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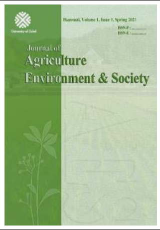

Response of physical dimension changes and fruit quality of Khatouni melon to chemical fertilizer application

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ABSTRACT

To investigate the effect of commonly used chemical fertilizers on certain quantitative and qualitative characteristics of Khatouni melon ecotype, an experiment was conducted in a randomized complete block design at the research farm of Ferdowsi University of Mashhad. The treatments included: T1: control (no fertilizer applied), T2: nitrogen fertilizer from urea at a rate of 120 kg/ha, T3: phosphate fertilizer from triple superphosphate at a rate of 120 kg/ha, and T4: potassium fertilizer from potassium sulfate at a rate of 100 kg/ha. Results indicated that the use of potassium fertilizer led to a 17% increase in melon fruit length compared to the control. The application of fertilizers T2 and T3 resulted in a 14% and 15.5% increase in fruit length, respectively, compared to the control. The fruit lengths for treatments T2, T3, and T4 were 38 cm, 38.6 cm, and 39.3 cm, respectively. The highest middle diameter of the melon (14.5 cm) was obtained from treatment T3 and the lowest from treatment T1. The number of seeds per fruit was 649 in the control, with a 3% and 6% increase observed with T2 and T4 treatments, respectively. The highest and lowest flesh thickness were recorded from treatments T2 (3.66 cm) and T1 (3.00 cm), respectively. The highest (3.16 kg) and lowest (1.97 kg) fruit weights were obtained from treatments T4 and T1, respectively. Treatment T2 resulted in a 33% increase in fruit weight compared to the control. The highest positive and significant correlation was found between single fruit weight and fruit length (r=0.82*) and middle diameter (r=0.82*). The highest sugar content was observed in treatments T2 and T4.

Highlights

- The study investigates the effects of different chemical fertilizers on the growth characteristics of the Khatouni melon ecotype.
- The study identifies that applying chemical fertilizers, particularly potassium and nitrogen, significantly enhances the quantitative and qualitative characteristics of Khatouni melons.
- The paper shows that the use of chemical fertilizers significantly improves both the growth and quality of Khatouni melons.
- Overall, this article highlights the importance of macronutrient fertilizers (nitrogen, phosphorus, and potassium) to maximize yield and quality and has an impact on improving the characteristics of Khatouni melon.

1. Introduction

Melon (*Cucumis melo* L.) is an annual plant from the Cucurbitaceae family and is one of the most important horticultural crops in arid and semi-arid regions of the world. The plant's high thermal requirement is advantageous for cultivation in these areas (Kashi and Abedi, 1998). With a wide variety of cultivars and landraces, melon cultivation has a broad distribution. In Iran, melon is cultivated on 76000 hectares under irrigation farming and 1400 hectares on rainfed lands , yielding a production of 20191 kg/ha and 827.6 kg/ha, respectively, totaling approximately 1,549,394.3 tons (Statistics of the

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Ministry of Agriculture Jihad, 2024).

Melon fruit, in addition to its sugar content, is a rich source of vitamins A, C, beta-carotene, and potassium. It is free of cholesterol and contains small amounts of fat, sodium, vitamin E, folic acid, iron, and calcium, making it suitable for consumption as fresh fruit or juice. Studies have shown that in the United States, high-fat and high-protein diets often lead to health issues that can be mitigated by incorporating melon, potentially improving many health conditions and overall wellness (Lester, 1997). The physical characteristics of melon are influenced by genetics, environmental conditions, and agricultural management practices. The interaction of these factors can affect processing industries and consumer acceptance (Valverde et al., 2006).

One of the key strategies for increasing crop yield is the use of mineral nutrients, and fertilizer trials play a significant role in determining the quantity and quality of plant production. The structural components of many macromolecules within the plant body and its final products are formed through the uptake of mineral nutrients, primarily from the soil. This uptake process depends on the hydration of these elements and is influenced by the quantitative relationships between ions and molecular complexes of elements in the soil. Therefore, the availability of nutrients is closely tied to these soil chemistry interactions.

