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# Synergy of Organic Fertilizer and Mulch in Improving Soil Chemical Properties for Golden Melon (*Cucumis melo* L.) Cultivation in Dry Land of North Lombok, Indonesia

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## ABSTRACT

*Dry land in Gumantar Village, North Lombok, Indonesia, faces challenges due to limited water availability and low soil fertility, affecting golden melon (Cucumis melo L.) cultivation. Despite the benefits of organic fertilizers and mulch, their combined effects on golden melon growth and yield remain underexplored. This study analyzes the synergy between organic fertilizer and mulch in improving soil chemical properties and crop productivity. A Randomized Block Design (RBD) was used with three fertilizer treatments: P0 (Phonska + 0.6 tons.ha⁻¹), P1 (Petroganik 2 tons.ha⁻¹), and P2 (manure 4 tons.ha⁻¹), combined with mulch (M1) or no mulch (M0). Each treatment was replicated three times, totaling 18 plots. Observed parameters included soil pH, C-organic content, cation exchange capacity (CEC), plant height, leaf number, biomass, moisture content, and fruit weight. Data analysis was performed using SPSS 26, including the Shapiro-Wilk test for normality. ANOVA at a 5% significance level identified treatment effects, followed by the Duncan's Multiple Range Test (DMRT) test. Pearson correlation examined variable relationships, while stepwise regression identified key influencing factors. Results showed soil pH ranged from 6.43 to 7.00, C-organic from 1.13% to 1.44%, and CEC from 11.63 to 14.01 cmol kg⁻¹. P1M1 produced the tallest plants (225.5 cm at 49 DAP), highest leaf number (58), and greatest fruit weight (28.95 tons.ha⁻¹). Regression analysis ($R^2$ = 0.902) indicated that 90.2% of growth and yield variability was explained by soil parameters. These findings highlight the potential of integrating organic fertilizer and mulch to enhance golden melon production in dry land areas.*

**Keywords**: **Dry land, organic fertilizer, mulch, sustainable agriculture**

## INTRODUCTION

Water availability is a crucial factor in the development of dry land agriculture, particularly in regions with low rainfall, such as North Lombok, West Nusa Tenggara (Heryani and Rejekiningrum, 2019; Hikmat *et al.,* 2022). This area often experiences annual rainfall below 2,000 mm, with some locations receiving less than 1,000 mm, coupled with prolonged dry periods lasting 7–8 months (Kusnarta *et al.,* 2021). The sandy soil texture and minimal vegetative cover further exacerbate challenges in retaining water and nutrients, making it difficult for farmers to sustain year-round agricultural activities (Li *et al.,* 2021). Consequently, they are heavily reliant on unpredictable rainfall, increasing the risk of seasonal droughts and reduced crop yields (Meena *et al.,* 2020; Jena *et al.,* 2023).

Despite these challenges, there is a significant gap in research regarding sustainable practices for dryland agriculture in North Lombok. While studies have highlighted the limitations of dryland farming, there is insufficient research on effective, region-specific solutions that combine organic fertilizers and mulching to improve soil properties and crop productivity. West Nusa Tenggara holds significant potential for dry land agriculture (Suwardji *et al.,* 2012), with North Lombok alone boasting approximately 47,653 hectares (75.7%) of dry land suitable for development (Mahardhika *et al.,* 2023). This highlights the need for sustainable agricultural practices that can address both the immediate and long-term challenges of soil fertility and water conservation in the region.

Research on soil management techniques for dryland farming in Indonesia has primarily focused on single interventions, such as the use of organic fertilizers or mulching (Singh *et al.,* 2020). For instance, studies by Khan and Kwot (2024) examined the effects of composting on soil nutrient availability and plant growth, showing that compost can enhance soil fertility and support sustainable crop production in water-scarce areas. Organic fertilizers, such as compost and manure, are well-documented for improving soil fertility by increasing macronutrients like nitrogen (N), phosphorus (P), and potassium (K) (Bhatt *et al.,* 2019). They also enhance soil organic matter (Hagemann *et al.,* 2018), improving nutrient retention and availability, which is especially critical in dry environments.

Studies have shown that the addition of organic amendments can significantly boost soil fertility and plant productivity while reducing dependency on synthetic fertilizers (Cesarano *et al.,* 2017; Singh *et al.,* 2022). Soil pH tends to increase, and plant-available nutrient concentrations may be higher under organic management (Agegnehu *et al.,* 2016; Thomas *et al.,* 2019). Additionally, organic matter plays a critical role in maintaining soil porosity and reducing erosion (Cotrufo and Lavallee, 2022), which is particularly important in sloping areas typical of North Lombok.

Mulching has been shown to improve soil moisture availability, which is essential for crop growth in water-limited areas (Liao *et al.,* 2021). It also minimizes weed competition and supports microbial activity necessary for nutrient cycling in the soil (McAmis *et al.,* 2024). Research by Ramos *et al.* (2024) demonstrated that mulching could help reduce soil evaporation by up to 30%, thereby increasing water retention and improving crop yields during dry spells in the Indonesian archipelago. Furthermore, research by Chaudhari *et al.* (2021) highlighted that the combination of mulching with organic fertilizers can further enhance the moisture-retaining capacity of the soil while promoting healthier root systems.

