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The Effect of Fixed Fruit Setting On The Quality Of Rockmelon (*Cucumis melo* L.)

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ABSTRACT

Rockmelon (*Cucumis melo* L.) is a popular tropical fruit and is widely cultivated in Malaysia. It is also known as cantaloupe or muskmelon from the Cucurbitaceae family. This study aimed to determine the interaction between different fruit setting positions on the quality of 'Glamour' rockmelon fruit. Rockmelon was grown at 0.6 m spacing between polybags in a two-row setup inside the ventilated rain shelter located at Politeknik Sandakan Sabah. Only one fruit per plant was maintained for each polybag according to the fruit setting position (lateral branch/node) that has been marked for easier data collection. Data for the yield parameters will be collected for each sample on Day 60. The results showed that the fruit position arrangement shows a different influence on the quality of 'Glamour' rockmelon fruit. The fruit position at the 12th node has greater diameter and weight. Conversely, fruits at lower positions, which is at the 4th node of the fruit tend to be sweeter. This indicated that the parameters of fruit weight, diameter, and sweetness level were strongly influenced by the location of the fruit. This study adds to the existing knowledge about fruit-growing methods and offers useful information for farmers and those involved in agriculture.

1.0 Introduction

Rockmelon (*Cucumis melo* L.), also known as cantaloupe or muskmelon, is an herbaceous plant belonging to the Cucurbitaceae family. It is a popular tropical fruit worldwide, known for its sweetness, fruit texture, and fragrance (Marveldani et. al., 2023). Rockmelon was initially introduced to Malaysia in 2000 (Wee et al., 2018). Since then, a lot of rockmelon cultivation has been developed in Malaysia due to high demand from both local and international markets. Melons are mostly planted in Johor, Kedah, Terengganu, Kelantan, and Pahang, as reported by Rasmuna et al., (2015). Optimal soil temperatures for planting melons range from 25°C to 32°C, with the growing season extending from March to May and July to September, encompassing two distinct periods. Nonetheless, Amarasinghe et al. (2022) mentioned that the upper temperature thresholds for melon crops are identified as 39°C to 45°C using a drip irrigation system. Melons are primarily found in tropical regions and are regarded as botanical relatives of cucumber, squash, and pumpkins.

The quality of rockmelon fruit is influenced by various factors, including fruit setting, which plays a crucial role in determining fruit characteristics such as size, shape, sweetness, and overall development. Fruit setting position is crucial for determining the ultimate quality of the rockmelon. Ultimately, it affects the marketability and consumer preference of the fruit. Most research studies related to fruit quality only compare biochemical assessments such as ascorbic acid content, calcium content, total carbohydrate content, titratable acidity (TA), total soluble solid (TSS), pH, and electrical conductivity (EC). However, some studies consider factors such as the temperature during planting, the number of leaves that grow, leaf area per plant, and planting area. Nevertheless, there are not many studies that consider the fruit position on the plant during growth. Therefore, more research is needed to understand the full impact of fruit setting on rockmelon quality. Moreover, a detailed study on the influence of each branch/node on the fruit quality has not yet been carried out. Therefore, this study was carried out to examine the relationship between each fruit setting position and yield parameters, specifically fruit weight, diameter, and sweetness, to find out whether the location of the fruit affected its quality.

2.0 Literature review

Several studies have investigated the quality assessment of fruit based on fruit position. In a prior study conducted by Bhering et al. (2013), it was discovered that a higher number of leaves led to higher leaf area and total soluble solids. Additionally, positioning the fruit in the middle section, rather than at the top of the plant, results in a shorter growth cycle. This is likely to be more economical and time-saving, especially for marketing purposes. Furthermore, this has been confirmed by a previous study by Kamiya (1969), which stated that the size and quality of melon fruit are influenced by their position on the plant. Fruits on the lower position of the stem exhibited smaller size and sweeter taste compared to those on the upper part. This study is supported by research conducted by Queiroga et al. (2009). Their study revealed that fruits located at the 15th to 18th nodes exhibited an extended harvest period, larger diameter, greater leaf area, and reduced sugar concentration. This suggests that meticulous control of fruit quantity and positioning can positively impact muskmelon yield. However, as per Hayata et al. (2000), it is suggested that the optimal position for fruit set on a melon plant is between the 9th and 13th nodes of the vine. Fruits at this position are noted to be larger and of superior quality, contrasting with those on the lower stem, which tend to be smaller and sweeter.

