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Research Article

# Role of Plant Growth Regulator and Organic Fertilizer in Growth Stimulation and Quality Enhancement of Muskmelon (*Cucumis melo* L.)

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**Abstract:** The application of Plant Growth Regulators (PGRs) and certain types of fertilizers can enhance plant growth, production as well as sugar content of muskmelon. Aiming to determine the role of PGRs in stimulating growth and to ascertain the ability of both organic fertilizers and biofertilizers to raise the level of sweetness in muskmelons, this study put a split-plot design into work – the main plots were assigned to fertilizers (P0 = no organic fertilizer, P1 = liquid organic fertilizer, P2 = organic biofertilizer) while sub-plots to PGRs (Z0 = no PGRs (water), Z1 = coconut water, Z2 = GA3). The result concluded that biofertilizer (P2) increased the fruit weight by 11.76 % at an average of 2.66 kg. It also boosted the sugar content by 29.53 %, much higher than organic fertilizer at 15.46 %. As for PGRs, GA3 (Z2) was proven to enhance the sweetness in muskmelon by 23.62 %, higher than coconut water at 16.63 %. The net pattern on the rind of the P2 treatment was smooth, while the ones of P1 were rough. The very fragrant aroma was obtainable by applying biofertilizer (P2) and coconut water as PGRs (Z1).

**Keywords:** Biofertilizer, Gibberellin, Integrated farming, Rind net pattern, Sweetness level

## 1. INTRODUCTION

Muskmelon (*Cucumis melo* L.) is widely consumed due to its sweet juicy flavor. It contains polyphenols, organic acids, lignan, and other polar compounds beneficial to health [1–4]. The appearance of the netted rind texture and the sweet flavor of the fruit are the most captivating features for end-users, and its nutritional aspects have made it one of the most demanded cucurbitaceous products.

The factors responsible for muskmelon's taste are genetic as well as non-genetic such as microclimatic environment, pest, disease, and inappropriate fertilization [5] – may be beyond the farmers' awareness, making them inattentive to maintain or even enhance the sweetness. Such purpose calls for plant growth and harvest quality management by administering organic fertilizers and plant growth regulators (PGRs).

An agreeable alternative both economically and environmentally is organic fertilization which supports nutrient cycle and supplies carbon to soil [6, 7] better than mineral fertilization. Muskmelon can extract > 80 % of total applied nutrients Nitrogen (N) and Potassium (K) are the most vital compounds. N particularly affects rooting system, fruit ripening, and K absorption in the muskmelon plant [8], therefore influential towards yield,

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quality, juice quantity, total dissolved solids (TDS), and total acidity [9] as well as flesh thickness and fruit quantity [10, 11]. Organic media of bokashi, cocopeat, and rice husk charcoal (60:20:20) has been proven effective in increasing the sweetness intensity in muskmelon of Action 434 F1 variety [12].

A hormone naturally produced in small amounts, gibberellin is able to boost germination, shoot formation, stem elongation, leaf growth, flower budding, fruit enlargement, and root growth as well as its differentiation. According to [13], applying 30 mg kg$^{-1}$ of gibberellin enhances muskmelon growth and quality. Rahman *et al.* [14] has proven that both soaking the plant root in 50 mg kg$^{-1}$ of GA3 and applying 25 mg kg$^{-1}$ of it in the flowering stage equally increase the quantity of flowers and yields significantly in each tomato plant.

Coconut water is a source of natural PGRs. Containing zeatin – a plant growth hormone in the cytokinin family – it reserves the capacity to encourage cell division and certain tissue differentiation in shoot formation and root growth. Yet, the presence of other phytohormones – particularly auxin – is key for cytokinin's role in cell division [15]. Ansar and Paiman [16] state that coconut water of 40 % concentration as natural PGRs gives the best result in heightening the growth and yield of shallot.