When combined, organic fertilizers and mulch create a synergistic effect, enhancing both soil chemical and physical properties (Wan *et al.,* 2021; Shyam *et al.,* 2023; and *Yang et al.,* 2023). Research has demonstrated that integrating organic fertilizer with mulch can increase soil pH to levels optimal for nutrient availability and improve the soil's capacity to support plant growth (Chakraborty *et al.,* 2016). These practices not only address immediate agricultural needs but also contribute to long-term soil health and sustainability. However, as highlighted by previous studies, the potential benefits of this synergy remain underexplored, particularly in the context of dryland areas in Indonesia.

While the application of organic fertilizers and mulching has been widely examined separately, studies on the synergistic effects of both in improving soil chemical properties in dryland areas are still limited. This gap in the literature, especially in the context of North Lombok, makes this study highly relevant. Previous research by Syamsiyah *et al.* (2023) in East Java explored the combined effect of mulching and organic fertilizers on soil nutrient status, but there remains a lack of in-depth analysis for dryland regions with similar conditions to North Lombok. Therefore, this study aims to investigate the impact of combining organic fertilizer and mulch on soil chemical property changes.

## MATERIALS AND METHODS

### Experimental site and meteorological condition

This research was conducted on the land owned by the Lembah Telaga farmer group in Gumantar Village, Kayangan District, North Lombok Regency, West Nusa Tenggara, Indonesia

(-8.256116° N; 116.288804° E). The research was carried out from June to September 2024. The location map of the study is presented in **Figure 1**.

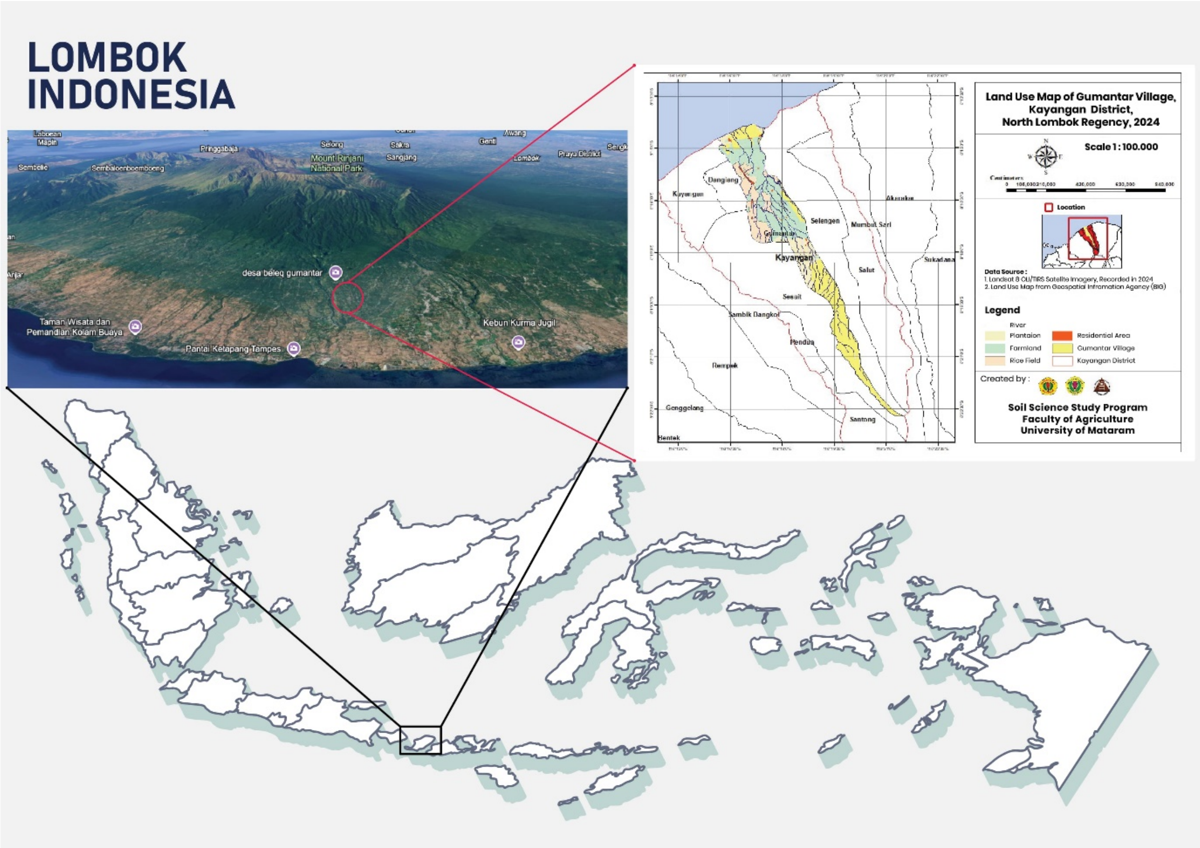


**Figure 1: Land Use Map of Gumantar Village, North Lombok, West Nusa Tenggara, Indonesia**

## Soil characteristics

The results of the analysis of the initial soil characteristics at the research location, which include the physical and chemical properties of the soil, are presented in **Table 1**.