Queiroga et al. (2008) also discovered the reduction in commercial productivity (CP) in plants with only one fruit, with a decrease of 21.4% for fruits set between the 5th and 8th nodes, and 24.9% for fruits set between the 15th and 18th nodes, compared to plants with two fruits. In contrast, Widaryanto et al. (2020) found that there was no correlation between pruning leaves and adjusting fruit positioning with yield parameters through conventional planting with soil as planting media on golden melon fruit. However, each of these treatments individually had a significant impact on these yield parameters. The treatment involving both pruning and arranging fruiting on the twelfth–thirteenth segment was found to be the most effective.

Amarasinghe et al. (2021) conducted a study to assess the growth, physiology, and yield of different rockmelon cultivars grown under high-temperature stress. Their study demonstrated that temperature has a significant impact on the positioning of fruit along the main branch. As the temperature rises, rockmelon fruits tend to migrate towards the upper branches. Subsequently, Wee et al., (2018) discovered that the mean fruit weight of one fruit set was higher when the location of the fruit set was at the 8^{th} to 14^{th} lateral branch. Nonetheless, the research findings also indicated that the total phenolic content was elevated at the lower fruit set position, suggesting that the fruit set position also plays a role in determining the nutritional composition of the fruit.

3.0 Methodology

3.1 Research Site

The experiment was conducted in a rain shelter located at Politeknik Sandakan Sabah, Malaysia. 'Glamour' rockmelon plants were grown using fertigation in a soilless medium (coco peat) in an enclosed rain shelter equipped with a ventilating fan and an automated drip irrigation system.

3.2 Plant Culture

Rockmelon seeds (*Cucumis melo L* 'Glamour') were sown individually in peat moss in the seedling trays at the nursery. The trays were watered twice daily to ensure optimal seed germination and growth. A total of fourteen days old of 36 seedlings from nursery trays were transplanted into 16x16 cm sized polybags which contained three-quarters of cocopeat. The polyethylene polybags were arranged with a spacing of 0.6 meters between each bag in two rows (Figure 1.1). After transplanting, the plants were fertigated six times per day in a drip irrigation system (0730, 0930, 1130, 1330, 1530, and 1730) using AB fertilizer. The irrigation schedule was set up using an electronic timer. Drip irrigation is installed for each polybag to facilitate fertilizer application and watering activities. Additional water was applied to the plants through drip irrigation during hot weather and if necessary.

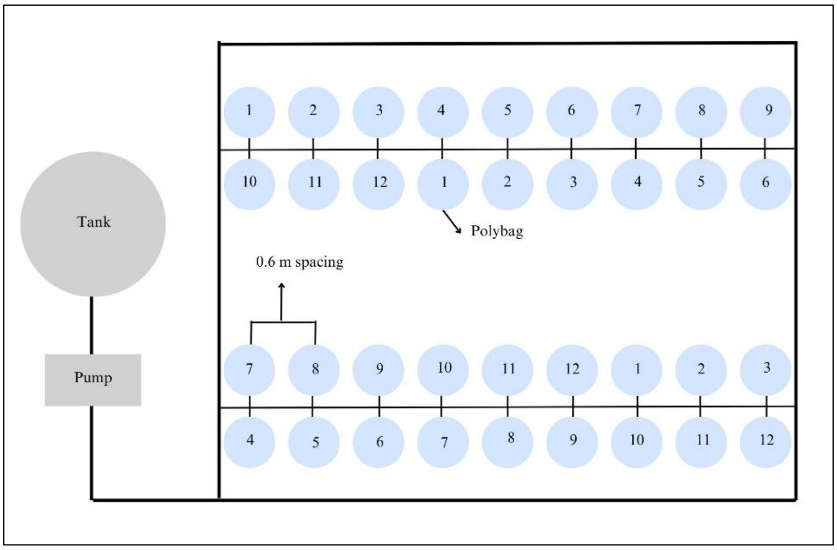

Figure 1.1: Experimental setup for each polybag with 0.6 meter spacing according to the fruit set position based on lateral branches inside the rain shelter