Based on the functions of organic fertilizers and growth hormones, it is necessary to combine the two to be applied to melon cultivation to increase the quality of melons. Several previous studies [17–21] recommended mixed research between PGRs and organic fertilizers (solid and liquid). With these considerations, this research was conducted to see how well organic fertilizers containing gibberellin and coconut water as natural PGRs work in the quality enhancement of muskmelon.

## 2. MATERIAL AND METHODS

The research was conducted between April and July 2019 in the farmland of Klurahan Village of Kartoharjo District, Magetan Regency, East Java, Indonesia, coordinate S 7°32'47.184" E 111°28'47.1252". It is situated in 60 m to (60-75)m above sea level, the area's rainfall is rated at 1 616.9 mm and environmental temperature at 20 °C to 30 °C with approximately 82.0 % humidity. The soil characteristics for this study are detailed in Table 1 below.

The organic fertilizer was of fruit sweetening, applied once per day at 10 g L$^{-1}$ water for 7 d during the generative period. The biofertilizer at 3 ml L$^{-1}$ water was sprinkled once per 7 d. The seeds for the treatments were soaked in their respective PGRs for 8 h. Once 3 to 4 leaves were formed in each seedling, they were transferred to the beds and planted at a distance of (60 × 50) cm. The basic fertilizers administered were 15 t ha$^{-1}$ manure, 250 kg ha$^{-1}$ urea, 250 kg ha$^{-1}$ SP-36, and 250 kg ha$^{-1}$ KCl, followed up weekly. Referring to Prasetyo *et al.* [21], Table 1 shows the research locations is categorized as medium soil fertility (N, P, and K nutrients), while organic matter and CEC are classified as high.

**Table 1**. Soil characteristics analyzed for the study

| Characteristics | Value |
|---|---|
| pH ($H_2O$) | 5.88 |
| C-organic (g 100 g$^{-1}$) | 4.16 |
| Organic substances (g 100 g$^{-1}$) | 4.40 |
| C/N ratio | 9.01 |
| N total (g 100 g$^{-1}$) | 0.46 |
| $P_2O_5$ total HCL 25 % (mg 100 g$^{-1}$) | 35.05 |
| $P_2O_5$ Bray (mg 100 g$^{-1}$) | 9.93 |
| $K_2O$ total HCl 25 % (mg 100 g$^{-1}$) | 36.81 |
| CEC (me 100 g$^{-1}$) | 32.79 |

Three multiplications of the split-plot design were performed. The main plots were of fertilizers planned to be P0 (without organic fertilizer), P1 (with liquid organic fertilizer), and P2 (with biofertilizer), while the sub-plots were of PGRs devising Z0 (fresh water without PGRs), Z1 (coconut water), and Z2 (GA3). Liquid organic fertilizers (Brix up) that are applied are fertilizers containing sucrose, sulfate salts, K, Ca, and Cl. The biofertilizer used is Bio to Grow Gold (BGG) fertilizer, an organic fertilizer containing macro and micronutrients, microbes, and growth regulators. The microbes contained in BGG include *Actinomycetes*, *Azotobacter* sp, *Azospirillium* sp, *Rhizobium* sp, *Pseudomonas*, *Lactobacillus* sp, *Bacillus* sp, *Cytophaga* sp, *Streptomycetes* sp, *Saccharomyces*, Cellulotic, BPF, Mycorrhiza, Trichoderma. The elements contained in BGG include organic materials, including 2 %, 7.5 % organic, 2.35 % N, 3.5 % $P_2O_5$, 2.24 % $K_2O$, 1.1 % CaO, 0.1 % MgO, S 1 %, Fe 0.58 %, Mn 0.3 %, B 2 250.80 mg $kg^{-1}$, Mo 0.01 %, Cu 6.8 mg $kg^{-1}$, Zn 0.2 %, and Cl 0.001 %.

