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Tomato Plant Production (*Lycopersicum esculentum*, Mill) Due to Main Branch Pruning and GDM Liquid Organic Fertilizer (POC) Concentration

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Abstract: Tomatoes (*Lycopersicum esculentum*, Mill) are classified as fruit vegetables that contain a lot of water, store a lot of seeds, contain vitamins A and C, and a little vitamin B. To ensure the availability of tomato production, improvements are needed, including pruning and liquid organic fertilizers. The study aimed to determine the effect of pruning and GDM POC on the growth and production of tomato plants. The design used was a factorial RAK pattern consisting of factor I: pruning the main shoot; P0: No pruning (control) P1: pruning the main shoot; Factor II: GDM POC; G0: Control (GDM Fertilizer); G1: concentration of 2 ml/liter of water/plot; G2: Concentration of 4 ml/liter of water/plot; G3: Concentration of 6 ml/liter of water/plot. The study's results showed that pruning the main branches and giving GDM POC concentration to tomatoes significantly affected the yield of tomato plants. The P1G3 treatment produced the best growth and yield of tomato plants. The interaction between pruning of the main branches and giving of 6 ml plot-1 concentration resulted in an average plant height of 98 cm, number of leaves 131 strands, flowering age 32 HST, number of fruits 2 plants-1, and fruit weight 21.83 g. The conclusion is that pruning and GDM POC influence the growth and production of tomato plants.

Keywords: *Lycopersicum esculentum;* Pruning; POC GDM.

Introduction

Tomatoes are a fruit vegetable with various uses and can be cultivated in lowland and highland areas. According to (Cheng et al., 2020), ripe tomatoes are highly sought after due to their fresh, delicious, and slightly sour taste. Tomato flesh contains a high-water content and numerous seeds. Furthermore, tomatoes are rich in health-boosting vitamins A and C, while vitamin B content is relatively low (Tufail et al., 2024).

The Statistics Indonesia (BPS) of East Nusa Tenggara Province (2019) stated that production in 2017, 2018, and 2019 reached 6,716 tons in 2017, 5,465 tons in 2018, and 9,950 tons in 2019. This fluctuating production impacts tomato availability, impacting tomato prices, which tend to increase during certain seasons (Ali et al., 2023). To ensure the availability of tomato production, improvements are needed, including in cultivation techniques (Geoffrey et al., 2014). Pruning is a cultivation technique that must be considered to improve fruit quality.

Pruning aims to reduce the number of shoots and stem tips, thus maximizing fruit growth (du Toit et al., 2020). Fruit produced by overly dense plants is generally small and takes longer to ripen because of the high nutrient requirements for leaf growth. Pruning is also helpful in reducing pest and disease infestation (Ramanjineyulu et al., 2024). Three types of pruning are

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generally used: young shoot pruning, stem pruning, and flower and fruit pruning (Dhillon & Thakur, 2014).

Pruning the main branches aims to reduce the number of primary branches, which is expected to maximize photosynthetic production for tomato fruit formation and development (Pasaribu et al., 2015). Pruning the main shoots aims to reduce the number of primary branches, which is expected to improve fruit quality by reducing the number of fruits, optimally storing assimilates in the fruit, increasing food reserves, and ensuring normal seed germination (Brizzolara et al., 2020). Research by (Xu et al., 2020) explains that pruning tomato plants significantly affects fruit diameter and number per plant. Research (Fallah et al., 2021) found that no-pruning treatments resulted in higher yield potential but had little impact on tomato fruit quality.

Research (Xu et al., 2020) showed that pruning significantly affected tomato fruit diameter and the number of fruits per plant. Still, it did not integrate organic fertilization factors that can optimally influence crop quality and quantity. Therefore, this study explores the effect of main branch pruning and the application of GDM liquid organic fertilizer on tomato production. This will provide new insights into more optimal and sustainable yield increases. In addition to main branch pruning to increase tomato productivity, cultivation improvements through fertilization are necessary. Fertilization provides nutrients or fertilizer to the soil so plants can absorb them. One organic fertilizer used by farmers is GDM POC.