**Table 1: Physical and chemical characteristics of the initial soil samples**

| Parameters | Unit | Value | Grade |
|---|---|---|---|
| pH | | 7.25 | Netral |
| Total N | % | 0.05 | Very low |
| C Organic | % | 0.72 | Very low |
| Rasio C/N | % | 13.44 | Medium |
| CEC | me.100 $g^{-1}$ | 4.35 | Very low |
| Soil texture | | | Sandy Loam |
| Water content | % | 3.95 | |
| Bulk density | gram. $cm^{-3}$ | 1.28 | |
| Porosity | % | 58.16 | Porous |

The analysis of the soil in research location indicates a neutral pH of 7.25, suitable for most crops. However, the total nitrogen and organic carbon levels are very low at 0.05% and 0.72%, respectively, which may hinder soil fertility and plant growth. The C/N ratio of 13.44 reflects a balanced carbon to nitrogen content, but low nitrogen levels can slow organic matter decomposition. The sandy loam soil has a bulk density of 1.28 g/cm³ and a porosity of 58.16%, classified as Entisols (Jaya *et al.,* 2021). This indicates good drainage but a low cation exchange capacity (CEC) of 4.35 me/100 g, which limits nutrient retention and makes the soil prone to leaching during heavy rainfall. The recorded maximum and minimum temperatures were 38°C and 24.8°C, respectively, with an average of 29.8°C. Meanwhile, relative humidity ranged from 53.3% to 91.8%, averaging 77% (Jaya *et al.,* 2021).

**Water availability at research location**

The matrix potential values (pF) were analyzed to determine the moisture content under specific conditions. A pF of 2.54 indicates that the water has reached field capacity, while a pF of 4.2 signifies that the water is at the permanent wilting point (**Table 2**).

**Table 2: Matrix Potential Values (pF) and soil moisture content**

| Matrix Potential (pF) | Groundwater Rate (% vol.) |
|---|---|
| 2.54 | 48.73 |
| 4.2 | 36.75 |

The analysis results indicate that the available water lies between the pF values of 2.54 (field capacity) and 4.2 (permanent wilting point), amounting to 11.98%. This indicates that, of the total soil volume, 11.98% consists of water that can be utilized by plants before reaching the wilting point. Soils with higher available water values typically have a better capacity to support plant growth by providing more water to plants over a longer duration.

**Experimental design**

The experimental design utilized a Randomized Block Design (RBD) with treatments involving different types and doses of fertilizers, as well as the application of mulch. Each treatment was replicated three times, resulting in a total of 18 experimental plots. The treatments for type and dose of fertilizer (P) consisted of three levels: P0 = Phonska fertilizer plus 0.6 tons.ha$^{-1}$; P1 = Petroganik fertilizer 2 tons.ha$^{-1}$; and P2 = Manure 4 tons.ha$^{-1}$. The mulch treatment (M) consisted of two levels: M0 = No mulch and M1 = Mulch. The experimental plot layout is designed to optimize plant distribution and the applied treatments. **Figure 2** illustrates the arrangement of raised beds, the number of plants per plot, and the combination of treatments used in this study.

This plot design organizes the experimental layout on a 38 m × 12.6 m area using a raised bed system with a planting distance of 50 cm × 50 cm. Each plot consists of 2 raised beds, with 16 plants per bed, resulting in a total of 1,152 plants across 36 plots. Different treatments, such as combinations of fertilization (P) and mulch application (M) are applied to each plot, allowing for a systematic analysis of plant growth.

The experiment used silver-black plastic mulch with a thickness of 25 microns. The mulch was tightly applied to fully cover the raised beds with the silver side facing upward, while the black side faced downward. Small planting holes were cut at a spacing of 50 cm × 50 cm to accommodate plant growth, ensuring optimal soil temperature regulation and water conservation.

