after planting, while fruit diameter, the number of fruits per plant, the percentage of fruits experiencing BER, and fruit weight per plot were recorded at each harvest and subsequently averaged.

A randomized group design (RGD) arranged factorially was used for the experiment, with the first factor comprising no mulch (M0), straw mulch (M1), and plastic mulch (M2). The second factor was five concentrations of biofertilizer, including 0 $ml.l^{-1}$ (L0), 5 $ml.l^{-1}$ (L1), 10 $ml.l^{-1}$ (L2) 15 $ml.l^{-1}$ (L3), and 20 $ml.l^{-1}$ (L4). This resulted in a total combination of 15 treatment levels, each of which was replicated three times, yielding 45 experimental units. Each experimental unit consisted of six plant samples, resulting in a total of 270 plant samples analyzed. Data collected from these samples were subjected to analysis using the F test (analysis of variance). In cases where significant differences were observed, further analysis was conducted using Duncan Multiple Range Test (DMRT) at an α level of. DMRT is used to compare all pairs of treatments and for treatments that are used more than two [9]

3 Results and Discussions

The use of diverse mulch types in this study expressed a significant impact solely on the total number of tomato fruits. Meanwhile, the application of various concentrations of biological fertilizers only had a substantial effect on the percentage of fruits experiencing BER. The interaction between these two treatments yielded a significant effect on plant height at 1 week after planting, the number of tomato fruits, and the number of fruits affected by BER. Detailed results of DMRT concerning impact of mulch and biological fertilizer on plant height, fruit diameter, number of fruits per plant, percentage of fruits experiencing BER, and fruit weight per plot in tomato plants could be found in Table 1. Furthermore, the interaction between mulch and biological fertilizer in relation to growth of plant height 1 week after planting, the number of fruits per plant, and the percentage of fruits experiencing BER could be observed in Table 2.

The isolated impact in Table 1 of applying various mulch types yielded no significant effects on the plant height, fruit diameter, the percentage of fruits experiencing BER, and fruit weight per plot. This result was consistent with [10] who showed that the application of organic mulch had no substantial effect on various parameters, including plant height, leaf count, leaf length and width, flowering time, and fruit weight in tomato plants. Furthermore, [11] reported that the use of straw mulch, plastic mulch, and no mulch had no significant impact on stalk weight and the total flower count in chili plants. This could be attributed to the incomplete decomposition of the organic mulch used, specifically rice straw, rendering the nutrients less accessible to plants. Moreover, the variable air temperature conditions in the planting location, particularly in Lampung, contributed to this effect.

[12] reported that the effectiveness of black and silver plastic mulch in vegetable crops was more pronounced when the surrounding temperature was relatively low. When the air temperature method optimal conditions, plastic mulch might not have yielded significant effects. Table 1 can be seen that the isolated application of various biofertilizer concentrations failed to have a significant influence on plant height, fruit diameter, fruit number, and fruit weight per plot. These results were consistent with [13], showing that the application of biofertilizer up to 20 $ml.l^{-1}$ did not affect growth and production of tomatoes. This might have been attributed to the higher concentration of applied biofertilizer, leading to increased microbial competition. According to [14], this competition among microbes for nutrients could result in suboptimal microbial performance.

The use of plastic mulch significantly increased the number of tomato fruits. Tomato plants, which used mulch showed a greater fruit yield compared to those without mulch. The result was consistent with the study by [15], showing that the application of black and silver plastic led to a higher number of fruits in tomato plants. This effect could be attributed to the capacity of mulch to reduce soil water evaporation, thereby maintaining adequate water availability for tomato plants. Mulch played a crucial role in mitigating soil temperature fluctuations and preserving soil moisture. The consistent water supply provided by mulch allowed tomato plants to achieve higher fruit production. The use of plastic mulch does not pollute the soil in the long term because waste from plastic mulch will be managed in waste management site.

The application of biofertilizer had a significant impact on increasing the percentage of fruits experiencing BER (Table 1). The addition of biological fertilizer to the soil is thought to increase the availability of nitrogen (N) and phosphorus (P) nutrients for the plants. Apart from that, the increase in N and P suspected that at the time of the research, NPK fertilizer was applied at a dose of 5 grams/plant which is applied 3 times during the planting period. BER in tomato fruit was commonly linked to abiotic factors and calcium (Ca) deficiency. This observation was consistent with the results from [16], who reported a lower incidence of BER disorder in plants receiving a calcium fertilizer dose of 10 kg ha^{-1} compared to those receiving 0 and 5 kg ha^{-1} doses. Furthermore, an imbalance between Ca and other elements such as N, P, and K in tomato fruits could lead to BER [17].