GDM liquid organic fertilizer is a multi-purpose liquid organic fertilizer that supports plant root growth and development, increases plant disease tolerance, and produces more vigorous plants under extreme conditions. GDM liquid organic fertilizer stimulates microbial activity in the soil, producing macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) (Rosalyne et al., 2024). When applied at the correct concentration, timing, and method (Beven, 2020), foliar fertilizer spraying is relatively easy for plants to absorb and prevents damage to the soil's physical and chemical properties. Research by (Rambe et al., 2019) explains that GDM Liquid Organic Fertilizer (POC) at a concentration of 4 ml/L of water produces the best results in terms of fruit number per plant, stem diameter, flowering days per plant, fruit number, and fruit weight on tomato plants.

However, while previous studies have provided information regarding the effect of pruning on tomato growth and fruit quality, most have not comprehensively examined the interaction between main branch pruning and the application of liquid organic fertilizer (POC) to support tomato production. This study aimed to determine the effect of pruning and GDM Liquid Organic Fertilizer on tomato plant growth and production. To obtain one pruning treatment and GDM POC concentration that provides the best growth and production of tomato plants, and to determine the interaction of pruning and GDM POC on the growth and production of tomato plants.

Method

Time and Location

The research was conducted in Kupang Regency, West Kupang District, Oenesu Village, from November to January 2024. The research area has unique environmental conditions, with predominantly latosol soils. The climate in this area is tropical, with two distinct seasons: the rainy and dry seasons. During the research period, the area experienced the rainy season from November to January, which is usually accompanied by relatively high rainfall. Average rainfall during the research period ranged from 150–250 mm per month, which supports optimal plant growth. The air temperature at the research site ranged from 25°C to 32°C, with relatively high relative humidity, reaching around 75–85%.

Research design

The design used was a factorial randomized block design (RBD) consisting of two factors:
Factor I: Main branch pruning
P0: No pruning (control)
P1: Main branch pruning
Factor II: GDM fertilizer (POC)
G0: Control (GDM fertilizer)
G1: Concentration of 2 ml/liter of water/plot
G2: Concentration of 4 ml/liter of water/plot
G3: Concentration of 6 ml/liter of water/plot

The research plot design used was as follows:

Treatment Combinations: There were eight treatment combinations derived from the interaction between the two factors (pruning and GDM fertilizer):
1. P0G0: No pruning and no GDM fertilizer
2. P0G1: No pruning and a concentration of 2 ml/liter of water/plot
3. P0G2: No pruning and a concentration of 4 ml/liter of water/plot
4. P0G3: No pruning and a concentration of 6 ml/liter of water/plot water/plot
5. P1G0: Pruning of primary branches and no GDM fertilizer
6. P1G1: Pruning of primary branches and a concentration of 2 ml/liter of water/plot
7. P1G2: Pruning of primary branches and a concentration of 4 ml/liter of water/plot
8. P1G3: Pruning of primary branches and a concentration of 6 ml/liter of water/plot

Block (Group): Each treatment combination will be replicated three times, resulting in three replication blocks. Each treatment combination will be randomly assigned to a different plot within each block.

Activity Parameters
1) Plant Height (cm)
2) Number of Leaves
3) Flowering Age (DAP)
4) Number of Fruits per Plant (fruits)
5) Fresh Fruit Weight per Plant (g)

Data Analysis

The mathematical model of the randomized block design (RBD) according to (VairaMariappan & Palanisamy, 2023) is:

$$Yijk = \mu + \alpha i + \beta j + (AB)ij + eij \quad (1)$$

Where:
Yijk = General observation value for the first factor at level i, the second at level j, and the kth replication.
μ = General mean
αi = Effect of the first factor at level i.
βj = effect of the second factor at level j.
(AB)ij = effect of the interaction between factor i at level j and factor II at level j.
eijk = Effect of experimental error
i = (1,2,3) and j = (1,2,3) and k = (1,2,3)

The research data obtained were analyzed using analysis of variance (ANOVA) to determine the effect of the treatments. If the treatment had an effect, a Duncan test (5%) was used to determine the differences between the treatments.