3.3 Experimental Design

Each polybag was marked after the transplanting process according to the fruit branch/node, making it easier to be recognized for weekly monitoring. They were divided into three samples for each fruit branch. For instance, the plant for 1st node consists of three samples, and the plant for 2nd node consists of another three samples (Table 1.1). So, each sample in the polybag was used to estimate fruit diameter, fresh fruit weight, and sugar content. The appearance of the fruit branch of each sample was accomplished by manual observation every week, starting from 1st node on the first week, when the seeds were transplanted. This experiment was designed by using a fertigation system for 60 days starting from the seedling transplant period until the fruit harvesting stage. Plant maintenance activities such as pruning, pesticide control, and foliar spraying were carried out according to the standard maintenance routines. Only one fruit per plant was maintained and pruned to leave a single stem, which was twined on a supporting string as the stems elongated according to the fruit setting position that had been marked on each polybag earlier. Meanwhile, hygienic measures were implemented to reduce pest and disease infestations. Pests and diseases were managed using recommended chemicals if necessary. Within the scope of this research, the rain shelter was ventilated and the temperature inside is neglected, presumed to be constant since rockmelon can tolerate high temperatures up to 45°C (Ertan, 2010).

Table 1.1: Several samples of plants based on fruit setting position in the sequence of the lateral branch of the plants

Fruit set position (lateral branch)	Number of samples
1st	3
2nd	3
3rd	3
4th	3
5th	3
6th	3
7th	3
8th	3
9th	3
10th	3
11th	3
12th	3

3.4 Observation and Data Collection

Melons were collected upon reaching ripeness and were readily separated from the vines (Paris et al., 2012). In order to ensure the uniformity of the experimental data, all rockmelon fruits were harvested on the same day which is Day 60 after two months of being transplanted onto coco peat media. After harvesting, the rockmelon fruits were measured. Yield parameters such as fruit diameter, fresh weight, and sugar content were evaluated at the end of the experiment. The diameter of the fruit was calculated from its circumference as measured by the centimeter using a measuring tape. The weight of the fruits was measured using an electronic weighing scale in a kilogram unit. Meanwhile, the destructive method was done for each fruit after the fruit diameter and weight had been recorded to identify the fruit sweetness by placing the fruit sap on the Brix Refractometer. All these parameters were obtained by averaging and analyzed further.

4.0 Discussion of analysis and findings

The results of different fruit positions on fruit diameter, weight, and sweetness at harvest on Day 60 are shown in Figure 3. It shows that there was a significant influence of each fruit position separately on these yield parameters.