Table 1. Effect of mulch and biofertilizer on plant height, fruit diameter, number of fruits per plant, percentage of fruits with BER, and fruit weight per plot of tomato plants

Treatment	Plant height 1 WAP (cm)	Plant height 3 WAP (cm)	Number of fruits per plant	Percentage of fruit with BER	Fruit diameter (cm)	Fruit weight/plot (gram)
Mulch						
No Mulch	20.21	125.80	22.97 b	10.63	4.45	6168.95
Straw	21.99	120.38	26.87 b	11.46	4.52	9907.98
Plastic	23.92	121.64	32.5 a	9.09	4.51	7976.46
Biofertilizer Concentration						
0 ml	22.54	117.35	27.98	6.83 b	4.48	5392.37
5 ml	20.81	117.52	23.81	12.21 a	4.40	12044.69
10 ml	20.57	141.80	29.50	13.06 a	4.69	8901.99
15 ml	21.23	115.37	28.91	9.40 ab	4.44	7052.98
20 ml	25.05	121.00	27.02	10.45 ab	4.45	6696.96
Interaction	*	tn	*	*	tn	tn

Notes: Numbers followed by the same letter in the same column indicate results that are not significantly different based on DMRT at $\alpha = 5\%$, tn = no significant effect, * = significant effect.

The combined application of mulch and biofertilizer treatments had a significant effect on plant height 1 week after planting, the number of fruits, and the percentage of fruits experiencing BER. The use of plastic mulch without biofertilizer resulted in the most robust plant height growth compared to the use of plastic mulch with a 20 ml.l^{-1} biofertilizer (Table 2). This suggested that the application of biofertilizer alongside mulch at the initial stages of planting might not have optimized plant growth.

Table 2. Interaction between mulch and biofertilizer on growth of tomato plant height at 1 week after planting, the number of fruits per plant, and the percentage of fruits experiencing BER

Treatment	Plant height at 1 WAP	Number of fruits per plant	Percentage of fruit with BER
M0P0	17.62 ef	28.00 bcde	8.81cdef
M0P1	16.44 ef	11.94 f	8.91cdef
M0P2	25.67 abcd	33.44 abc	8.54cdef
M0P3	25.14 abcd	21.89 def	6.97def
M0P4	16.17 ef	19.56 ef	19.90 a
M1P0	19.28 def	29.39 bcde	9.47 bcdef
M1P1	16.50 ef	19.44 ef	16.90 ab
M1P2	23.14 bcde	27.61 bcde	14.53 abcd
M1P3	22.47 cde	33.50 abc	10.73 bcde
M1P4	28.58 abc	24.39 cde	5.66 ef
M2P0	30.72 a	26.56 bcde	2.22 f
M2P1	29.47 ab	40.06 a	10.82 bcde
M2P2	12.92 f	27.44 bcde	16.11 abc
M2P3	16.08 ef	31.33 abcd	10.51 bcde
M2P4	30.39 a	37.11 ab	5.78 ef

Notes: Numbers followed by the same letter in the same column indicate results that are not significantly different based on DMRT at α = 5%, tn = no significant effect, * = significant effect, M0 = without mulch, M1 = straw mulch, M2 = silver plastic mulch, P0 = without biofertilizer, P1 = 5ml.l-1, P2 = 10ml.l-1, P3 = 15ml.l-1, P4 = 20ml.l-1.

The black portion of PHP mulch was positioned facing downward, making direct contact with the soil. This configuration has a significant impact on increasing soil moisture and creating a favorable microclimate. Simultaneously, the provision of NPK fertilizer during transplanting played a crucial role in initiating nutrient absorption essential for early-stage plant growth.

The silver part of mulch, situated above the ground, functioned by indicating sunlight that reached the surface of mulch [18]. This showed sunlight provided plants with increased light and influenced the temperature above the ground, resulting in higher temperatures. Therefore, any rain or irrigation water collected on mulch surface dried more rapidly [19]. This feature proved particularly advantageous in reducing the percentage of fruits affected by BER. Based on the data obtained, the use of black and silver plastic mulch appeared more effective in reducing the percentage of BER-affected fruits. Table 2 showed that the lowest percentage of fruits experiencing BER occurred when black and silver plastic were used without biofertilizer application.