Result and Discussion

Plant Height (cm)

The variance analysis results indicate that the interaction between the primary branch pruning treatment and the GDM liquid organic fertilizer (POC) concentration significantly affected tomato plant height. The average tomato plant height resulting from the main branch pruning treatment and GDM liquid organic fertilizer (POC) concentration can be seen in Table 1. The results of the 5% Duncan test in the table above show the lowest average tomato plant height in the interaction between the use of GDM POC at a concentration of 6 ml/liter of water/plot and main branch pruning (P0G0), which differed from the other treatments. This is because pruning of the main branches, although performed, did not reduce tomato plant growth. Pruning is necessary to balance vegetative growth (Albarracín et al., 2017). The treatment that produced the highest plant height was P0G0 (control). This was due to limited nutrient availability and the lack of pruning, resulting in many lateral branches and competition for nutrients and photosynthesis.

Table 1. Average Tomato Plant Height Due to Main Branch Pruning and GDM Liquid Organic Fertilizer (POC) Concentration

Factor P	Factor N			
	G0	G1	G2	G3
P0	142.33a	137.33b	135.00c	133.67d
P1	120.67e	119.33f	118.00g	98.00h

Note: Average figures followed by different notations show significant differences, but those with the same notation do not differ significantly at the 5% Duncan test level.

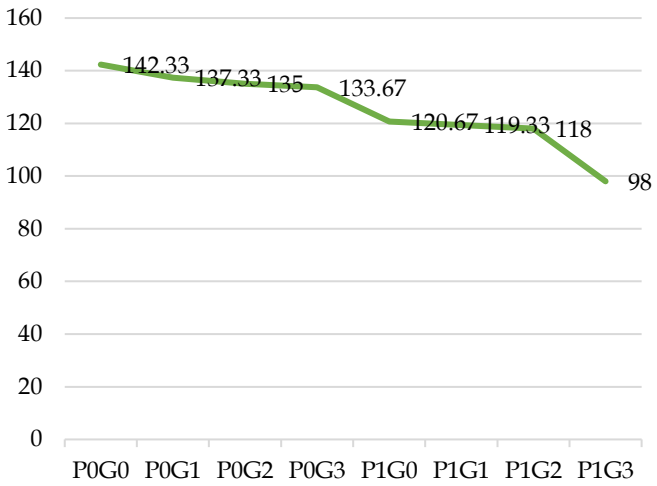

Figure 1. Average Plant Height

Pruning of the main branches is also performed. Pruning the upper part of the plant results in the loss of apical dominance and stimulates the growth of new shoots in the axillary part of the stem. Apical dominance is the regulation of dominant growth at the tip of the plant, which suppresses other meristematic regions (Beveridge et al., 2023). This apical dominance plays a role in plant branching (Rubio-Moraga et al., 2014). Availability of nutrients in a sufficient, balanced amount supports plant growth, cell division, photosynthesis, and cell elongation during the vegetative phase (Shrivastava et al., 2020)

Plant height growth is closely related to the N content that the plant can absorb. Explain that plant height increases continuously from vegetative to generative phases (Evstigneev & Korotkov, 2016). However, the most rapid increase in plant height occurs during the vegetative phase. Therefore, plant growth will be optimal if all growth requirements are met during the vegetative phase. Explain that nitrogen is beneficial for vegetative plant growth, namely the

formation of new cells such as leaves and branches, and the replacement of damaged cells (Rambe et al., 2019). Furthermore, (Luo et al., 2020) explains that nitrogen increases plant height, stimulates budding, and increases protein content.

Leaf Number

The analysis of variance indicates that the interaction between the primary branch pruning treatment and the GDM liquid organic fertilizer (POC) concentration significantly affected the number of leaves on tomato plants. Table 2 shows the average number of tomato leaves from the main branch pruning treatment and the GDM liquid organic fertilizer (POC) concentration.

Table 2. Average Number of Tomato Plant Leaves Due to Pruning of Main Branches and Concentration of GDM Liquid Organic Fertilizer (POC)

Factor P	Factor N			
	G0	G1	G2	G3
P0	51.44a	73.33b	74c	75d
P1	75.99e	94.33f	93g	131h

Note: Average figures followed by different notations show significant differences, but those with the same notation do not differ significantly at the 5% Duncan test level.

The results of the 5% Duncan test in the table above show the highest average number of tomato leaves in the interaction between the use of GDM Organic Fertilizer (POC) at a concentration of 6 ml/liter of water/plot and pruning of the main branches (P1G3), differing from the other treatments. This is due to the GDM Organic Fertilizer providing nutrients that the plants can absorb. The adequate phosphorus availability in GDM Organic Fertilizer plays a role in plant growth (stems, roots, and branches). Pruning can also stimulate vegetative growth, including leaf number.