Soil, as a crucial medium for production, experiences fluctuations in its mineral content and reserves. Continuous use of soil resources without replenishment can lead to a decline in its productive capacity. The nutritional components present in plants, such as proteins, fats, acids, vitamins, and minerals, determine the quality of plant products, including flavor and aroma compounds. These attributes are influenced not only by genetics but also by agricultural management practices. The application of specific mineral nutrients alters the synthesis of these compounds; for instance, excessive use of potassium compounds enhances the metabolism of carbohydrate synthesis, while an abundance of nitrogen shifts assimilates towards the production of amino acids and amides. Therefore, heavy nitrogen fertilization increases the production of nitrogenous organic compounds (crude protein), whereas high potassium fertilization boosts the synthesis of carbohydrates and fats (Alizadeh, 2022).

Phosphorus is a key component of essential molecules such as nucleic acids and phospholipids. The storage form of phosphate in seeds and fruits is myo-inositol hexakisphosphate (phytate). Phytate production occurs during the maturation phase. Plants, along with phytate, transfer important mineral elements such as magnesium and phosphate to the embryo and young seedling for phosphorylation processes. Studies have shown that phosphorus deficiency in plants and fruit trees negatively affects flower, seed, and fruit production due to impaired nucleic acid and protein synthesis (Hagh Paraste Tanha, 1992).

The optimal amount of nitrogen for the growth of cucurbit family plants depends on the species, location, climate, soil characteristics, and crop management practices (Van Eerd and O'Reilly, 2009). Research by Simsek and Comlekcioglu (2011) on melons demonstrated that nitrogen treatments at 0, 30, 60, and 90 kg/ha during fruit development significantly affected various fruit attributes (fruit weight, fruit length, fruit width, seed cavity diameter, and dry matter weight). Specifically, the greatest fruit width (18.7 cm) was observed with the zero-nitrogen treatment, while the greatest fruit length was achieved with the 30 kg nitrogen treatment. Additionally, Kirnak et al. (2005) found that applying nitrogen levels of 0, 40, 80, and 120 kg/ha to a melon variety (*Cucumis melo* L. cv. Polidor) resulted in fruit diameters of 19, 26, 31, and 35 cm, respectively. Similar results were obtained in this study regarding fruit length, with the treatments resulting in lengths of 11, 16, 19.5, and 22 cm in the first year under non-stressed irrigation conditions.

In another study, Drake et al. (2002) evaluated the response of apple trees to nitrogen fertilization, concluding that the highest fruit firmness and skin color quality were achieved with the lowest nitrogen application rates. Nava et al. (2008) reported that potassium fertilization led to reduced fruit firmness in apples over two years of testing. They attributed the decrease in fruit firmness to the concurrent increase in fruit size, which resulted from potassium application. Given the limited information available on the structural role of different chemical fertilizers in affecting melon fruit characteristics, this study aims to evaluate the quantitative responses of melon fruit to the application of various chemical fertilizers (urea, phosphate, and potassium) under field conditions.

2. Materials and methods

This experiment was conducted at the research farm of the Faculty of Agriculture, Ferdowsi University of Mashhad, using a randomized complete block design with three replications. The experimental treatments included: T1: control (no fertilizer applied), T2: nitrogen fertilizer from urea at a rate of 120 kg/ha, T3: phosphate fertilizer from triple superphosphate at a rate of 120 kg/ha, and T4: potassium fertilizer from potassium sulfate at a rate of 100 kg/ha (Saber Ali and Nasrabadi, 2020; Keshtehgar et al., 2020). All phosphate and potassium fertilizers, along with 40% of the urea fertilizer, were applied before planting to the respective plots, while the remaining nitrogen fertilizer was applied in two splits, three weeks after planting, with a one-week interval between applications. The soil of the experimental site was loamy sand, and a soil sample was analyzed at the soil laboratory before the experiment to determine the soil physical and chemical properties (Table 1).

The land had been left fallow the previous year, and preparatory operations were carried out in April and May. Each experimental plot consisted of two rows, each 3 meters wide and 4 meters long, with a plant spacing of 60 centimeters within the rows. Direct sowing was performed on May 5, 2023. Melon seeds of the Khatouni variety were procured and disinfected with the fungicide Carboxin-Thiram before planting. Seeds were sown in pre-heated soil, with five seeds planted per hole at a depth of 5 centimeters. After germination and at the four-leaf stage, thinning and earthing up around the plants were carried out. Irrigation was conducted weekly with furrow irrigation methods. Maintenance operations included mechanical weed control and pesticide applications to combat aphids and melon flies.

