

Effects of MKP Concentration and Apical Pruning on the Growth and Yield of Melon (*Cucumis melo* L.) var. Inthanon under NFT Hydroponics System

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Article History:

Received : 28 July 2025
Revised : 13 January 2026
Accepted : 29 April 2026

Keywords:

Hydroponics,
Melon,
MKP,
Pruning shoots.

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ABSTRACT

Melon (*Cucumis melo* L.) is a horticultural crop with high economic value, but its production is still low due to suboptimal cultivation techniques, especially in terms of fertilization and pruning. This study aims to determine the effect of monopotassium phosphate (MKP) fertilizer concentration and shoot pruning on the growth and yield of Inthanon melon variety. The study was conducted in the greenhouse, using a factorial Completely Randomized Design (CRD) with two factors, namely: MKP fertilizer concentration (0, 5, 10, and 15 g/L) and shoot pruning (internodes 25, 28, and 30). The results showed that the combination of MKP 15 g/L and pruning at the 30th internode gave the best results in terms of fruit weight and fruit flesh thickness. MKP 15 g/L fertilizer had a very significant effect on the parameters of plant length, stem diameter and number of leaves. Pruning shoots at the 30th internode increased the efficiency of assimilate distribution to the fruit. The application of MKP at 15 g/L combined with pruning at the 30th internode increased fruit weight 22.12% and fruit diameter 11.38% compared to control.

1. INTRODUCTION

Melon (*Cucumis melo* L.) is a high value horticultural commodity widely favored by consumers due to its sweetness, high water content, and rich composition of vitamins and minerals beneficial to human health (Siswanto, 2010). However, melon production in Indonesia has shown a declining trend over the past three years, decreasing from 129,147 tons in 2021 to 117,794 tons in 2023 (BPS, 2024). This decline suggests the presence of constraints in melon cultivation, particularly related to limited land availability, climate variability, and the suboptimal application of cultivation practices such as fertilization and pruning (Sinaga & Zahara, 2022). Improved cultivation strategies are required to enhance nutrient uptake efficiency and optimize the allocation of photosynthates, ultimately improving both yield and fruit quality.

Advancements in controlled environment agriculture, including greenhouse systems and hydroponic cultivation using the Nutrient Film Technique (NFT), offer promising solutions to increase melon productivity. These systems enable precise nutrient management throughout the plant growth cycle and facilitate intensive crop maintenance practices. One important practice is shoot pruning, which reduces apical dominance that can otherwise limit fruit development. A major challenge in melon cultivation lies in managing plant maintenance, particularly ensuring nutrient availability at critical growth stages and regulating assimilate partitioning toward fruit organs. This can be achieved by pruning competing sink organs, such as shoot tips. Inadequate nutrient supply during key developmental stages, especially during fruit formation, results in reduced fruit size and lower sweetness levels (Ferdiansyah, 2022).

Mono potassium phosphate (MKP) fertilizer represents an effective alternative nutrient source for melon cultivation (Efendi, 2021). MKP is a water-soluble compound fertilizer containing essential macronutrients, namely phosphorus

(52%) and potassium (34%). Its high solubility allows for foliar application, thereby improving nutrient uptake efficiency during the generative stage (Arnoldi *et al.*, 2021). Phosphorus plays a critical role in root development and flowering, while potassium enhances assimilate translocation and increases fruit sugar accumulation (Wijiyanti & Soedradjad, 2019). Prayuda *et al.* (2024) application of MKP at 9 g/L significantly increased fruit weight, diameter, and sweetness, highlighting its potential to improve melon productivity.

In addition to fertilization, shoot pruning is a key agronomic practice influencing melon yield. This technique involves removing the apical portion of the stem at a specific node to suppress apical dominance. Consequently, assimilates are redirected from vegetative growth toward fruit development, resulting in improved fruit size and quality (Sofyadi *et al.*, 2021). Pruning also stimulates lateral shoot growth and accelerates flowering. Pruning significantly improved fruit weight, flesh thickness, and sweetness (Koentjoro, 2012). However, information regarding the optimal timing and position of pruning remains limited, particularly when integrated with fertilization strategies.