The treatment with the lowest leaf number was P0G0 (control). This was due to limited nutrient availability and the lack of pruning, resulting in numerous lateral branches and competition for nutrients and photosynthesis. Phosphate is needed by plants for cell formation in growing root and shoot tissues and to strengthen stems, preventing them from falling over in natural ecosystems (Bechtaoui et al., 2021; Malhotra et al., 2018). Furthermore, (Adhikari & Kandel, 2015) said that the number of productive branches of the plant increased as a result of pruning the shoots, resulting in more fruit being formed and a greater number of productive leaves.

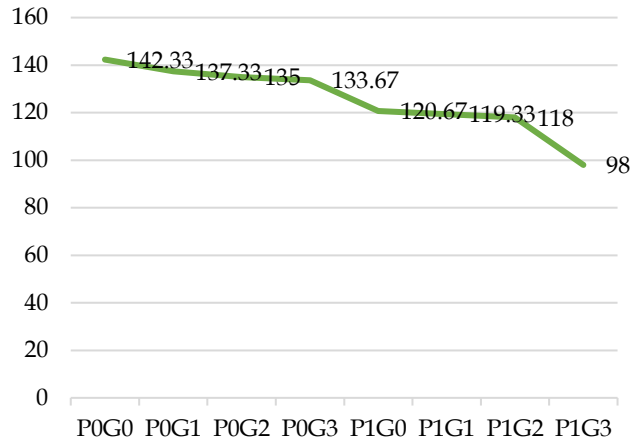

Figure 2. Average Number of Leaves

Flowering Age (DAA)

The analysis of variance indicates that the interaction between the primary branch pruning treatment and the concentration of GDM liquid organic fertilizer (POC) significantly affected the flowering age of tomato plants. Table 3 shows the average number of leaves on tomato plants resulting from the main branch pruning treatment and GDM liquid organic fertilizer (POC) concentration.

Table 3. Average Flowering Age of Tomato Plants Due to Main Branch Pruning and GDM Liquid Organic Fertilizer (POC) Concentration

Factor P	Factor N			
	G0	G1	G2	G3
P0	43.33 a	43.00a	42.00 ab	40.33 b
P1	36.33 c	34.67 cd	32.00 d	28.00 e

Note: Average figures followed by different notations show significant differences, but those with the same notation do not differ significantly at the 5% Duncan test level

Duncan's test results at the 5% level (Table 4) showed that the lowest average flowering age was found in the P1G3 treatment (pruning and applying 6 ml of GDM Organic Fertilizer per plot-1) and significantly different from the other treatments. This is likely due to the GDM Organic Fertilizer increasing nutrient uptake by tomato plants, thereby accelerating the flowering process. Furthermore, pruning the main branches resulted in no competition between lateral branches and generative parts that grew and developed after pruning. Generative parts, such as flowers and fruit, received adequate assimilates. Adequate assimilate distribution can maximize flower and fruit formation (Anuradha & Bishnoi, 2017).

The longest average flowering age was found in the P0G0 treatment (no treatment). This is suspected to be due to the lack of GDM Organic Fertilizer treatment,

which resulted in a nutrient deficiency in the plant's metabolic processes. Furthermore, the treatment without pruning resulted in numerous littoral and bilateral branches, leading to competition for photosynthesis.

