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(Research Article)

The effect of topping and fruit position on the yield and quality of melons (*Cucumis melo* L.) in a greenhouse

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Abstract

Topping melon plants breaks apical dominance. Fruit positioning is linked to the allocation of photosynthates within the plant. This study aimed to determine the effects of topping and fruit position on melon yield and quality in a greenhouse setting. A Randomized Complete Block Design (RCBD) with two factors was employed: three topping levels (at nodes 19, 21, and 23) and four fruit position levels (nodes 7–9, 10–12, 13–15, and 16–18), with three replications. Data were analyzed using ANOVA and the Least Significant Difference (LSD) test at the 5% level. The results showed a significant interaction between the two treatments regarding the number of female flowers, with a maximum of 4.43 flowers. Topping significantly affected fruit rind thickness—peaking at node 21 (7.87 mm)—and had a highly significant effect on leaf chlorophyll content. Fruit position significantly influenced total soluble solids—highest at nodes 7–9 (13.41 °Brix)—and had a highly significant effect on fruit rind thickness. Fruits at nodes 10–12 yielded higher fruit weight, vitamin C content, and rind thickness, whereas the highest total soluble solids were obtained from fruits at nodes 7–9.

Keywords: Fruit Position; Melon; Topping; Vitamin C

1. Introduction

1.1. Materials

The materials used in this study included AB Mix fertilizer, foliar fertilizer (ultradap), KNO3 fertilizer, calcium, and Sakata Glamour melon seeds. These plants were given two treatments: topping and fruit positioning, which were then cultivated in a greenhouse. The tools used in this study included polybags, a sprayer tank, a pH and TDS meter, scissors, and a knife. The tools used to observe the research variables were a refractometer to measure the sweetness level of the fruit, and a digital scale to measure the fresh weight of the fruit per plant and the percentage of edible fruit.

1.2. Method

The study was conducted using a 2-factor Randomized Block Design (RBD) with 3 replications. The first factor, topping/pruning the main stem at the shoot tip (T), consisted of 3 levels: T1 = Topping the main stem at the 19th node, T2 = Topping the main stem at the 21st node, and T3 = Topping the main stem at the 23rd node. The second factor, the position of the fruit allowed to grow (P), consisted of 4 levels: P1 = The position of the fruit allowed to grow at nodes 7-9, P2 = The position of the fruit allowed to grow at nodes 10-12, P3 = The position of the fruit allowed to grow at nodes 13-15, and P4 = The position of the fruit allowed to grow at nodes 16-18. There were 12 treatment combinations with 3 replications, resulting in 36 experimental units.

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The research began with the preparation of tools and materials inside the greenhouse, such as drip irrigation hoses, polybags, and supporting equipment like hoes, buckets, shears, and staking twine. Next, the growing medium was prepared by sun-drying it to sterilize it against bacteria, pathogenic fungi, and pests that cause root diseases. Once dried, the medium was transferred into 35 x 35 cm polybags, which were then arranged in the greenhouse with a spacing of 45 x 45 cm. Melon seeds were first soaked in shallot skin extract for 2–3 hours; afterwards, they were covered and stored in a low-light area for 1–2 nights to accelerate germination. Once germinated, the seeds were sown in seedling trays. After 7–12 days—indicated by the emergence of 2 to 3 leaves—the seedlings were transplanted into the polybags. Nutrients and fertilizers were applied either by drenching the growing medium directly or by spraying the foliage. Fertilizers applied via drenching included AB Mix, NPK, and humic acid, while those applied via spraying included KNO3, Ultradap, Calcium, and MKP. Topping was performed once the plants reached the desired stage; regarding fruit positioning, only one fruit meeting the specific criteria was retained, while fruits at other nodes that did not meet the requirements were immediately removed.

Measurements of the observed variables were conducted one day after fruit harvesting. Fruit weight was determined by weighing the freshly harvested fruit on a digital scale and recording the displayed value. Total soluble solids were measured using a Brix refractometer by placing 1–2 drops of fruit juice onto the refractometer's prism and recording the resulting reading. The percentage of edible fruit was calculated using the formula.

$$\text{BDD\%} = \left(\frac{edible\ fruit\ weight}{whole\ fruit\ weight}\right) x\ 100\%$$

The vitamin C content variable was determined using iodometric titration in the PKHT IPB laboratory. The formula used is:

$$\text{Vitamin C content} = a \times k \times fp \times 100/b \times 100$$

a = titration result (ml)
k = constant value of 0.88
fp = dilution frequency of 4
b = weight (g)

2. Results and Discussion

The results of the ANOVA test analysis showed that the interaction of topping with fruit position did not significantly affect the yield and quality of melons.