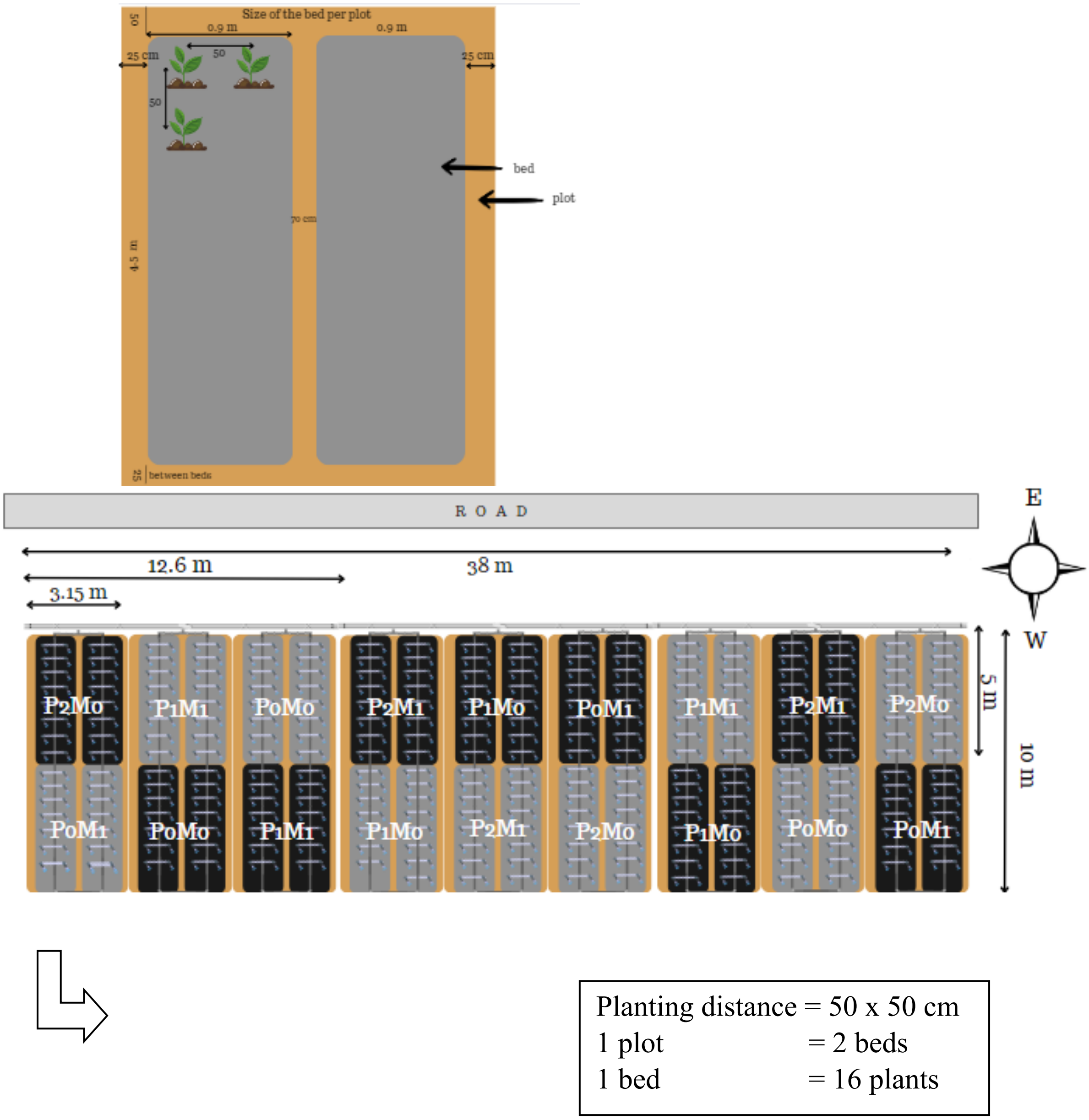


**Figure 2: Experimental plant layout with fertilization and mulching treatments**

**Irrigation practices**

This study uses a drip irrigation system with water sourced from a bore well. Calibration ensures uniform water distribution by measuring the flow rate (1.1 $m^3$ per hour) and checking emitter output. Pressure regulation and emitter maintenance are adjusted if discrepancies occur. Once distribution is uniform, irrigation operates every 2 days for 1 hour between 07:00–09:00 A.M using a timer to optimize plant water supply.

**Soil sampling**

Undisturbed soil samples were collected using a ring sampler to analyze the initial physical properties of the soil before land preparation. Meanwhile, soil samples for chemical analysis were taken as composite samples from the 0–20 cm tillage layer. Before sampling, the soil surface was cleared of grass, stones, gravel, and plant residues. The soil samples were collected using a mini shovel, following a zig-zag pattern across the entire field to ensure representative sampling. A total of 5 sampling points were selected within the observation area, with approximately 1 kg of soil collected. The samples were then air-dried, crushed, sieved, and prepared for laboratory analysis. Chemical analysis of the soil was carried out in the Laboratory of Soil Chemistry, Faculty of Agriculture, University of Mataram, West Nusa Tenggara, Indonesia.

**Parameters**

The recorded parameters included soil chemical characteristics, namely C-Organic, soil pH, and cation exchange capacity (CEC). The C-Organic content was measured using the Walkley & Black method (Mylavarapu *et al.,* 2014), soil pH was determined using a pH meter (Thomas, 1996), and CEC was measured by the distillation method (Chapman, 1965).

1. **C-organic measurement (Walkley & Black method)**

   A 0.500 g soil sample (particle size < 0.5 mm) is weighed and placed into a 100 mL volumetric flask. Then, 5 mL of 1 N $K_2Cr_2O_7$ is added and mixed thoroughly. Next, 7.5 mL of concentrated $H_2SO_4$ is carefully added, and the mixture is shaken before being left to stand for 30 minutes. The solution is then diluted with deionized water and allowed to cool. The following day, the absorbance of the clear solution is measured using a spectrophotometer at 561 nm. A calibration curve is prepared using 0 ppm and 250 ppm standards by pipetting 0 mL and 5 mL of a 5000 ppm standard solution into 100 mL volumetric flasks, following the same procedure as the sample analysis.

$$\%C = \frac{(b-s)\times N \times 0.003 \times 100}{Sample\ Weight\ (g)}$$

   Where:

   b = Volume of $FeSO_4$ solution used for blank titration (mL)
   s = Volume of $FeSO_4$ solution used for soil sample titration (mL)
   N = Normality of $FeSO_4$ solution
   0.003 = Milliequivalent weight of carbon

2. **Soil pH measurement**

   A 10 g soil sample is weighed and placed in a shaking bottle. Then, 50 mL of deionized water is added, and the mixture is shaken on a mechanical shaker for 30 minutes to ensure proper suspension. The soil pH is then measured using a pH meter.