The observed variables were plant height, leaf size, chlorophyll content (determined with a spectrophotometer at harvest time), fruit weight, and sugar content (recorded using a hand refractometer at harvest time). Also tested organoleptically – involving 20 panelists – were taste, aroma, flesh texture, and net patterns on the rind. The data obtained were run through analysis of variance and statistically recorded using Statistical Product and Service Solutions (SPSS) version 25.0. Any significant difference that occurred should call for Duncan's test at the value of $\alpha = 5$ % [22, 23].

## 3. RESULTS AND DISCUSSION

In general, it is inferred that mixed treatments of PGRs and organic fertilizer administration are not significantly effective towards all studied variables.

### 3.1. Plant Height

The stem development represents muskmelon growth. While PGRs were insignificantly effective, fertilizers were considerably useful in boosting the plant height at the beginning and the end of the observation period (Table 2). While soaking muskmelon seeds in coconut water as PGR did not significantly affect the plant heights, their maximum growth of 131.10 cm was the highest – allowing them to reach up to 150.41 cm at 50 d old. Coconut water helps to boost metabolism and provides the required energy for seedlings to grow. The study of Zainudin and Adini [24] discovered that soaking in coconut water for 8 h promoted papaya seed germination and seedling time as well as improved the plant's height, leaf quantity, fresh mass, and dry mass. Muttaleb *et al.* [25] also confirmed that seed soaking enhanced both physiological and morphological features of vegetables, including germination and harvest. Yet, the absence of a positive response in the attempt to maximize their development potential is perceived to be the result of a clash between the seeds' endogenous auxin and the PGR's exogenous one, preventing the latter from contributing.

Organic fertilizer administration has significantly influenced the plant height at 50 d old. Muskmelon plants applied with organic fertilizer produced taller plants of 158.80 cm. It is convincing that substances in organic fertilizer have played a key role in improving the biological, chemical, and physical activities in the soil to suit it better for plants.

### 3.2. Leaf Size and Chlorophyll Content

Significant differences are recorded for both leaf sizes and chlorophyll contents after PGR soaking and fertilizer administering as detailed in Table 3. While GA3 immersion has expanded the leaves up to 705.75 $mm^2$, biological organic fertilizer administration has extended their spreads up to 695.82 $mm^2$. There are evidences that nutrient management involving gibberellin as PGR and biological organic fertilizer is feasible for better plant development. Specifically on PGR, gibberellin is proven to be more effective than coconut water as it advances the cellular expansion process by

**Table 2**. Effects of PGRs and fertilizers on plant height

| Treatment | Plant height (cm) | | | | |
|---|---|---|---|---|---|
| | 10 d old | 20 d old | 30 d old | 40 d old | 50 d old |
| *Plant Growth Regulator* | | | | | |
| Without PGR (Z0) | 19.81 a | 27.53 a | 65.16 a | 123.71 a | 150.30 a |
| Coconut water (Z1) | 19.31 a | 27.59 a | 65.69 a | 111.97 a | 150.41 a |
| GA 3 (Z2) | 20.95 a | 29.60 b | 66.86 a | 124.82 a | 146.84 a |
| *Fertilizer* | | | | | |
| Without organic fertilizer (P0) | 18.19 a | 28.31 a | 65.98 a | 121.98 a | 139.20 a |
| Organic fertilizer (P1) | 21.73 b | 28.35 a | 66.29 a | 112.78 a | 158.80 c |
| Biofertilizer (P2) | 20.15 b | 28.06 a | 65.44 a | 125.73 a | 149.56 b |

Note: Values shared by the same letters are not significantly different among the treatments at Duncan's test with $\alpha = 0.05$ %.