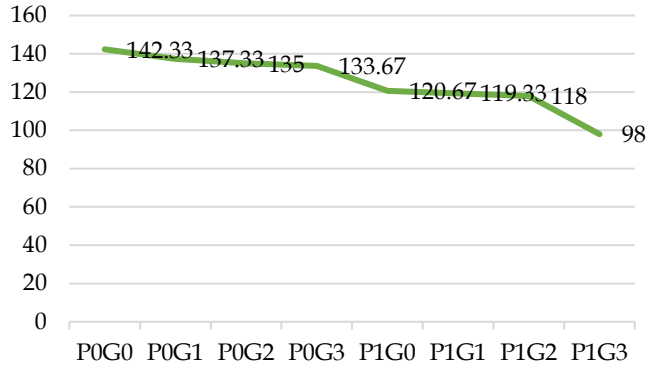

Figure 3. Average flowering age

Adequate nutrient availability, especially phosphorus (P), for plants can aid the flowering process, resulting in more fruit formation (Malhotra et al., 2018). Phosphorus is a key nutrient for plant growth because it is a constituent of all proteins and nucleic acids and a component of the plant's protoplasm (Sarif, 1985). Therefore, with sufficient phosphorus (P) in tomato plants, all cellular tissue activities within the plant will proceed normally, accelerating flowering, fruit formation, and seed formation. The longest average flowering time was found in the P0G0 treatment (without treatment). This is suspected to be due to the lack of nutrient requirements for metabolism without GDM liquid organic fertilizer (POC). Furthermore, the treatment without pruning resulted in numerous littoral and bilateral branches, leading to competition for photosynthesis.

Fruit Number

The analysis of variance revealed a significant interaction between the primary branch pruning treatment and the concentration of GDM liquid organic fertilizer (POC) on the flowering time of tomato plants. Table 4 shows the average number of tomato plants resulting from the primary branch pruning treatment and GDM liquid organic fertilizer (POC) concentration.

Table 4. Average Number of Tomato Fruits Due to Pruning of Main Branches and Concentration of GDM Liquid Organic Fertilizer (POC)

Factor P	Factor N			
	G0	G1	G2	G3
P0	12.89a	14.00ab	13.66 ab	14.17 ab
P1	14.77 abc	15.00 abc	16.00 abc	22.00d

Note: Average figures followed by different notations show significant differences, but those with the same notation do not differ significantly at the 5% Duncan test level

Duncan's test results at the 5% level, the P1G3 treatment (pruning the main branches and administering 6 ml of GDM POC/plot) showed the highest average number of fruits, significantly different from the other treatments. This increase in the number of fruits can be explained by two main factors: fertilization using GDM POC and pruning the main branches. The lowest number of fruits was in the P0G0 treatment interaction and significantly differed from the other treatments. This is thought to be due to a lack of nutrients in tomato plants, which causes low photosynthesis, which impacts the generative development of tomato plants.

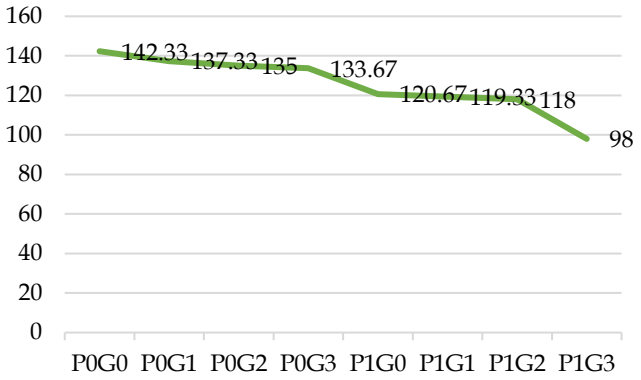

Figure 4. Average number of fruits

GDM Organic Fertilizer (POC) contains essential plant nutrients, such as nitrogen, phosphorus, potassium, and microelements, essential for supporting plant physiological processes, particularly protein synthesis, cell division, and fruit formation. Providing GDM Organic Fertilizer (POC), which contains a complete range of nutrients, can improve plant nutrient balance, increase photosynthetic efficiency, and support the development of vegetative and generative organs (fruit). As a liquid organic fertilizer, GDM Organic Fertilizer (POC) can also increase nutrient availability in the soil, which is more easily absorbed by plant roots than solid fertilizers. Research by (Ye et al., 2020) shows that fertilization with POC can improve tomato plant growth and yield, as the nutrients contained in POC can increase the number of flowers and fruits.

Furthermore, pruning main branches is crucial in optimizing the distribution of photosynthate energy to more productive plant parts, such as flowers and fruit. By reducing unproductive main branches, plants can focus more on producing assimilates for fruit formation, increasing fruit production. Pruning main branches can

also reduce competition between branches for sunlight and nutrients, thus maximizing the photosynthesis process necessary for fruit growth. Research by (Xu et al., 2020) revealed that pruning tomato plants can increase fruit set because more energy and nutrients are allocated to fruit formation after the removal of unproductive branches.