3. **Cation Exchange Capacity (CEC) measurement**

   A 1.0 g finely ground soil sample is placed in a 250 mL Erlenmeyer flask, followed by the addition of 10 mL of pH 7 ammonium acetate solution. The mixture is shaken for 60 minutes, and this step is repeated four times. Next, 10 mL of ethanol is added to remove excess ammonium, with the washing step also repeated four times. The soil residue is then transferred to a distillation flask with the addition of 10 mL of distilled water. Subsequently, 50 mL of distilled water and 20 mL of 40% NaOH are added, and the mixture is distilled. The distillate is collected in 15 mL of 0.1 N $H_2SO_4$ containing three drops of Conway indicator. The distillation process is stopped once the distillate volume reaches approximately 40 mL. Finally, the distillate is titrated with standardized 0.1 N NaOH until the color changes from red to green.

$$\text{CEC (me}\cdot 100\ \text{g}^{-1}) = \frac{(Vol\ Blanko - Vol\ Sample)\times NNaOH \times 100}{Sample\ Weight\ (g)}$$

   Where : Vol Blanko = Titration volume of the blank sample (without soil) (mL)
   Vol Sample = Titration volume of the soil sample (mL)

N NaOH = Normality of NaOH

Growth parameters included plant height (cm), number of leaves, fresh biomass, dry biomass, moisture content, and fruit weight (kg). Plant height was measured with a meter, the number of leaves was counted manually per plant, and the fresh biomass was measured using a balance, followed by oven-drying at 60°C until a constant dry weight was achieved. Harvested golden melon fruits were weighed and converted to t $ha^{-1}$.

**Statistical analysis**

The experimental data were analyzed using SPSS 26, starting with the Shapiro-Wilk test to assess normality. ANOVA analysis of variance was conducted at a 5% significance level, and if significant differences were detected, the DMRT test was performed at the same level to determine differences between treatments. Pearson correlation analysis (Sedgwick, 2012) was used to examine relationships between variables, while stepwise regression analysis (Freund, 2006) was conducted to identify key influencing factors.

## RESULTS AND DISCUSSION

**Soil chemical properties**

The results of the analysis of soil chemical properties including soil pH, C-organics, and CEC are presented in the **Figure 3**, **4 and 5** below.

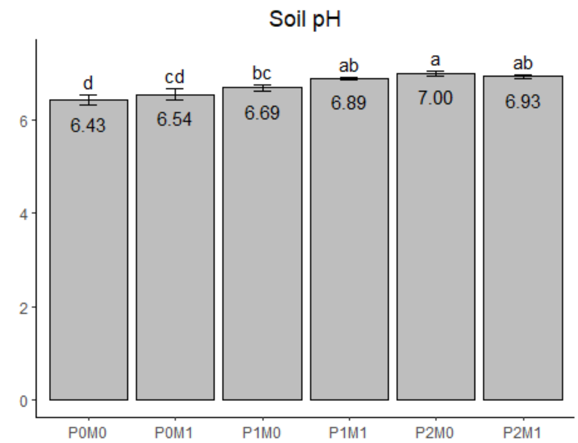


**Figure 3: Effect of different types and doses of fertilizers, and the application of mulch on soil pH**

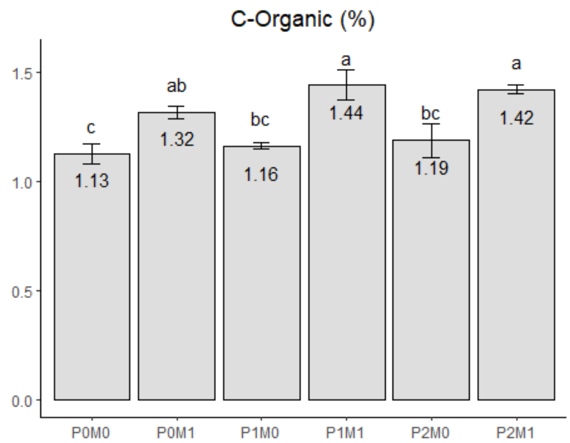


**Figure 4: Effect of different types and doses of fertilizers, and the application of mulch on C-organic soil**

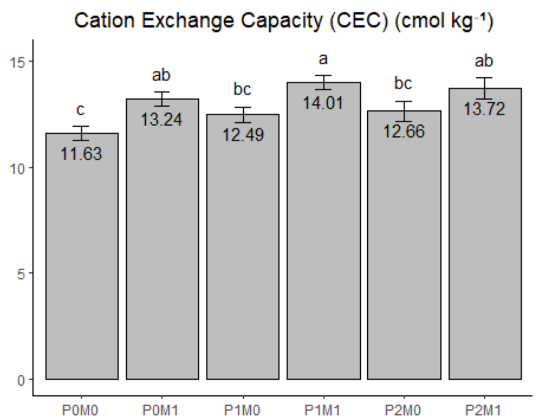


**Figure 5: Effect of different types and doses of fertilizers, and the application of mulch on soil CEC**

Note: Different letters represent significant differences at p <0.05 using Duncan's Multiple Range Test. P0M0 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + no mulch; P1M0 = Petroganik fertilizer 2 tons. $ha^{-1}$ + no mulch; and P2M0 = Manure 4 tons. $ha^{-1}$ + no mulch. P0M1 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + mulch; P1M1 = Petroganik fertilizer 2 tons. $ha^{-1}$ + mulch; and P2M1 = Manure 4 tons. $ha^{-1}$ + mulch

The soil pH values ranged from 6.43 to 7.00, with the highest pH observed in the (manure at 4 tons $ha^{-1}$ without mulch). This finding aligns with previous studies (Sellan *et al.,* 2020) that reported an increase in soil pH following organic fertilizer application due to the decomposition process, which releases base cations such as calcium, magnesium, and potassium. However, the relatively lower pH in mulched treatments (P0M1, P1M1, P2M1) compared to P2M0 was unexpected, as mulching is generally associated with reduced leaching and improved nutrient retention (Pitman and Peace, 2021). A possible explanation is that mulch decomposition may have contributed organic acids, slightly offsetting the pH increase from manure application. From a practical perspective, these findings suggest that farmers using organic fertilizers should consider the type and decomposition rate of mulch materials to optimize soil pH management.