Table 1 Effect of Topping Treatment and Fruit Position on Fresh Fruit Weight, Total Soluble Solids, Percentage of Edible Fruit and Vitamin C Content

Treatment	Fresh weight of fruit Total	Dissolved Solids (0Brix)	Percentage of edible fruit (%)	Vitamin C content
Topping (T)				
T1	1,3 a	12,38 (3,65) a	64,94 (8,12) a	17,78 (4,26) a
T2	1,52 a	12,86 (3,72) a	64,47 (8,12) a	18,02 (4,28) a
T3	1,50 a	12,23 (3,63) a	65,00 (8,09) a	16,18 (4,06) a
LSD 5%	0,21	0,16	0,14	0,36
Fruit Position (P)				
P1	1,45 a	13,41 (3,79) a	65,55 (8,15) a	15,03 (3,90) b
P2	1,60 a	13,20 (3,77) ab	64,17 (8,07) a	19,24 (4,43) a
P3	1,47 a	12,02 (3,61) b	63,83 (8,05) a	18,45 (4,35) ab
P4	1,32 a	11,33 (3,50) c	65,67 (8,16) a	16,59 (4,13) b
LSD 5%	0,24	0,19	0,16	0,41

Note : Values followed by the same letter within the same treatment and column indicate no significant difference according to the Least Significant Difference (LSD) test at the 5% level. Values outside parentheses represent the data.

The single factor of topping on plants had no significant effect on the variables of fresh fruit weight, percentage of edible fruit, TPT and vitamin C content. The single factor of fruit position had a significant effect on TPT and no significant effect on fresh fruit weight, percentage of edible fruit and vitamin C content.

2.1. Effect of Topping on Melon Yield and Quality

Regarding the fruit weight variable, the highest value was observed in T2 (1.52), while the lowest was in T1 (1.35), indicating that T2 was 12.59% higher than T1; however, the differences in fruit weight between treatment levels were not statistically significant. Physiologically, the application of topping breaks apical dominance, thereby reducing the plant's vegetative growth rate. With reduced vegetative growth activity, the demand for photosynthates to form new tissue decreases; consequently, a larger proportion of photosynthetic products is allocated to reproductive organs—specifically the fruit, which acts as a sink [2]. In this study, the topping treatments at the various levels did not yield significant differences. This is likely because all topping treatments were performed at relatively close growth stages—specifically at the 19th, 21st, and 23rd nodes—resulting in a similar number of retained leaves across treatments and, consequently, comparable amounts of photosynthate production. This resulted in a relatively uniform supply of photosynthates allocated to the fruit. These findings align with research by [7], which states that melon fruit growth is influenced by the capacity of leaves (acting as the source) to produce photosynthates that are subsequently translocated to the fruit (acting as the sink).

In the Total Dissolved Solids (TPT), no significant differences were obtained between treatment levels. The highest total dissolved solids value was shown in T2, which was 38.58, while the lowest total dissolved solids was shown by T3, which was 36.70, which indicates that the total dissolved solids in T2 were 5.12% greater than T3. The T2 treatment produced the highest level of sweetness. Biologically, this indicates that topping at a certain intensity is able to optimize the distribution of photosynthesis results to the fruit, thereby increasing sugar accumulation in the fruit, while topping with an intensity that is too light or too heavy tends to be less optimal in supporting sugar formation. This is suspected to be an increase in the effectiveness of photosynthesis, thereby increasing the translocation of photosynthate at the sink, which will reduce the absorption of photosynthate at the source. [2]. Previous research also stated that topping at the 21st segment showed better total dissolved solids compared to other levels. This is because topping done at the right and correct time will inhibit the growth of secondary branches on the plant, so that later the results of plant photosynthesis will be used more for fruit formation, pruning can also result in an increase in the carbon and nitrogen ratio in the plant, resulting in carbohydrate fertilization which will stimulate fruit formation [5]