This study aimed to evaluate the effects of MKP fertilizer concentration and shoot pruning on the growth and yield of *Cucumis melo* L. cv. Inthanon cultivated hydroponically using the NFT system. Additionally, this study sought to determine the optimal combination of treatments to enhance fruit quality and productivity. Given the limited studies investigating the combined application of MKP fertilization and shoot pruning in hydroponic melon systems, this research is expected to provide valuable insights for both scientific development and practical applications in sustainable melon cultivation.

2. MATERIALS AND METHODS

2.1. Study Site and Research Period

The research was conducted from February to May 2025 in a greenhouse facility belonging to the Caping Kota Farmer Group, Surabaya, East Java, Indonesia. The study site is located at an altitude of approximately 5 m above sea level.

2.2. Materials and Equipment

The equipment used in this research included a hydroponic system based on the Nutrient Film Technique (NFT), a water pump, pH meter, total dissolved solids (TDS) meter, water reservoir, aerator, mini sprayer. The materials used in this study consisted of melon (*Cucumis melo* L.) cv. Inthanon seeds and AB Mix nutrient solution. The A solution contained macronutrients, including calcium nitrate, potassium nitrate, and iron, while the B solution contained micronutrients such as magnesium oxide, sulfur trioxide, potassium sulfate, boron, and copper. Additional materials included rockwool as the growing medium, water, mono potassium phosphate (MKP) fertilizer (Meroke MKP), as well as insecticide with fipronil as the active ingredient and containing fungicide (Mancozeb).

2.3. Research Methodology

The research was arranged using a completely randomized design (CRD) with a factorial scheme consisting of two factors and three replications. The first factor was the concentration of mono potassium phosphate (MKP) fertilizer, consisting of four levels: 0, 5, 10, and 15 g/L. MKP was applied at 14, 21, 28, 35, 42, and 49 days after planting (DAP). The fertilizer was applied by dissolving MKP in water and spraying the solution onto the leaves using a mini pump sprayer until evenly wetted, according to the designated spray volume. To prevent treatment interference, each application was conducted using plastic barriers to separate treatments. The second factor was shoot pruning, consisting of three levels: pruning at the 25th, 28th, and 30th nodes. Pruning was performed during the generative stage after pollination and fruit selection had been completed. Based on these two factors, a total of 12 treatment combinations were obtained, each replicated three times, resulting in 36 experimental units. Each experimental unit consisted of four sample plants for observation. All treatment combinations were randomly assigned to the experimental units. The layout of the experimental design is presented in Figure 1.

The observed parameters of melon plants were classified into vegetative and generative variables. Vegetative observations included plant length (cm), stem diameter (cm), and number of leaves. Generative observations consisted of fruit weight (kg), fruit diameter (cm), and fruit cavity diameter (cm).

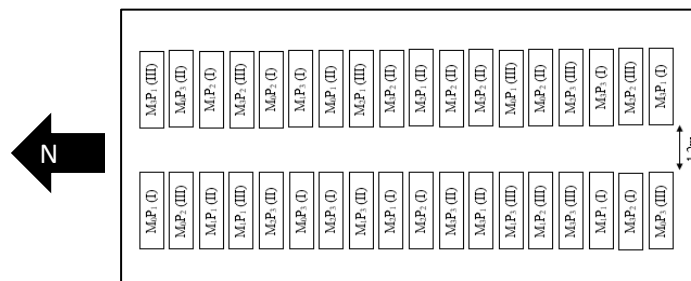


Figure 1. Layout of the hydroponic NFT experimental system

2.4. Data Analysis

The research data were analyzed using analysis of variance (ANOVA) based on a completely randomized design (CRD) with a factorial arrangement, following the method described by [Mardinata \(2013\)](#):

$$Y_{ij} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \tag{1}$$

where Y_{ij} is observation value under the MKP fertilizer concentration treatment (M) at the i^{th} level, shoot pruning treatment (P) at the j^{th} level, and the k^{th} replication, μ is overall mean, α_i is effect of the i^{th} level of MKP fertilizer concentration (M), β_j is effect of the j^{th} level of shoot pruning (P), $(\alpha\beta)_{ij}$ is interaction effect between the i^{th} level of MKP fertilizer concentration (M) and the j^{th} level of shoot pruning (P), ε_{ijk} is random error associated with the i^{th} level of M, the j^{th} level of P, their interaction, and the k^{th} replication.