C-organic levels ranged from 1.13% to 1.44%, with the highest value observed in P1M1 (Petroganik at 2 tons $ha^{-1}$ with mulch). This result is consistent with previous studies (Yang and Feng, 2018) that reported higher soil organic carbon content in mulched treatments (P0M1, P1M1, P2M1) due to the additional organic matter input and the reduction of organic carbon loss through erosion and decomposition under high temperatures. However, the relatively lower C-organic content in P2M0 compared to P1M1 was unexpected, considering that manure application (P2) is known to enhance soil organic carbon due to its high organic matter content and slower decomposition rate (Bhattacharyya *et al.,* 2022). A possible explanation is that the decomposition dynamics of manure differ depending on environmental conditions and microbial activity, which may have influenced carbon stabilization. These findings highlight the importance of selecting appropriate organic amendments and mulching strategies to optimize soil carbon sequestration for long-term soil fertility management.

The CEC values ranged from 11.63 to 14.01 cmol $kg^{-1}$, with the highest value observed in the P1M1 treatment (Petroganik at 2 tons $ha^{-1}$ with mulch). This finding aligns with previous studies (Murphy, 2015) that reported an increase in CEC with organic fertilizer application, as organic matter provides negatively charged functional groups that enhance soil nutrient retention and exchange capacity. However, the relatively higher CEC in P1M1 compared to P2M0 (manure at 4 tons $ha^{-1}$ without mulch) was unexpected, given that manure also contributes to soil organic matter and cation retention. This may be due to differences in decomposition rates and the stabilization of organic matter, which can vary depending on environmental conditions. From a practical perspective, these results suggest that combining organic fertilizers with mulch can be an effective strategy for improving soil fertility and nutrient availability, particularly in soils with low CEC.

**Growth and yield of golden melon**

The growth of golden melon was analyzed based on plant height, leaf number, biomass weight, and plant water content. The results of the melon crop analyzed included fruit diameter and golden melon weight. Plant height and leaf number was measured weekly, starting from 14 days after planting (DAP) until the maximum vegetative phase of the golden melon plants at 49 DAP. The results of the plant height measurements and number of leaves are presented in **Figure 6**.

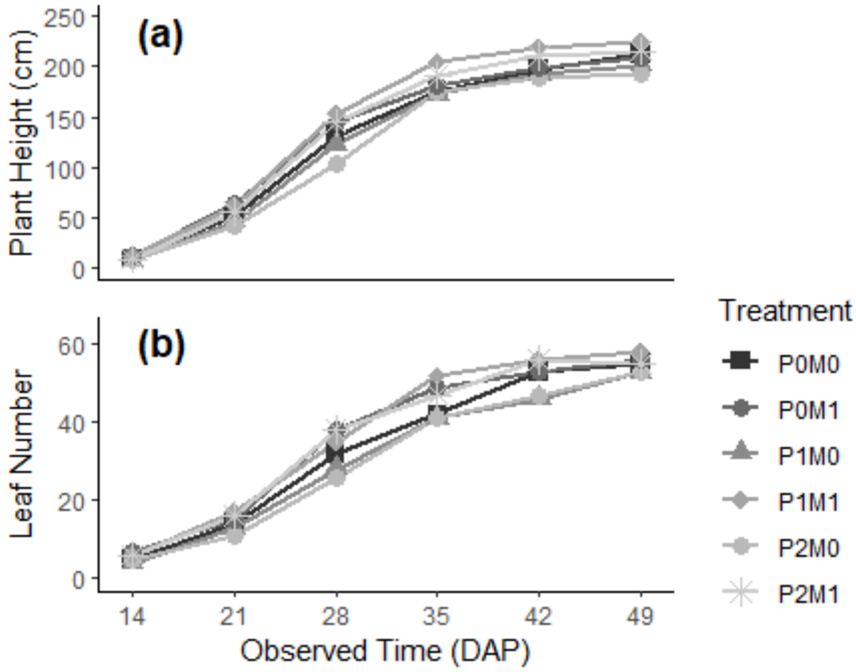


**Figure 6: Effect of different types and doses of fertilizers, and the application of mulch. (a) plant height and (b) leaf number. Different letters represent significant differences at p <0.05 using Duncan's Multiple Range Test.**
Note: P0M0 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + no mulch; P1M0 = Petroganik fertilizer 2 tons. $ha^{-1}$ + no mulch; and P2M0 = Manure 4 tons. $ha^{-1}$ + no mulch. P0M1 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + mulch; P1M1 = Petroganik fertilizer 2 tons. $ha^{-1}$ + mulch; and P2M1 = Manure 4 tons. $ha^{-1}$ + mulch

Golden melon plant height was significantly influenced by fertilization and mulching, with Phonska fertilizer (P0) performing well due to its balanced macronutrient content, while Petroganik fertilizer with mulch (P1M1) achieved the greatest height (225.5 cm at 49 DAP) because of enhanced microbial activity and nutrient availability (Bhattacharyya *et al.,* 2022). Mulching consistently improved growth across treatments by retaining soil moisture, regulating temperature, and reducing weed competition, creating a favorable root environment (Kader *et al.,* 2017). These findings demonstrate the synergistic effects of mulching and fertilization, particularly organic inputs, in optimizing growth, aligning with research on nutrient balance and soil management in dryland agriculture.