At the stage of fruit maturity, after removing the border effects, fruits from five plants were harvested. For each of three fruits per treatment, quantitative and qualitative traits were measured: length, highest middle diameter, fruit width, peel thickness, flesh thickness (measured with a caliper), and number of lobes. The mean values of these measurements were recorded as representatives for each treatment.

To measure seed count, seeds were separated from the fruit, thoroughly washed, dried in the shade, and then manually counted. The number of fruits produced per plant was recorded along with their weights, and the average weight per fruit was noted as the single fruit weight per plant.

For sugar content analysis, the colorimetric method was used (Dubois et al., 1956). In this method, the reaction of sugars with sulfuric acid and phenol produces a yellowish-orange color. For this purpose, 50 grams of fruit flesh were mixed with 200 cc of 96% ethanol for 60 seconds. From the resulting mixture, 20 microliters were taken and mixed with 20 microliters of phenol, 5000 microliters of sulfuric acid, and 1980 microliters of distilled water. The absorbance was measured using a spectrophotometer at a wavelength of 490 nm. The sugar concentration in the solution (x) was determined using a standard curve {y=mx+b}, where y represents absorbance and x represents sugar concentration in micrograms per milliliter. The percentage of sugar in the total fruit flesh was then calculated. Data analysis was performed using SAS software version 9.4. Mean comparisons were conducted using Duncan's multiple range test at a 5% probability level.

Table 1. Physical and chemical characteristics of field soil before planting

P	K	N	Organic carbon (%)	C/N	Electrical conductivity Ds.m^{-1}	Bulk density g.cm^{-3}	pH
(mg/kg)							
9	192	0.11	1.1	11	2.1	1.2	7.5

3. Results

The evaluation of the effects of individual chemical fertilizers on the traits studied revealed that certain traits did not exhibit the expected behavior in this experiment. For example, the fertilizer treatments did not significantly affect traits such as the number of fruits per plant, peel thickness, and the number of lobes (Table 2). In the case of the number of fruits per plant, it was anticipated that urea, due to its role in amino acid production and accumulation, and the high rate of transport of these compounds via the xylem and phloem to organs with elevated protein synthesis (such as young leaves and reproductive organs), would promote the formation of reproductive tissues and structures. Although this did not happen as expected, there was still a 6% increase compared to the control. Regarding the number of lobes per fruit, while no statistically significant difference was observed, the application of phosphate fertilizer (T3) resulted in an 11% increase in the number of lobes compared to the control (Table 3). The use of urea fertilizer (T2) increased the fruit peel thickness to 3.93 mm, with the lowest value observed in the potassium fertilizer treatment. Lotfi et al. (2015) reported a peel thickness of 3.8 mm for Khatouni melon in their study. Additionally, Rekha et al**.** (2017) showed that the highest number of fruits in bell peppers (8.23 fruits per plant) was obtained with the application of chemical fertilizer at the recommended rate, while the lowest number (6.78) was recorded for the organic fertilizer treatment.

Table 2. Analysis of variance (means of squares) for quantitative and qualitative traits of melon fruit under different fertilizer treatments

S.O.V	df	Number of seeds per fruit	Number of lobes	Fruit peel diameter	Percentage of sugar	Diameter of the fruit	Fruit flesh thickness	Fruit length	Weight of single fruit	fruits per plant
Block	2	3247^{ns}	1.75^{ns}	0.270^{ns}	0.770^{ns}	0.000^{ns}	0.060^{ns}	10.3^{ns}	0.004^{ns}	0.009^{ns}
Treatment	3	10437**	0.555^{ns}	0.453^{ns}	2.20**	4.72*	0.243*	27.8*	0.963**	0.010^{ns}
Error	6	5658	0.305	0.136	0.728	0.805	0.034	5.22	0.020	0.004
CV		11.6	4.31	6.54	5.47	9.64	7.56	8.64	10.5	11.2

ns, *, and **: denote no significant, significant at 5 and 1% probability levels, respectively

Table 3. Effects of nitrogen, phosphate and potassium fertilizers with control on fruit characteristics in melon