If a significant effect was observed, the analysis was followed by Tukey’s Honestly Significant Difference (HSD) test at the 5% significance level using Microsoft Excel.

3. RESULTS AND DISCUSSION

3.1. Plant Length

The mean plant length under different MKP concentrations and pruning treatments is presented in Table 1. Analysis of variance indicated that there was no significant interaction between MKP fertilizer concentration and shoot pruning on melon plant length at all observation times (21, 28, and 35 days after planting, DAP), as the calculated F -values for the interaction were lower than the F -table values at the 5% significance level. In contrast, the main effect of MKP fertilizer concentration had a highly significant effect on plant length at 21–35 DAP, with F -values of 6.55, 8.25, and 7.94, respectively, which exceeded the F -table value at the 1% significance level (4.72). Meanwhile, shoot pruning did not significantly affect plant length at any observation time, as indicated by F -values lower than the F -table at the 5%

Table 1. Effect of MKP Fertilizer Concentration and Shoot Pruning on Melon Plant Length at 21–35 Days after Planting (DAP)

Treatment	Plant Length (cm)		
	21 (DAP)	28 (DAP)	35 (DAP)
MKP Fertilizer Concentration (M)			
0 g/L (M ₀)	119.90 a	219.64 a	287.00 a
5 g/L (M ₁)	129.43 b	225.47 ab	297.56 ab
10 g/L (M ₂)	130.5 b	227.86 b	299.67 b
15 g/L (M ₃)	133.10 b	231.42 b	307.67 b
HSD 5 %	7.95	6.08	10.66
Shoot Pruning (P)			
25 th node (P ₁)	125.72	224.15	296.29
28 th node (P ₂)	129.69	226.56	297.79
30 th node (P ₃)	129.29	227.58	299.83
HSD 5 %	ns	ns	ns

Note: Means followed by the same letter within the same treatment and observation time are not significantly different according to Tukey’s HSD test at the 5% level; ns = not significant

level. These results suggest that variation in melon plant length at 21–35 DAP was more strongly influenced by MKP fertilizer concentration than by shoot pruning.

The data presented in Table 1 indicate that melon plant length increased across all observation periods with increasing MKP fertilizer concentration. The application of MKP enhanced plant length; however, no significant differences were observed among the concentrations of 5, 10, and 15 g/L. This trend suggests that the availability of phosphorus (P) and potassium (K) at optimal concentrations effectively supports vegetative growth in melon plants. Phosphorus plays a crucial role in energy transfer through ATP formation, which is essential for cell division and elongation, while potassium regulates osmotic balance, activates enzymes, and improves the efficiency of photosynthate translocation (Arnoldi *et al.*, 2021).

In the hydroponic Nutrient Film Technique (NFT) system, the nutrient solution containing MKP is continuously circulated, ensuring a stable supply of P and K in the root zone. This continuous nutrient flow allows roots to absorb nutrients more efficiently compared to conventional cultivation systems, thereby promoting vegetative growth, as reflected in increased stem length and leaf development (Savvas & Gruda, 2018). Adequate availability of P and K enhances cell division and elongation, which in turn stimulates stem growth and leaf formation. An increase in leaf number contributes to a larger photosynthetic surface area, leading to higher photosynthate production, which supports overall plant growth and may enhance fruit weight during the generative stage.

Conversely, plants without MKP application exhibited lower plant length due to limited availability of P and K, which can restrict metabolic activity and reduce photosynthetic efficiency. This finding is consistent with Pradana *et al.* (2015), phosphorus deficiency can inhibit vegetative growth. The shoot pruning treatment did not significantly affect plant length, as pruning had not yet been applied during the 21–35 DAP observation period; therefore, no physiological response was observed. From an agronomic perspective, these results indicate that the application of MKP at 15 g/L in the NFT system was the most effective treatment for promoting vegetative growth in melon plants.