Overall, combining pruning main branches and applying GDM Liquid Organic Fertilizer (POC) at a concentration of 6 ml/liter of water/plot can improve plant growth and increase fruit production. GDM Liquid Organic Fertilizer accelerates fruit formation by providing a more optimal nutrient supply, while pruning reduces competition between plant parts, making the energy distribution for fruit formation more efficient. GDM Organic Fertilizer (POC) contains the nutrient P, which plays a role in flower and fruit formation. Nutrients, especially P, are needed by plants to stimulate the growth and development of young roots, flowering and fruit ripening, and fruit ripening and seed filling (Abobatta & Abd Alla, 2023).

Furthermore, pruning reduces competition for photosynthate. The greater the photosynthate production, the greater the food reserves that can enhance fruit development (Garrido et al., 2023). Phosphate functions include accelerating seedling root growth, strengthening young plant roots, accelerating flowering and fruit ripening, and increasing grain production. Some phosphate in the soil functions as a building block and is bound to organic compounds (Mabagala & Mng'ong'o, 2022). Phosphate is a component of every living cell and tends to be more abundant in seeds and growing points(Hellal et al., 2019). Phosphate fertilization can stimulate early seedling growth and flower, fruit, and seed formation (Abobatta & Abd Alla, 2023; Zhou et al., 2020).

Fruit Weight

The analysis of variance indicates that the interaction between the primary branch pruning treatment and the GDM liquid organic fertilizer (POC) concentration significantly affected the fruit weight of tomato plants. The average fruit weight of tomato plants resulting from the main branch pruning treatment and GDM liquid organic fertilizer (POC) concentration can be seen in Table 5. Duncan's test results at the 5% level (Table 4.6) showed that the highest average fruit weight was found in the P1G3 treatment (pruning and application of 6 ml of GDM POC fertilizer per plot-1), which was significantly different from the other treatments. The high fruit weight of tomato plants is due to the P1G3 treatment's ability to supply nutrients, thereby increasing photosynthesis, which impacts fruit weight. Furthermore, pruning can increase yield by directing photosynthesis to fruit formation (Harjadi et al., 2012).

Table 5. Average weight of tomato fruit due to pruning of main branches and concentration of GDM liquid organic fertilizer (POC)

Factor P	Factor N			
	G0	G1	G2	G3
P0	3.83a	5.17 b	6.20b	8.40c
P1	8.97cd	9.63de	10.20e	21.83f

Note: Average figures followed by different notations show significant differences, but those with the same notation do not differ significantly at the 5% Duncan test level

The lowest average fruit weight was found in the P0G0 treatment and significantly differed from the other treatments. This is thought to be due to low nutrient uptake. This lack of nutrient intake decreases the rate of carbohydrate-producing photosynthesis, which can affect plant fruit weight. Low soil nutrients disrupt plant metabolism, inhibiting root development and stunting plant growth (Abbas et al., 2021).

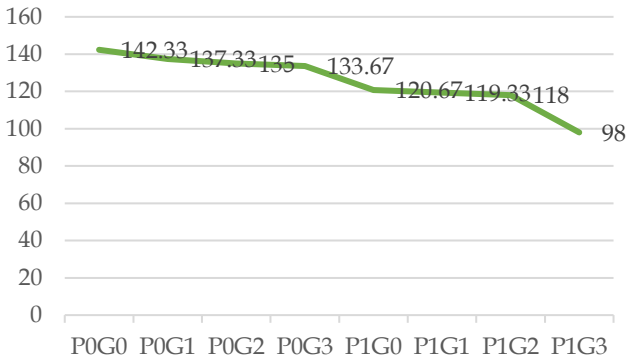

Figure 5. Average fruit weight

Comparison of the results of this study with previous research

Study on branch pruning showed that pruning the main branches of tomato plants can increase fruit number because more energy is allocated to fruit formation (Xu et al., 2020). Pruning also reduces competition between branches for sunlight and nutrients. Although pruning reduces branch number, the more efficient distribution of energy and photosynthates to more productive plant parts (fruits) can result in optimal yields, as seen in the fruit's increased number and weight in the pruning treatment. This contrasts with the results of this study, where pruning the main branches increased fruit number (2 fruits/plant) and fruit weight (21.83 g), which is consistent with the findings of (Xu et al., 2020) study, which also noted increased fruit yield in tomato plants after pruning the main branches.