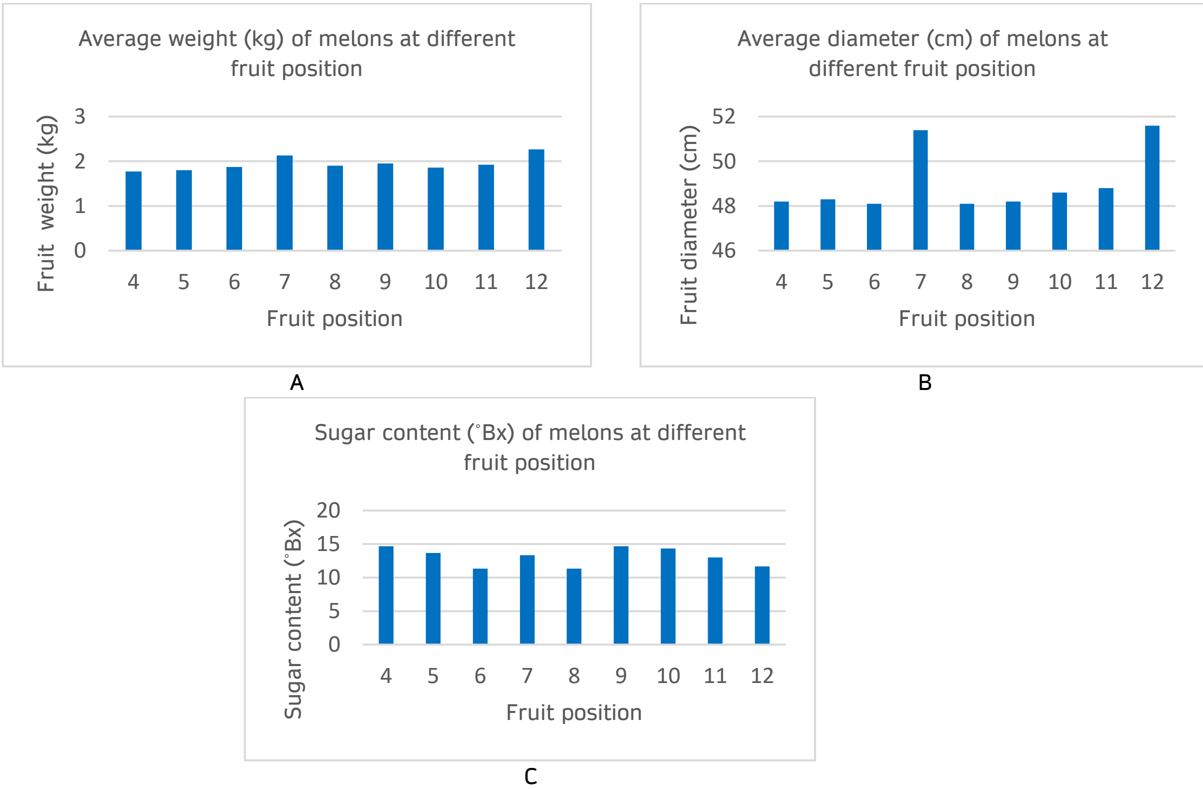

Figure 1.2: Relationship between fruit position and yield parameters. Fruit position in relation to fruit diameter (**A**), fruit weight (**B**) and fruit sweetness (**C**) of melon plants.

Based on the study conducted, melons begin to bear fruit starting from the 4th node. The study was conducted up to the 12th node only, considering that cultivation through fertigation system is faster compared to conventional planting method. Additionally, fertigation system utilizes AB fertilizer which is absorbed directly by the plants through the drip irrigation system. This will accelerate the fruit ripening rate. However, conventional method, which used soil as media uses NPK fertilizer, where the fertilizer needs to be broken down in the soil before being absorbed by the plant roots.

The results indicated a gradual increase in the average diameter of the fruit as the fruit node ascended the vine vertically. Specifically, melons originating from lower fruit nodes exhibited a smaller average diameter compared to those from higher nodes. Based on the graph in Figure 1.2A, 'Glamour' rockmelons from the 4th to 5th node increased in diameter, 48.2 cm, and 48.3 cm respectively but experienced a decrease at the 6th node, which is 48.1 cm. While those from the 8th to 12th node demonstrated a slightly larger diameter from the lowest 48.1 cm at the 4th node until 51.6 cm at the 12th node. This trend persisted consistently across all fruit nodes studied. The highest average diameter of melons is 51.5 cm at the 12th node, followed by 51.4 cm and 48.8 cm, at the 7th and 11th node respectively.

Based on previous studies, fruit position can be divided into two sections: the lower part of the plant, from the 8th node and below, and the upper part of the plant, which starts from the 9th node and above. Based on previous research conducted by Queiroga et al. (2009), fruit at the 5th to 8th node tend to be greater in size compared to fruit at the upper part of the plants. This could be a factor causing the fruit at the 7th node to be larger than the fruit at the 8th node, which is 51.4 cm. However, according to an earlier study by Hayata et al. (2000), the fruit setting position between the 9th and 13th nodes of the vine is considered the ideal location for fruit setting on a melon plant. Fruits in this area are larger and of higher quality, in contrast to those on the lower stem, which are typically smaller and sweeter. As stated by Pereira et al. (2017), an increase in fruit diameter suggests improved fruit quality in melons, signifying favorable growing conditions and reduced competition for resources among the fruits. This confirms the experimental findings indicating that the largest size of melon fruit is at the 12th node which is 51.5 cm, reaching optimum quality.