3.2. Stem Diameter

The analysis of variance indicated that there was no significant interaction between MKP fertilizer concentration and shoot pruning on melon stem diameter at all observation times. This was evidenced by the interaction *F*-values, which were lower than the *F*-table values at the 5% significance level at 21 DAP ($0.56 < 2.51$), 28 DAP ($0.09 < 2.51$), and 35 DAP ($0.58 < 2.51$). The main effect of MKP fertilizer concentration showed a highly significant influence on stem diameter at 21–35 DAP. The calculated *F*-values were 8.48 (21 DAP), 8.34 (28 DAP), and 7.15 (35 DAP), all of which exceeded the *F*-table value at the 1% significance level (4.72). In contrast, shoot pruning had no significant effect on stem diameter at any observation time, with *F*-values of 0.04 (21 DAP), 0.01 (28 DAP), and 0.07 (35 DAP), all lower than the *F*-table value at the 5% level (3.40). These results indicate that variation in melon stem diameter at 21–35 DAP was primarily influenced by MKP fertilizer concentration rather than shoot pruning. The mean stem diameter under different MKP concentrations and pruning treatments is presented in Table 2.

Table 2. Effect of MKP fertilizer concentration and shoot pruning on stem diameter of melon plants at 21–35 DAP

Treatment	Stem Diameter (mm)		
	21 (DAP)	28 (DAP)	35 (DAP)
MKP Fertilizer Concentration (M)			
0 g/L (M ₀)	0.89 a	1.06 a	1.23 a
5 g/L (M ₁)	0.92 ab	1.09 ab	1.26 ab
10 g/L (M ₂)	0.95 b	1.13 b	1.31 b
15 g/L (M ₃)	0.98 b	1.16 b	1.34 b
HSD 5 %	0.04	0.06	0.07
Shoot Pruning (P)			
25 th node (P ₁)	0.94	1.11	1.28
28 th node (P ₂)	0.94	1.11	1.29
30 th node (P ₃)	0.93	1.11	1.29
HSD 5 %	ns	ns	ns

Note: Means followed by the same letter within the same treatment and observation time are not significantly different according to Tukey’s HSD test at the 5% significance level; ns = not significant

The data presented in Table 2 show that, at 21–35 DAP, the application of MKP fertilizer increased stem diameter; however, no significant differences were observed among the concentrations of 5, 10, and 15 g L⁻¹. The highest stem diameter was recorded at 35 DAP (1.34 mm), while the lowest value was observed in the control treatment (0 g L⁻¹) at 1.23 mm. Accordingly, the application of MKP at 15 g L⁻¹ increased stem diameter by 8.94% compared to the control.

The increase in stem diameter is likely associated with the roles of phosphorus and potassium in plant physiological processes. Phosphorus is essential for meristematic tissue development and energy metabolism through ATP and ADP, which are crucial for cellular activities, while potassium contributes to cell wall strengthening and osmotic regulation (Singh *et al.*, 2014). In the hydroponic Nutrient Film Technique (NFT) system, nutrient solutions containing MKP are continuously circulated around the root zone, ensuring a stable and readily available supply of phosphorus and potassium. This condition enhances nutrient uptake efficiency and supports consistent stem growth. Furthermore, foliar application of MKP is considered efficient, as nutrients are directly absorbed through the leaves and support the development of plant organs, including the stem, during the vegetative phase and the transition to the generative stage (Permana *et al.*, 2023).

Shoot pruning did not significantly affect stem diameter. This may be attributed to the fact that pruning had not yet been applied during the observation period (21–35 DAP), and therefore its physiological effects on stem growth were not yet evident. Nevertheless, pruning is known to reduce apical dominance, which can otherwise suppress stem growth, and to redirect assimilates toward generative organs such as flowers and fruits. According to Sofyadi *et al.* (2021), shoot pruning reduces auxin production, thereby weakening apical dominance and allowing greater allocation of photosynthates toward fruit development. The application of MKP at 15 g L⁻¹ effectively promotes stem diameter growth, whereas shoot pruning plays a more prominent role in regulating reproductive development.

3.3. Number of Leaves

The analysis of variance indicated that there was no significant interaction between MKP fertilizer concentration and shoot pruning on the number of leaves of melon plants at all observation times. This was evidenced by the interaction *F*-values, which were lower than the *F*-table values at the 5% significance level at 21 DAP (0.97 < 2.51), 28 DAP (1.16 < 2.51), and 35 DAP (1.29 < 2.51). However, the main effect of MKP fertilizer concentration showed a highly significant influence on the number of leaves at 21–35 DAP. The calculated *F*-values were 16.57 (21 DAP), 28.26 (28 DAP), and 28.11 (35 DAP), all of which exceeded the *F*-table value at the 1% significance level (4.72). In contrast, shoot pruning did not significantly affect the number of leaves at any observation time, with *F*-values of 0.58 (21 DAP), 1.48 (28 DAP), and 1.40 (35 DAP), all lower than the *F*-table value at the 5% level (3.40). These results indicate that the variation in the number of leaves at 21–35 DAP was primarily influenced by MKP fertilizer concentration rather than shoot pruning. The mean number of leaves under different MKP concentrations and pruning treatments is presented in Table 3.