The analysis of variance indicates that fertilization and mulch significantly impact leaf number at 14, 21, and 35 days after planting (DAP), with the highest count of 58 leaves observed in the P1M1 treatment (Petroganik fertilizer 2 tons. $ha^{-1}$ + mulch). Mulch improves moisture retention and nutrient availability while decreasing soil water evaporation and enhancing fertilizer efficiency (Demo and Bogale, 2024). In contrast, treatments without mulch, like P0M0 and P2M0, resulted in lower leaf number. The combination of Petroganik fertilizer at 2 tons $ha^{-1}$ and mulch effectively promotes leaf growth by mitigating water stress. This synergy enhances plant growth by improving nutrient uptake and moisture retention.

**Fresh biomass, dry biomass, and moisture content**

The results of fresh biomass, dry biomass, and moisture content of golden melon plants are presented in **Figure 7**.

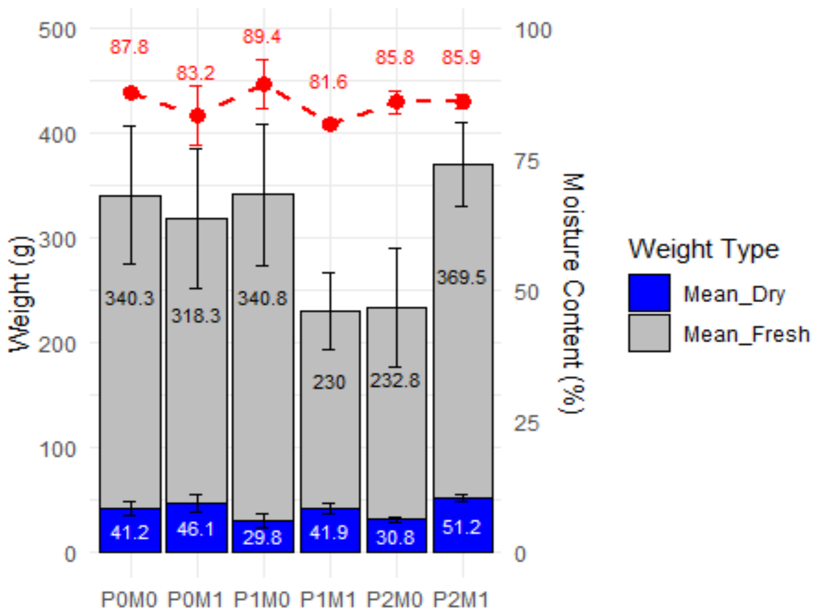


**Figure 7: Effect of different types and doses of fertilizers, and the application of mulch on fresh biomass, dry biomass, and moisture content. Different letters represent significant differences at p <0.05 using Duncan's Multiple Range Test.**

Note: P0M0 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + no mulch; P1M0 = Petroganik fertilizer 2 tons. $ha^{-1}$ + no mulch; and P2M0 = Manure 4 tons. $ha^{-1}$ + no mulch. P0M1 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + mulch; P1M1 = Petroganik fertilizer 2 tons. $ha^{-1}$ + mulch; and P2M1 = Manure 4 tons. $ha^{-1}$ + mulch.

The analysis of variance revealed that the fresh and dry biomass weights, as well as the moisture content of golden melon plants, showed no significant differences across treatments involving various combinations of fertilizers and mulch. All treatments resulted in similar fresh weights, with P2M1 (4 tons $ha^{-1}$ of organic fertilizer with mulch) having the highest weight at 369.5 g and P2M0 (without mulch) the lowest at 229.98 g. This indicates that fertilizer type does not significantly impact fresh weight. For dry biomass, P2M1 recorded the highest weight (51.17 g), while P1M0 (2 tons $ha^{-1}$ of Petroganik without mulch) had the lowest at 29.83 g. The higher dry weight in treatments with mulch may be attributed to reduced water loss and enhanced nutrient absorption (Salem *et al.,* 2021). However, moisture content percentages were similar across treatments, ranging from 87.63% in P0M0 to 85.62% in P2M1. Overall, while mulch aids in soil moisture retention and nutrient efficiency, it did not significantly affect fresh biomass or moisture content.

## Yields of golden melon

The harvest results showing the fruit weight of golden melon plants are presented in **Table 3**. The application of different fertilizer and mulch treatments with notable variations across treatments.The results indicate that the highest fruit weight was observed in the Petroganik 2 tons $ha^{-1}$ + mulch treatment producing 28.95 tons $ha^{-1}$, though the differences among treatments were not statistically significant. The combination of organic fertilizer and mulch appears to enhance soil moisture retention and nutrient availability, leading to better fruit development. These findings align with previous research, such as Fan *et al.* (2023), which reported that organic fertilizers improve nutrient availability, supporting optimal fruit growth and development.

Similar studies on melon yield under different fertilization strategies support these findings. For instance, Acharya *et al.* (2024) reported that organic fertilizers combined with mulch significantly improved fruit weight due to increased nutrient uptake and reduced soil evaporation. However, in this study, manure 4 tons.ha-1 + mulch treatment and Petroganik + no mulch treatment did not show significant differences, suggesting that mulch alone may not always enhance fruit yield without the appropriate nutrient balance. The slow nutrient release from manure may have also contributed to the lack of significant yield improvement in the manure 4 tons.ha-1 + mulch treatment.