Regarding the percentage of edible fruit, the highest value was observed at treatment level T3 (65.00), while the lowest was at T2 (64.47); this indicates that T3 yielded a value 0.82% higher than T2. The lack of significant differences between treatment levels suggests that shoot pruning at varying intensities did not result in a significant difference in the proportion of fruit flesh to fruit skin. This is likely because, physiologically, topping primarily influences the distribution of photosynthates to plant organs, whereas the formation of fruit flesh is determined more by genetic factors and the fruit development process. As long as the remaining leaves are capable of producing sufficient assimilates, the growth of both flesh and skin proceeds proportionally, causing the percentage of edible fruit to remain relatively constant across treatments. These findings align with the results of study [6], which indicated that pruning plays a greater role in influencing assimilate distribution and fruit size than in altering the proportions of the tissues constituting the fruit.

In the topping treatment, the results obtained were not significantly different between treatment levels. The highest vitamin C content value was found at the T2 level, which was 18.02 and the lowest vitamin C content value was shown by T3, which was 16.18. This shows that T2 is 11.37% greater than the T3 value. The highest vitamin C content value at T2 can be associated with the balance of sources and sinks in plants, where too intensive topping has the potential to reduce the plant's ability to synthesize and accumulate secondary metabolite compounds, including vitamin C, in the fruit. [6].

2.2. The effect of fruit position on melon yield and quality

The effect of fruit position on the fresh fruit weight variable, the highest fruit weight value was found in T2, which was 12.59, while the lowest fruit weight value was found in T1, which was 1.35, which shows that T2 was 12.59% greater than T1. The highest fruit weight value was in T2, this condition shows that fruit located in the middle segment of the plant generally has better access to photosynthesis results and nutrient supply, so it is able to support fruit growth more optimally.[1]

In the fruit position treatment, the total dissolved solids value at P1 showed a value that was not significantly different from P2 but significantly different from P2 and P3, and very significantly different from P4. The highest total dissolved solids was shown by the P1 level, which was 13.41, while the lowest total dissolved solids was shown by P4, which was 11.44, which showed that the total dissolved solids at P1 were 18.35% greater than P4. The highest total dissolved solids value at P1 was thought to be due to light being the main factor in influencing the photosynthesis process of leaves around the fruit, which in turn determines the amount of photosynthates available to be translocated to the fruit as a sink, so that the position of the fruit in the plant canopy correlates with fruit quality due to differences in light exposure and photosynthetic efficiency at various fruit positions [3]

In the fruit position treatment, there were no significant differences between treatment levels. The highest value was found at level P4, at 65.67, and the lowest value was found at level P3, at 63.83. This difference indicates that fruit position can influence the proportion of fruit flesh to other parts of the fruit, although this effect does not always correspond to an increase in fruit weight or sweetness.

In treatment P2, the vitamin C content was not significantly different from P3, but significantly different from P1 and P4. P2 showed the highest vitamin C content at 19.24, and the lowest vitamin C content at 15.03 was not significantly different from P1. This indicates that fruit position is related to the efficiency of photosynthetic translocation and assimilates distribution in melon plants, which has the potential to affect melon quality. [4].

3. Conclusion

Based on the research results obtained, it can be concluded that the topping treatment significantly affected the thickness of the fruit skin. The highest value of fruit skin thickness was at the T2 level, which was 7.87 and the smallest value of fruit skin thickness was at T1, which was 7.22. The treatment of fruit position significantly affected the total soluble solids of the fruit with the largest value at P1, which was 13.41 and the smallest value at P4, with a value of 11.33 and a very significant effect on the thickness of the fruit skin with the largest value at P2, which was 8.24 and the smallest value at P4, with a value of 6.75. The interaction between the topping treatment and fruit position only significantly affected the number of female flowers, while the yield and fruit quality variables did not show a significant effect. The best treatment combination was obtained at the 23rd topping and the fruit position at segments 7–9 with the highest number of female flowers of 4.43 flowers.

Compliance with ethical standards

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Disclosure of conflict of interest

There are No. conflicts of interest to disclose.

Statement of ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Statement of informed consent

Informed consent does not apply because this research does not involve human participants.

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