Table 3. Effect of MKP fertilizer concentration and shoot pruning on the number of leaves of melon plants at 21–35 DAP

Treatment	Number of Leaves		
	21 (DAP)	28 (DAP)	35 (DAP)
MKP Fertilizer Concentration (M)			
0 g/L (M ₀)	19.64 a	30.36 a	39.50 a
5 g/L (M ₁)	20.06 ab	30.78 a	40.08 a
10 g/L (M ₂)	21.00 b	31.42 b	41.42 b
15 g/L (M ₃)	22.14 c	32.47 c	42.94 c
HSD 5 %	0.96	0.61	1.02
Shoot Pruning (P)			
25 th node (P ₁)	20.60	31.10	40.65
28 th node (P ₂)	20.60	31.21	41.19
30 th node (P ₃)	20.92	31.46	41.13
HSD 5 %	ns	ns	ns

Note: Means followed by the same letter within the same treatment and observation time are not significantly different according to Tukey's Honestly Significant Difference (HSD) test at the 5% significance level; ns = not significant

The data presented in Table 3 indicate that the application of MKP at 15 g/L (M3) resulted in the highest number of leaves and was significantly different from the other MKP concentration treatments at 21–35 DAP. The highest number of leaves was recorded at 35 DAP (42.94), while the lowest value was observed in the control treatment (M0) at 39.50. The increase in leaf number by 8.74% under the M3 treatment suggests that an optimal MKP concentration enhances the formation of vegetative organs, particularly leaves, which serve as the primary source of photosynthates for plant growth and development.

Physiologically, the increase in leaf number under the application of MKP at 15 g/L is associated with the roles of phosphorus and potassium in promoting cell division, tissue formation, and photosynthetic efficiency. Phosphorus is involved in ATP synthesis and nucleic acid formation, both of which are essential for cell growth, while potassium regulates water balance, stomatal opening, and enzyme activation, thereby enhancing carbohydrate accumulation. An increased number of leaves expands the photosynthetic surface area, leading to higher assimilate production. This indicates a functional relationship between leaf number and the potential increase in fruit weight. These findings are consistent with Rahmiati *et al.* (2023), that phosphorus and potassium in MKP improve metabolic efficiency and support flower and fruit formation. Furthermore, Singh *et al.* (2014) stated that potassium plays a key role in physiological processes such as water regulation, stomatal activity, and carbohydrate synthesis, which support leaf development.

In the hydroponic Nutrient Film Technique (NFT) system, the application of MKP at 15 g L⁻¹ through a circulating nutrient solution ensures the continuous availability and efficient uptake of phosphorus and potassium by plant roots, thereby improving fertilization efficiency compared to non-circulating systems. Meanwhile, the absence of a significant effect of shoot pruning on leaf number suggests that pruning does not directly stimulate the formation of new vegetative organs, but rather functions in the redistribution of plant energy. Rasilatu *et al.* (2016) shoot pruning redirects photosynthates from the shoot apex to generative organs, while Sofyadi *et al.* (2021) noted that pruning reduces auxin production, thereby weakening apical dominance and promoting assimilate allocation toward fruit development. The application of MKP at a concentration of 15 g/L was effective in significantly increasing the number of leaves, whereas shoot pruning did not significantly influence this parameter.