**Table 3.** Effect of PGRs and fertilizers on leaf size and chlorophyll content.

| Treatment | Leaf width ($mm^2$) | Chlorophyll a (mg $kg^{-1}$) | Chlorophyll b (mg $kg^{-1}$) | Total Chlorophyll (mg $kg^{-1}$) |
|---|---|---|---|---|
| *Plant Growth Regulator* | | | | |
| Without PGR (Z0) | 479.01 a | 584.14 a | 849.43 a | 1 432.41 a |
| Coconut water (Z1) | 579.72b | 626.18 b | 933.95 b | 1 558.87 b |
| GA 3 (Z2) | 705.75 c | 663.75 c | 967.48 c | 1 629.92 c |
| *Fertilizer* | | | | |
| Without organic fertilizer (P0) | 477.60 a | 601.68 a | 879.99 a | 1 480.49 a |
| Organic fertilizer (P1) | 603.73 b | 62.16 b | 912.92 b | 1 533.85 b |
| Biofertilizer (P2) | 695.82 c | 650.24 c | 957.94 c | 1 606.88 c |

Note: Values shared by the same letters are not significantly different among the treatments at Duncan's test with $\alpha = 0.05$ %.

stimulating xyloglucan endo-transglycosylase – an enzyme component to the cell walls – to detach hemicellulose, allowing microfibrillated cellulose reposition and widen cell walls. This outcome agrees with Rahman *et al*. [14] stating that immersing the root of a tomato seedling in 50 mg $kg^{-1}$ of GA3 increased flower, fruit, and harvest production.

Regarding chlorophyll, GA3 immersion has boosted the formings of chlorophyll a up to 663.75 mg $kg^{-1}$ and chlorophyll b up to 967.48 mg $kg^{-1}$ with a total of 1 629.92 mg $kg^{-1}$ while biofertilizer administration has enhanced the amounts of chlorophyll a up to 650.24 mg $kg^{-1}$ and chlorophyll b up to 957.94 mg $kg^{-1}$ with a total of 1 606.88 mg $kg^{-1}$. Able to produce higher chlorophyll contents quite substantially, GA3 immersion is, therefore, more effective than biofertilizer administration for the purpose. It is the result of improved absorption of stimulated nutrients – particularly nitrogen and chlorophyll synthesis – essential in assimilating amino acids and nucleic acid to promote chloroplast in forming better chlorophyll [26].

Chlorophyll construction relies on sun rays and nitrogen as well as magnesium [13] therefore broader leaves should receive more sunlight and be able to produce more chlorophyll. Since GA3 and biological organic fertilizer optimize leaf size, muskmelon plants with such treatments contain more amounts of chlorophyll than ones with different treatments.

### 3.3. Fruit weight and sugar content

While PGR treatment made an insignificant difference in fruit weight, it was noteworthy regarding sugar content. Fertilizer administration, on the other hand, was significantly influential in determining fruit weight and sugar content (Table 4).

Bioto Grow Gold (BGG) – the biofertilizer employed in this study – has complemented the weight rate of muskmelon up to 0.15 kg compared to liquid organic fertilizer. Among the microbes contained in the product are phosphate-solubilizing

**Table 4.** Effects of PGRs and fertilizers on fruit weights and sugar contents

| Treatment | Fruit Weight (kg) | Sugar Content (%) |
|---|---|---|
| Without PGR (Z0) | 2.47 a | 8.00 a |
| Coconut water (Z1) | 2.56 a | 9.33 b |
| GA 3 (Z2) | 2.52 a | 9.89 b |
| *Fertilizer* | | |
| Without organic fertilizer (P0) | 2.38 a | 7.89 a |
| Organic fertilizer (P1) | 2.51 ab | 9.11 b |
| Biofertilizer (P2) | 2.66 b | 10.22 c |

Note: The same letter following each number in a group signifies an insignificant difference in accordance with Duncan's test at $\alpha = 5$ %.

bacteria (PSB) and *Lactobacillus*. PSB is beneficial in enhancing soil and plants by providing available phosphate, while *Lactobacillus* facilitates the organic decomposition of cellulose into monomer glucose pertinent to carbon and energy sources. In addition to weight increase, the aforementioned microbial activities are proven to intensify the fruit's sweetness by up to 10.22 %. These results are in agreement with the study of Aritonang, and Surtinah [27] which discovered the highest sugar content in the Sakata Glamour variety of muskmelon at 12.25 % after BGG application at 3 mL $L^{-1}$. References [28, 29] confirmed that higher K, Mg, and Mn absorption performed by microbes in fertilizer amplifies sugar content in fruit.