Creating a favorable microenvironment enhanced nutrient availability for plant absorption, increased cation exchange capacity, and improved soil porosity, collectively supporting the survival of soil microbes. For instance, biofertilizers contained aerobic bacteria such as *Pseudomonas sp.* and *Bacillus sp.,* commonly found in biofertilizer. These aerobic bacteria expanded in oxygen-rich environments, optimizing the mineralization process [20].

The mineralization process signified the final stage of organic matter decomposition, converting it into mineral plant nutrients in relatively modest quantities. Soil organic matter serving as a nitrogen source, was subjected to a transformation known as ammonification, where microbes converted it into amino acids and subsequently into ammonium. This process might not have significantly benefited plant growth, as observed in the plant height at 1 week after planting (Table 3). In treatments with plastic mulch and no biofertilizer (M2P0), plant height expressed superior growth compared to those with 20ml.l^{-1} biofertilizer application (M2P4).

The mineralization process and the efficacy of biofertilizer were believed to become optimal after several weeks of observation. In Table 2, it was evident that the combination of plastic mulch with 20 ml.l^{-1} biofertilizer yielded a higher number of fruits when compared to other treatment combinations. Biofertilizer contributed to increased phosphorus (P) availability in the soil. [21] stated that when phosphorus was adequately available in the root zone, it facilitated the absorption of other essential nutrients, such as potassium (K). Phosphorus was instrumental in the fertilization process, while potassium enhanced fruit quality, ultimately influencing the harvest.

4 Conclusions

In conclusion, it was observed that plastic mulch became the most effective, yielding the highest tomato fruit count compared to other alternatives. The concentration of 0 $ml.l^{-1}$ LOB proved to be the most effective in mitigating the occurrence of BER-affected fruits. The interaction between mulch types and LOB concentrations manifested significant effects exclusively in terms of plant height 1 week after planting, the number of fruits, and the percentage of fruits experiencing BER. An optimal combination for achieving the highest fruit yield per plant in tomato cultivation comprised the use of black and silver plastic mulch in conjunction with a 5 $ml.l^{-1}$ LOB concentration.

Acknowledgements

The authors are grateful to all those who contributed to the successful execution of this study. The authors extend their gratitude to the Lampung State Polytechnic for providing the necessary funding for the publication of this article.

References

[1] Badan Pusat Statistik, Produksi Tanaman Sayuran 2023, Available: https://www.bps.go.id/indicator/55/61/1/produksi-tanaman-sayuran.html, 2023.

[2] S. Sabahannur and L. Herawati, Pertumbuhan dan produksi tanaman tomat (*Lycopersicum esculentum* Mill.) pada berbagai jarak tanam dan pemangkasan, *Jurnal Agrotek*, vol. 1, no. 2, pp. 32-42, 2017.

[3] R. Kumar, N. Kumawat, and Y.K. Sahu, Role of biofertilizers in agriculture, Popular Kheti. vol. 5, no. 4, pp. 63-66, 2017.

[4] P. Sanjaya, N. Kurnia, K. Hendarto, and F. Yelli, Pengaruh pupuk kandang dan pupuk hayati pada pertumbuhan dan produksi tanaman tomat (*Lycopersicum esculentum* Mill.), *Jurnal Agrotek Tropika*, vol. 9, no. 1, pp. 171-176, 2021.

[5] D.R.R. Damaiyanti, N. Aini, and Koesriharti, Kajian penggunaan macam mulsa organik pada pertumbuhan dan hasil tanaman cabai besar (*Capsicum annuum* L.), *Jurnal Produksi Tanaman*, vol. 1, no. 2, pp. 25-32, 2013.

[6] D. Anggorowati, R. Sulistyono, and N. Herlina. Respon tanaman tomat (Lycopersicum esculentum Mill.) pada berbagai tingkat ketebalan mulsa jerami padi. *Jurnal Produksi Tanaman*, vol. 4, pp. 378-384, 2016.