Based on Figure 1.2B, the results of the average weight of melons at various fruit nodes in melon plants revealed notable trends. Results indicated a systematic increase in average weight as fruit nodes progressed along the vine. The weight of melons increased gradually as the fruit nodes increased from 1.77 kg at the 4th to 2.13 kg at the 7th node. However, it turned out to slightly decrease to 1.90 kg at the 8th node. The average weight of melons showed a steady increase, rising from 1.86 kg at the 10th node to 2.27 kg at the 12th node. Just like the trend observed in diameter size, melons attained their maximum weight at the 12th node, reaching 2.27 kg. This was followed by weights of 2.13 kg and 1.95 kg at the 7th and 9th node respectively along the vine.

As per the melon group classification based on fruit characteristics provided by Wehner et al. (2020), the weight of cantalupensis melons typically falls between 1.5 and 2.2 kg. According to FAMA (2011), melon sizes are classified into three categories: large (weight > 1.3 kg), medium (weight between 1.00 - 1.29 kg), and small (weight < 1.00 kg). As per Cabello et al. (2009) stated that melon fruits are deemed suitable for the market potential if they exhibit no visible flaws and weigh over 1 kg. This indicates that the fruits produced meet market standard requirements. In a previous study done by Widaryanto et al. (2020), they discovered that the fruit position at the 12th to 13th node had the highest fruit weight. The study done by Wee et al. (2018) found that plants with one fruit set a higher position 8th to 14th node produced the heaviest mean fruit weight. This statement has been validated in this experiment, where the fruit at the 12th node position is the heaviest, weighing 2.27 kg.

The graph in Figure 1.2C shows that the sweetness level of 'Glamour' rockmelon decreased from the 4th to the 6th node of the fruit position. There was a fluctuation in the sugar content level of rockmelon at the 6th to 8th node. This is because, twenty days after flowering, approximately at the 4th node, the melon fruit enters the expanding stage, with still low fruit volume, and sugar content. However, the fruit position at the 4th and 9th nodes had highest sugar content (14.67°Bx), probably due to less inter-plant competition for light, allowing the plants to produce larger canopies that can provide more photosynthates for sugar accumulation in the fruit during ripening. Wee et al. (2018) suggested that wider plant spacing and positioning fruits in the middle to the upper part of the plant canopy are beneficial for increasing sugar content and improving overall fruit quality in rockmelons. The sugar content continued to decrease along the increment of the fruit position. This confirms the findings of a previous study by Kamiya (1969), which stated that the size and quality of melon fruit are significantly impacted by their position on the plant. Fruits located lower on the stem were smaller and sweeter compared to those on the upper portion. Furthermore, fruits located at the lower position will ripen faster compared to those at the upper position.

5.0 Conclusion and future research

Fruit position arrangement shows different influences on the quality of 'Glamour' rockmelon fruit. A spacing of 0.6 m for each plant has been proven to be the most suitable, as demonstrated in the previous studies. The parameters of fruit weight, diameter, and sweetness level were strongly influenced by the location of the fruit. This indicated that the higher the fruit position, the greater the diameter and the weight of the fruit. Conversely, fruits at lower positions on the plant tend to be sweeter. In order to verify the sugar content in each fruit at different positions, it is recommended to analyze the data using image processing techniques to determine the differences in sugar content through the pixel intensity values of the fruit. Moreover, it is also recommended to increase the sample size to further prove its efficacy. Additionally, this study adds to the existing knowledge about fruit-growing methods and offers useful information for farmers and those involved in agriculture.

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Author Contributions

Nik Salwani Nik Yusoff: Conceptualization, Data Curation, Writing-Original Draft Preparation; **Tony Ontok:** Methodology, Validation, Supervision; **Hasmidah Md Isa:** Validation, Writing-Reviewing and Editing.

Conflicts of Interest

The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

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