3.4. Fruit Weight

The analysis of variance revealed a highly significant interaction between MKP fertilizer concentration and shoot pruning on melon fruit weight. This was indicated by the interaction *F*-value (5.20), which exceeded the *F*-table value at the 1% significance level (3.67). This finding suggests that the effect of MKP fertilizer concentration on fruit weight was strongly influenced by the shoot pruning treatment. In addition, the main effect of MKP fertilizer concentration showed a highly significant effect on fruit weight, with an *F*-value of 72.15, which was higher than the *F*-table value at the 1% significance level (4.72). Similarly, shoot pruning also had a highly significant effect on fruit weight, as indicated by an *F*-value of 57.80, exceeding the *F*-table value at the 1% level (5.61). Overall, these results demonstrate that MKP fertilizer concentration, shoot pruning, and their interaction played a crucial role in determining melon fruit weight. The mean fruit weight under the combined treatments of MKP concentration and shoot pruning is presented in Table 4.

Table 4. Effect of the interaction between MKP fertilizer concentration and shoot pruning on melon fruit weight

Treatment Combination	Fruit Weight (kg)		
	Shoot Pruning (P)		
MKP Fertilizer Concentration (M)	25 th node (P ₁)	28 th node (P ₂)	30 th node (P ₃)
0 g/L (M ₀)	2.08 a	2.10 ab	2.19 ab
5 g/L (M ₁)	2.16 ab	2.23 bc	2.28 bc
10 g/L (M ₂)	2.20 b	2.33 c	2.41 cd
15 g/L (M ₃)	2.22 bc	2.47 d	2.54 d
HSD 5 %	0.11		

Note: Means followed by the same letter are not significantly different according to Tukey’s Honestly Significant Difference (HSD) test at the 5% significance level.

The data presented in Table 4 indicate that the combination of MKP fertilizer at 15 g/L and shoot pruning at the 30th node produced the highest melon fruit weight, reaching 2.54 kg per fruit. This treatment was significantly different from all other treatment combinations. In contrast, the lowest fruit weight was observed in the control treatment (0 g/L MKP) combined with pruning at the 25th node, which resulted in a fruit weight of 2.08 kg. This represents an increase of 22.12% in fruit weight for the best treatment combination (M3P3) compared to the lowest (M0P1). These results indicate that the application of MKP at 15 g/L combined with shoot pruning at the 30th node effectively enhances melon fruit weight. The increase in fruit weight reflects the plant's physiological response to optimal nutrient availability and canopy management. An improved source capacity, indicated by efficient leaf function, is balanced by a stronger sink in the form of fruit development. This demonstrates a close relationship between vegetative and generative parameters, particularly between leaf number as a source of photosynthates and fruit weight as a sink for assimilate accumulation.

The increase in fruit weight was presumably influenced by the roles of potassium and phosphorus contained in MKP fertilizer. According to [Martias \(2011\)](#), stated that potassium functions as a catalyst in carbohydrate formation during photosynthesis, protein synthesis, and in improving both the quality and quantity of plant yield. [Álvarez *et al.*, 2025](#) stated that Phosphorus supports cell division and root growth, while also facilitating energy transfer through ATP, thereby enhancing nutrient and water absorption and enabling fruits to reach their maximum size. Physiologically, adequate potassium improves carbohydrate transport efficiency via the phloem, thereby increasing assimilate accumulation in the fruit, whereas phosphorus supports respiration and cell division during fruit enlargement. In the hydroponic Nutrient Film Technique (NFT) system, the continuous circulation of nutrient solution containing MKP ensures the availability of P and K in forms readily absorbed by plant roots, thereby enhancing nutrient uptake efficiency and supporting higher fruit weight.

In addition, Shoot pruning at the 30th node helps reduce the number of actively growing branches or shoots, allowing the plant to focus more on distributing energy and nutrients to the main fruit. This is consistent with [Sintinjak *et al.*, 2024](#) who stated that shoot pruning affects the production and flow of auxin to lateral shoots. As a result, assimilates are redirected from vegetative growth toward the development of generative organs, such as fruits, thereby significantly increasing yield. [Nugroho \(2021\)](#) further stated that pruning improves canopy structure, optimizes light interception, and accelerates fruit filling. From an agronomic perspective, such canopy management enhances photosynthetic efficiency and reduces internal competition among plant organs. Thus, the combination of MKP at 15 g/L and shoot pruning at the 30th node was the most effective treatment for increasing melon fruit weight in the hydroponic NFT system, as it optimizes both nutrient uptake and assimilate distribution toward the fruit, ultimately improving overall crop productivity.