Effect of GDM Liquid Organic Fertilizer (POC): Research by (Rosalyne et al., 2024) on the use of GDM liquid organic fertilizer (POC) also found that liquid organic fertilizer can increase tomato plant growth and production. The study found that applying Liquid Organic Fertilizer (POC) accelerated flower and fruit formation because it provided nutrients that were more readily absorbed by plants, improved photosynthesis and plant metabolism, and enhanced crop quality. Meanwhile, in this study, a concentration of 6 ml of GDM POC plot-1 significantly increased plant growth (98 cm plant height) and leaf number (131 leaves), as well as accelerated flowering time (32 days after planting). This aligns with previous research showing that liquid organic fertilizers support improved plant organ formation.

Plant Height and Leaf Number: (Goda et al., 2014) study, which examined the effects of pruning and fertilization on tomato plants, found that pruning can affect vegetative plant growth, including plant height and leaf number. However, in that study, pruning alone did not always increase leaf count because most of the energy was focused on fruit formation. Meanwhile, in this study, pruning the main branches together with the administration of POC GDM at a concentration of 6 ml/liter resulted in a greater number of leaves (131 strands) and optimal plant height (98 cm), indicating that the combination of these two treatments can produce more balanced vegetative and generative growth.

Implications of the Results for Overall Tomato Cultivation

Several important implications for tomato cultivation can be suggested as follows:

1. Increased Fruit Production: The results showed that the interaction between pruning the main branches and applying GDM POC at a concentration of 6 ml per plot-1 significantly increased fruit number and weight. In cultivation practice, this indicates that the combination of these two treatments can be applied to increase tomato yields. By improving the distribution of photosynthates and nutrients, farmers can achieve better fruit quantity and quality yields, increasing their income.
2. Optimizing Plant Growth: The increase in plant height (98 cm) and leaf number (131) in the combined pruning and GDM POC treatment indicates that tomato plants can grow healthier and stronger. Plants can focus more on vegetative growth that supports flower and fruit formation by applying main branch pruning, which reduces competition between branches for sunlight and nutrients. This means that proper pruning techniques, combined with appropriate fertilization, can increase tomato productivity and quality.
3. Fertilizer Use Efficiency: Applying liquid organic fertilizer (GDM POC) at a concentration of 6 ml per plot-1 has produced optimal results. In the context of tomato cultivation, this can help farmers save on using more expensive and potentially environmentally damaging chemical fertilizers. Using liquid organic fertilizers, such as GDM Organic Fertilizer (POC GDM), which contains essential micro and macro nutrients, can increase nutrient availability more environmentally friendly and sustainably.
4. Improving Plant Quality: Pruning main branches focuses on increasing fruit number and quality. By removing unproductive branches, plants can focus more on producing larger, higher-quality fruit and optimizing the formation of food reserves in the fruit. Applying GDM Organic Fertilizer (POC GDM) also supports the growth of healthier and larger fruit, given its comprehensive nutrient content.
5. Controlling Flowering and Ripening Times: In this study, pruning main branches and applying GDM Organic Fertilizer resulted in a flowering time of 32 days after planting (DAP), which can provide farmers with the advantage of controlling tomato harvesting times. Farmers can harvest tomatoes earlier and in line with market demand by accelerating flower formation and fruit ripening, which is crucial for increasing farming profitability.

Conclusion

Pruning main branches and applying GDM POC to tomatoes significantly affected tomato yield. The P1G3 treatment resulted in the best tomato plant growth and yield. The interaction between pruning main branches and applying 6 ml of the GDM concentration plot-1 resulted in an average plant height of 98 cm, 131 leaves, 32 days after flowering, 2 plants per plant, and 21.83 g of fruit weight. This research was limited to the use of GDM organic fertilizer. Future research could use other types of organic fertilizers to compare the effects of each fertilizer.

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Author Contributions
Conceptualization, U,J,R; methodology, U,J,R; resources, U,J,R and J,N; writing of the original draft, preparation of the manuscript by U,J,R and J.N.

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Conflicts of Interest
The authors declare no conflict of interest.

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