[7] G.D. Trenaldi, Y. Sepriani, D.H. Adam, and I.A.P. Septyani, Respon penggunaan plastik hitam perak terhadap pertumbuhan tanaman cabai merah (*Capsicum annuum* L.) di Perkebunan Afdeling 2 Kecamatan Bilah Barat Kabupaten Labuhan Batu, *Jurnal Education and Development*, vol. 10, no. 3, pp. 14-18, 2022

[8] B. Liu *et al.*, “Straw mulch improves soil carbon and nitrogen cycle by mediating microbial community structure and function in the maize field,” *Front. Microbiol.*, vol. 14, 2023, doi: 10.3389/fmicb.2023.1217966.

[9] A. . Matjik and I. . Sumertajaya, *Perancangan Percobaan I*. 2006.

[10] H. Yulianingrum, E. Supraptomo, and P. Setyanto, Pengaruh pemberian mulsa jerami padi terhadap kelimpahan gulma dan pertumbuhan tanaman tomat (*Solanum lycopersicum*) di lahan tadah hujan. Prosiding Konser Karya Ilmiah. Universitas Kristen Satya Wacana, Salatiga. 4 Agustus 2016, 2016.

[11] S. Ardhona, K. Hendarto, A. Karyanto, and Y.C. Ginting, Pengaruh pemberian dua jenis mulsa dan tanpa mulsa terhadap karakteristik pertumbuhan dan produksi tanaman cabai merah (*capsicum annum* L.) pada dataran rendah, *Jurnal Agrotek Tropika*, vol.1, no. 2, pp. 153-158, 2013.

[12] R. Rukmana, Budidaya Kubis Bunga dan Broccoli, Kanisius, Yogyakarta, 1995.

[13] A.R. Ziladi, K. Hendarto, Y.C. Ginting, and A. Karyanto, Pengaruh jenis pupuk organik dan aplikasi pupuk hayati terhadap pertumbuhan dan produksi tanaman tomat (*Solanum lycopersicum* Mill.) di Desa Sukabanjar Kecamatan Gedong Tataan, *Jurnal Agrotek Tropika*, vol. 9, no. 1, pp. 145-151, 2021.

[14] R.D.M. Simanungkalit, A.S. Didi, S. Rasti, S. Diah, and H. Wiwik, Pupuk Organik dan Pupuk Hayati, Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian, Jawa Barat, 2006.

[15] R. Fadel, R. Yusuf, and A. Syakur, Pertumbuhan dan hasil tanaman tomat (*Lycopersicum esculentum* mill.) pada pemberian berbagai jenis mulsa, *Jurnal Agrotekbis*, vol. 5, no. 2, pp. 152 – 160, 2017.

[16] C. Rachmah, M. Nawawi, and Koesriharti, Pengaruh aplikasi pupuk kalsium ($CaCO_3$) dan giberaline pada pertumbuhan, hasil, dan kualitas buah pada tanaman tomat (*Lycopersicum esculentum* Mill.), *Jurnal Produksi Tanaman*, vol. 5,no. 3, pp. 515-520, 2017.

[17] L.C.Ho and P. Adams, Nutrient uptake and distribution in relation to crop quality, Acta Hort, 396: 33-44, 1995.

[18] M. Muslim and R. Soelistyono, “The Effect Of Silver Black Plastic Mulch With Various Form And High Of Seedbed On Growth Of Cauliflower (Brassica oleracea var. Botrytis L.),” *PLANTROPICA J. Agric. Sci. 2017*, vol. 2, no. 2, pp. 85–90, 2017.

[19] M. Setyowati, T. Sarwanidas, and Maimunsyah, “The Effect Of Types Mulch And Doses Of NPK Fertilizer On The Growth And Results Melon Plants (Cucumus melo L.),” *J. Agrotek Lestari*, vol. 2, no. 2, pp. 37–46, 2016.

[20] E. Marista, S. Khotimah, and R. Linda, “Bakteri Pelarut Fosfat Hasil Isolasi dari Tiga Jenis Tanah Rizosfer Tanaman Pisang Nipah (Musa paradisiaca var. nipah) di Kota Singkawang,” *Protobiont*, vol. 2, no. 2, pp. 93–101, 2013.

[21] Koesriharti and D. R. Meylia, “Pengaruh Pemberian Pupuk Fosfor dan Sumber Kalium Yang berbeda Terhadap Pertumbuhan dan Hasil Tanaman Tomat (Lycopersicum esculentum Mill .) effect of phosphorus fertilizer and potassium different source on the growth and yield of tomato plants (Lycoper,” *J. Produksi Tanam.*, vol. 6, no. 8, pp. 1934–1941, 2018.

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