3.5. Fruit Diameter

The analysis of variance revealed a highly significant interaction between MKP fertilizer concentration and shoot pruning on melon fruit diameter. This was indicated by the interaction *F*-value (5.65), which exceeded the *F*-table value at the 1% significance level (3.67). These results suggest that the effect of MKP fertilizer concentration on fruit diameter was strongly influenced by the shoot pruning treatment. In addition, the main effect of MKP fertilizer concentration showed a highly significant effect on fruit diameter, with an *F*-value of 38.65, which was higher than the *F*-table value at the 1% significance level (4.72). Similarly, shoot pruning also had a highly significant effect on fruit diameter, as indicated by an *F*-value of 36.19, exceeding the *F*-table value at the 1% significance level (5.61). Overall, these findings demonstrate that MKP fertilizer concentration, shoot pruning, and their interaction played a significant role in determining melon fruit diameter. The mean fruit diameter under the combined treatments of MKP concentration and shoot pruning is presented in Table 5.

The combination of MKP fertilizer at 15 g/L and shoot pruning at the 30th node resulted in the highest fruit diameter (16.74 cm), which was significantly different from other treatment combinations. In contrast, the lowest fruit diameter was observed in the control treatment (0 g/L MKP combined with pruning at the 25th node), with a value of 15.03 cm. This indicates that the M3P3 treatment increased fruit diameter by 11.38% compared to the control (M0P1). These results reflect the effectiveness of combining optimal nutrient supply with appropriate canopy management in promoting fruit development.

Table 5. Interaction effects of MKP fertilizer concentration and shoot pruning on melon fruit diameter

Treatment Combination	Fruit Diameter (cm)		
	Shoot Pruning (P)		
	MKP Fertilizer Concentration (M)	25 th node (P ₁)	28 th node (P ₂)
0 g/L (M ₀)	15.03 a	15.09 a	15.21 ab
5 g/L (M ₁)	15.26 ab	15.49 ab	15.81 b
10 g/L (M ₂)	15.29 ab	16.24 bc	16.32 bc
15 g/L (M ₃)	15.35 ab	16.68 c	16.74 c
HSD 5 %	0.61		

Note: Means followed by the same letter are not significantly different according to Tukey’s Honestly Significant Difference (HSD) test at the 5% significance level.

The increase in fruit diameter is associated with enhanced assimilate accumulation during the fruit-filling stage, which depends on efficient translocation of photosynthates from leaves to fruits. Potassium in MKP plays a key role in carbohydrate translocation to storage organs such as fruits, thereby increasing fruit size and reserve accumulation (Wardani *et al.*, 2016). Efendi (2021) also reported that MKP application at 9 g/L resulted in the highest fruit diameter due to adequate phosphorus and potassium supply. Physiologically, phosphorus contributes to energy provision (ATP) required for cell division and enlargement, while potassium enhances the efficiency of assimilate transport through the phloem, supporting the development of larger fruits. In the hydroponic Nutrient Film Technique (NFT) system, the continuous and thin flow of nutrient solution improves root zone aeration, thereby enhancing root physiological activity in nutrient uptake and translocation. This condition supports a stable supply of nutrients and assimilates during the fruit enlargement phase, contributing to increased fruit diameter.

Furthermore, shoot pruning at the 30th node reduces competition among vegetative organs, allowing assimilates and nutrients to be preferentially allocated to the main fruit. Koentjoro (2012) pruning at the 26th node significantly increased fruit diameter and fruit weight compared to other pruning treatments. Pruning also improves light distribution within the canopy and enhances photosynthetic efficiency, thereby maximizing assimilate accumulation in the fruit. Thus, the combination of MKP at 15 g/L and shoot pruning at the 30th node was the most effective treatment for increasing melon fruit diameter in the hydroponic NFT system, with important agronomic implications for improving fruit size and overall quality.

3.6. Fruit Cavity Diameter

The mean fruit cavity diameter under different MKP concentrations and pruning treatments is presented in Table 6. The analysis of variance indicated that there was no significant interaction between MKP fertilizer concentration and shoot pruning on melon fruit cavity diameter. This was evidenced by the interaction *F*-value (0.13), which was lower than the *F*-table value at the 5% significance level (2.51). Similarly, the main effect of MKP fertilizer concentration did not significantly affect fruit cavity diameter, with an *F*-value of 0.49, which was lower than the *F*-table value at the 5% level (3.01). The main effect of shoot pruning also showed no significant influence, with an *F*-value of 1.47,

Table 6. Effect of MKP fertilizer concentration and shoot pruning on melon fruit cavity diameter.