### 3.4. Organoleptic test

An organoleptic test involving 20 panelists was performed to reveal the taste, aroma, flesh texture, and rind pattern of muskmelons harvested from the treatments [30]. The results are graphically presented in Figure 1, Figure 2, Figure 3, and Figure 4.

The panelists have selected the fruit of plants with biological organic fertilizer administration (P2) to be the sweetest; Z0P2, Z1P2, and Z2P2 treatments each scored a > 50 %. This result goes along with the result of the sugar content test. It is therefore concluded that macro and micro substances in BGG – e.g., Organic = 7.5 %, Organic ingredients = 2 %, N = 2.35 %, $P_20_{5:}$ = 3.5 %, $K_2O$ = 2.24 %, CaO = 1.1 %, MgO = 0.1 %, S = 1 %, Fe = 0.58 %, Mn = 0.3 %, B = 2 250.80 mg $kg^{-1}$, Mo = 0.01 %, Cu = 6.8 mg $kg^{-1}$, Zn = 0.2 %, and Cl = 0.001 % – are supportive towards sugar increase in muskmelon [31, 32].

Most treatments delivered enough aroma in muskmelon to the panelists to score > 50 % except for the fruit from plants treated with coconut water and liquid organic fertilizer (Z1P1) at 36.67 %. Most panelists declared the fruit from plants treated