**Table 3: Fruit weight of golden melon plants**

| Treatments | Fruit weight (ton. $ha^{-1}$) |
|---|---|
| **P0M0** | 19.94 ± 6.08 a |
| **P1M0** | 21.16 ± 6.18 a |
| **P2M0** | 20.97 ± 6.24 a |
| **P0M1** | 21.71 ± 7.41 a |
| **P1M1** | 28.95 ± 3.86 a |
| **P2M1** | 24.38 ± 8.08 a |

Note: Different letters represent significant differences at p <0.05 using Duncan's Multiple Range Test. P0M0 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + no mulch; P1M0 = Petroganik fertilizer 2 tons. $ha^{-1}$ + no mulch; and P2M0 = Manure 4 tons. $ha^{-1}$ + no mulch. P0M1 = Phonska fertilizer plus 0.6 tons. $ha^{-1}$ + mulch; P1M1 = Petroganik fertilizer 2 tons. $ha^{-1}$ + mulch; and P2M1 = Manure 4 tons. $ha^{-1}$ + mulch.

The lack of significant differences among treatments may be attributed to soil nutrient availability, or the interaction between fertilizer type and mulch efficiency. The relatively high variability (large standard deviations) suggests that environmental factors, such as rainfall distribution or soil heterogeneity, may have influenced the results. For golden melon cultivation, these findings highlight the potential benefits of combining organic fertilizer with mulch to optimize fruit weight. Farmers aiming to maximize yield should consider using Petroganik 2 tons $ha^{-1}$ with mulch, as it resulted in the highest fruit production.

## Correlation between treatment and response variables

The Pearson correlation analysis reveals interrelated relationships among soil parameters, plant growth, and fruit weight, as shown in **Table 4**. Several key correlations suggest potential mechanisms influencing golden melon productivity.

**Table 4: Pearson Correlation among parameters**

| | pH | C Organic (%) | CEC (cmol.$kg^{-1}$) | Plant height (cm) | Leaf Number | Dry biomass weight (kg) | Moisture content (%) | Fruit weight (kg) |
|---|---|---|---|---|---|---|---|---|
| **pH** | | 0.346 | .478* | -0.295 | -0.341 | 0.041 | -0.224 | 0.089 |
| **C Organic (%)** | | | .662** | -0.105 | -0.240 | 0.463 | -0.361 | 0.446 |
| **CEC (cmol.$kg^{-1}$)** | | | | -0.193 | -0.166 | 0.053 | -.677** | 0.453 |
| **Plant height (cm)** | | | | | .514* | -0.388 | -0.080 | 0.110 |
| **Leaf Number** | | | | | | -0.283 | -0.214 | 0.068 |
| **Dry biomass weight (kg)** | | | | | | | 0.149 | .528* |
| **Moisture content (%)** | | | | | | | | -0.385 |

Note: *) moderate correlation; **) strong positive correlation. Based on pearson correlation analysis, the tabel above shows several significant correlations (r>0.5)

Soil pH exhibits a moderate positive correlation with cation exchange capacity (CEC) (r = 0.478), indicating that higher soil pH enhances nutrient retention capacity. This is consistent with Franco-Pesantez and Torres (2023), who noted that increased soil alkalinity improves cation availability. Additionally, soil organic carbon shows a strong positive correlation with CEC (r = 0.662), suggesting that higher organic matter content enhances nutrient-holding capacity, which is crucial for sustaining soil fertility. However, a negative correlation between CEC and plant moisture content (r = -0.667) indicates that soils with higher CEC may retain nutrients too strongly, reducing water mobility and plant water uptake (Costa *et al.,* 2014). This phenomenon might also be influenced by the use of silver black plastic mulch, which stabilizes soil temperature (Sharma and Menon, 2020) and enhances soil organic matter while maintaining soil moisture levels (Choudhary *et al.,* 2023). The mulch's contribution to improving soil resilience, fertility, and cation exchange capacity (Ferreiro *et al.,* 2016) may also play a role in shaping these interactions.

From a plant growth perspective, plant height and leaf number exhibit a moderate positive correlation (r = 0.514), indicating that taller plants tend to develop more leaves. This supports enhanced photosynthesis efficiency, contributing to higher biomass accumulation (Suo *et al.,* 2024). Furthermore, dry biomass weight correlates positively with fruit weight (r = 0.528), suggesting that strong vegetative growth leads to improved reproductive output (Ali *et al.,* 2021). The regression analysis ($R^2$ = 0.902) further indicates that 90.2% of the variability in plant growth and yield can be explained by the observed parameters, while the remaining 9.8% may be influenced by unmeasured environmental or physiological factors. Future research should explore whether optimizing fertilization strategies and water management could further enhance these relationships and improve fruit yield stability.

## CONCLUSION

The synergy between organic fertilizer and mulch effectively improved soil chemical properties and enhanced vegetative growth of Golden Melon in the dry land of North Lombok, Indonesia. The application of Petroganik at 2 tons $ha^{-1}$ combined with mulch resulted in the best plant performance, indicating that the combination enhances nutrient availability and soil moisture retention. Correlation analysis showed positive relationships between soil pH, CEC, plant height, and leaf count, while regression analysis ($R^2$ = 0.902) confirmed the significant influence of soil chemical properties on plant growth and yield. However, as the study was limited to a single growing season, future research should explore multi-season trials and long-term soil impacts. These findings highlight that integrating organic fertilizer and mulch is a promising strategy for improving soil fertility and supporting sustainable golden melon production in dry land farming systems.

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