Treatment	Fruit Cavity Diameter (cm)
MKP Fertilizer Concentration	
0 g/L (M ₀)	6.33
5 g/L (M ₁)	6.28
10 g/L (M ₂)	6.11
15 g/L (M ₃)	6.00
HSD 5 %	not significant
Shoot Pruning	
25 th node (P ₁)	6.33
28 th node (P ₂)	6.29
30 th node (P ₃)	5.92
HSD 5 %	not significant

which was lower than the *F*-table value at the 5% level (3.40). These results suggest that variations in MKP fertilizer concentration and shoot pruning treatments did not significantly influence the formation of fruit cavity diameter.

The data presented in Table 6 show a decreasing trend in fruit cavity diameter with increasing MKP fertilizer concentration and higher levels of shoot pruning. The highest fruit cavity diameter was observed in the control treatment (0 g L⁻¹ MKP), with a value of 6.33 cm, while the lowest value was recorded under the application of 15 g L⁻¹ MKP (6.00 cm). A similar trend was observed for shoot pruning treatments, where fruit cavity diameter decreased from 6.33 cm at the 25th node to 5.92 cm at the 30th node. Although these differences were not statistically significant, this trend suggests that increasing MKP concentration and more intensive pruning tend to reduce fruit cavity diameter.

The decrease in fruit cavity width is presumably related to the roles of phosphorus and potassium. Pradana *et al.*, (2015) stated that phosphorus enhances plant metabolism and photosynthesis, resulting in greater assimilate production. Furthermore, according to Suriatna (2017), potassium contributes to stomatal regulation, thereby improving water uptake and photosynthetic activity. This indicates a relationship between fruit diameter and fruit weight parameters with fruit cavity width, where increased fruit biomass accumulation tends to be accompanied by better internal tissue filling.

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Although shoot pruning did not significantly affect fruit cavity diameter, it plays a role in directing assimilate allocation by reducing competition among vegetative organs. Canopy management through pruning improves photosynthetic efficiency and assimilate distribution to the fruit, thereby indirectly supporting the development of more compact fruit tissue. Thus, despite the absence of significant differences, the observed trend suggests that the combination of MKP fertilization and shoot pruning has the potential to improve internal fruit quality, particularly under hydroponic NFT systems that enhance nutrient uptake efficiency and assimilate distribution.

4. CONCLUSION

Based on the results of this study, MKP fertilizer application increased plant length and stem diameter; however, no significant differences were observed among concentrations of 5, 10, and 15 g/L. MKP application significantly affected both growth and yield of melon plants, with the concentration of 15 g/L producing the best results in terms of number of leaves, fruit weight, and fruit diameter. Shoot pruning did not significantly influence vegetative growth but had a highly significant effect on generative parameters, particularly fruit weight and diameter, with pruning at the 30th node producing the best results. A highly significant interaction between MKP concentration and shoot pruning was observed for fruit weight and diameter, where the combination of 15 g/L MKP and pruning at the 30th node resulted in the highest yield performance. Therefore, the combination of MKP fertilizer at 15 g/L and shoot pruning at the 30th node is recommended as an effective cultivation strategy to maximize melon yield, particularly in improving fruit weight and size under hydroponic NFT systems.

AUTHOR CONTRIBUTION STATEMENT

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
YEP	✓	✓		✓	✓	✓		✓	✓	✓	✓			
RH	✓	✓		✓		✓			✓	✓		✓		
NT	✓	✓		✓		✓			✓	✓		✓		
C: Conceptualization			Fo: Formal Analysis			O: Writing - Original Draft			Fu: Funding Acquisition					
M: Methodology			I: Investigation			E: Writing - Review & Editing			P: Project Administration					
So: Software			D: Data Curation			Vi: Visualization								
Va: Validation			R: Resources			Su: Supervision								

ACKNOWLEDGMENTS

The authors express their gratitude to the Caping Kota Farmer Surabaya, Agrotechnology UPN “Veteran” Jawa Timur and all colleagues who contributed to and supported this research.

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