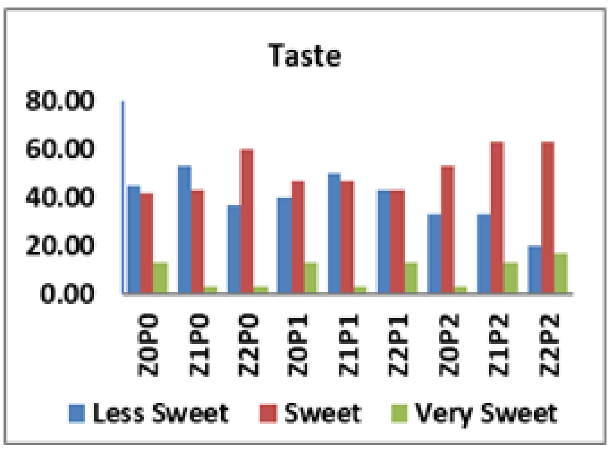


**Fig. 1.** Organoleptic test on taste

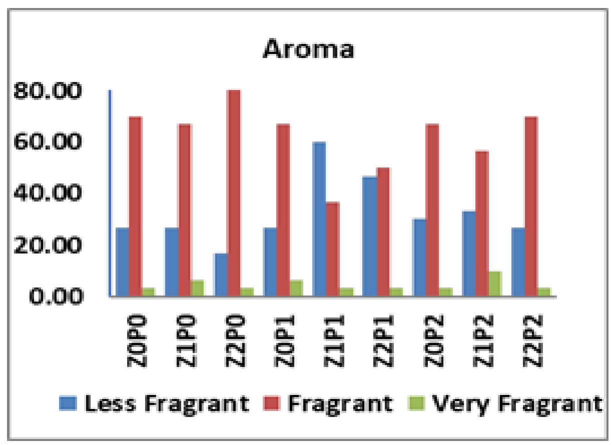


**Fig. 2.** Organoleptic test on aroma

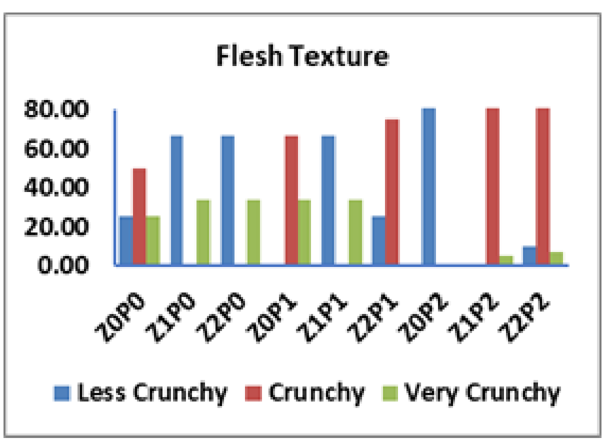


**Fig. 3.** Organoleptic test on flesh texture

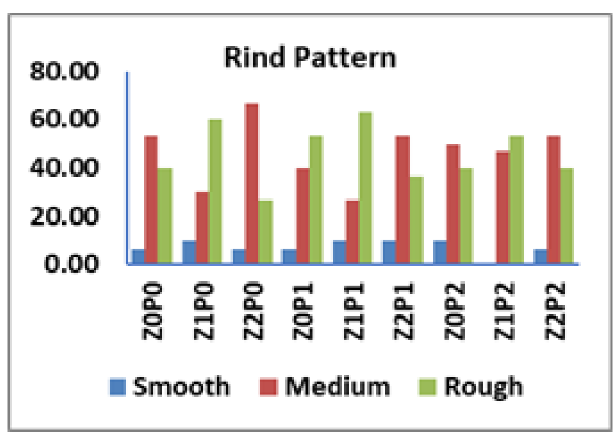


**Fig. 4**. Organoleptic test on rind pattern

with coconut water and biological organic fertilizer (Z1P2) to be very fragrant. Oh *et al.* [31] stated that the volatile aroma in muskmelon should change following the fruit development to ripeness, which appears in the muskmelon of the Pertiwi variety used in this study.

Assorted answers regarding flesh texture were recorded by the panelists. All muskmelons from plants with PGR and biofertilizer treatments are generally considered crunchy. Meanwhile, the ones from plants without PGR but with biofertilizer are declared less crunchy by all panelists.

Net pattern is formed on the rind of all muskmelons. Most panelists preferred the medium or rough patterns, while only a small number of them (≥ 10 %) chose the smooth ones. Daryono, and Maryanto [33] affirmed that net patterns differ after the quantity of water obtained by a plant. The effect of rind surface cracking is due to faster cell growth in the fruit center than in rind, a sufficient amount of water should accelerate the process, forming more distinctive net patterns on the rind.

Future research should be carried out in locations with low soil fertility which is expected to show mixed research performance between organic fertilizers (liquid and solid) and PGRs [17–21]. Likewise, the aim of farmers' self-reliance should be studied using local PGRs and liquid and solid organic fertilizers produced locally by farmers [34–41]. Integrating agricultural waste residue, leftover, kitchen waste, manure, and livestock urine in an anaerobic digester should be studied [42–45]. With this action, there are several advantages. Namely, farmers get high-quality biogas - renewable energy [46–48], a liquid and solid organic fertilizer [49–51]. It is a wise policy to implement toilet-linked anaerobic digesters (TLADs), *i.e.*, connect household-scale or communal-scale biogas digesters to household latrines/toilets [52–54] to improve environmental health and the quality of renewable energy and its residues in organic fertilizers (solids and liquids) [55–57].

## 4. CONCLUSION

PGRs immersion is conclusively supportive towards muskmelon plant growth as it increases the leaf size, allowing more chlorophyll to form and work in fruit bearing process. Further, organic fertilizer administration – be it liquid or biological – is beneficial in producing bigger, sweeter muskmelon. Since all favorable features of muskmelon – sweet taste, fragrant aroma, crunchy texture, and rough rind pattern – are overall achieved by administering biofertilizer, its use is therefore recommended to optimize the yield.

## 5. CONFLICT OF INTEREST

The authors declared no conflict of interest.

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