Treatment	Number of seeds per fruit	Number of lobes	Fruit peel diameter(mm)	Diameter of the fruit (cm)	fruit flesh thickness (cm)	Fruit length (cm)	Weight of single fruit (kg)	fruits per plant
T1*	649ab	9.00a	3.33a	11.6b	3.00b	32.6b	1.97c	1.33a
T2	673ab	9.66a	3.93a	13.8ab	3.66a	38.0a	2.95b	1.42a
T3	559b	10.0a	3.33a	14.5a	3.50ab	38.6a	3.15a	1.23a
T4	692a	9.33a	3.00a	14.0ab	3.33ab	39.3a	3.16a	1.33a

In each column, means sharing at least one common letter are not significantly different at the 5% probability level according to Duncan's multiple range test.

*: T1: Control (without adding fertilizer), T2: Nitrogen fertilizer from urea source at 120 kg/ha, T3: Phosphate fertilizer from triple superphosphate source at 120 kg/ha, and T4: Potassium fertilizer from potassium sulfate source at 100 kg/ha

3.1. Length and diameter of melon fruit

The effect of potassium on the growth of meristematic cells cannot be solely attributed to its impact on turgor. However, for guiding growth processes in meristematic tissue, a low apoplastic pH is necessary, within which potassium's effect on ATPase activity is evident at a pH of 6.5. Additionally, potassium has a close synergistic relationship with plant hormones such as indole acetic acid and cytokines, which influence the formation of new tissues by activating certain related enzymes (Cocucci and Dalla Rosa, 1980). The experiment showed that the application of potassium fertilizer resulted in a 17% increase in melon fruit length compared to the control. The shortest fruit length was recorded in the control treatment (Table 3). The range of melon fruit length varied between 32.6 cm and 39.3 cm across different treatments. The use of fertilizer treatments T2, T3, and T4 resulted in increases of 14%, 15.5%, and 17%, respectively, in fruit length compared to the control. Kokabi and Tabatabai (2011) found that when potassium concentration combined with calcium increased from 1.5 to 3, the fruit length of Galia melon reached its maximum value of 18.1 cm, representing a 6% increase compared to the 1.5 concentration. In another study, Kirnak et al (2005) reported that under optimal irrigation conditions, increasing nitrogen fertilizer led to an increase in the fruit length of muskmelon over two consecutive years. In the present study, the fruit length in the urea, phosphate, and potassium treatments were 38 cm, 38.6 cm, and 39.3 cm, respectively. Regarding the middle diameter of the melon fruit, the highest value (14.5 cm) was obtained from treatment T3, which represented approximately a 20% increase compared to the control. The middle diameter of the fruit in treatments T4, T2, and T1 were 14 cm, 13.8 cm, and 11.6 cm, respectively. A study indicated that the ratio of fruit length to width in the Mashhadi melon variety ranged from 2.15 to 2.31 across different poultry manure fertilizer treatments, showing significant effects from the various treatments (Norouzi et al., 2010)

3.2. Number of seeds per fruit

The results from the analysis of variance table indicated that the fertilizer treatments had a significant effect ($p \leq 0.01$) on the number of seeds per fruit (Table 2). The range of variation in the number of seeds per fruit was 649 in the control, with approximately 3% and 6% increases observed with the application of fertilizer treatments T2 and T4, respectively, compared to the control. The use of phosphate fertilizer (T3) resulted in a 19% decrease in the number of seeds per fruit compared to the control. Notably, the increase in the number of seeds per fruit was observed with treatments T2 and T4, while the application of treatment T3 led to a reduction in seed number (Table 3). Investigations reveal that the amount of phosphorus absorbed by the plant depends on the extent of root development. An increase in mineral phosphorus in the plant leads to the accumulation of this nutrient in older leaves, while younger leaves contain relatively high levels of organic phosphate, mostly in the form of nucleic acid phosphates. Consequently, when other essential co-factors for the plant are not supplied optimally, such as magnesium, the transfer of phosphate to the embryo and seedling for phosphorolysis processes is restricted. As a result, some fertilized seeds do not grow due to reduced synthesis of nucleic acids and proteins, leading to a decrease in seed number (Hagh Paraste Tanha, 1992).

3.3. Fruit flesh thickness

The experimental treatments had a significant effect ($p \leq 0.05$) on fruit flesh thickness (Table 2). The highest and lowest values for fruit flesh thickness were obtained from the urea treatment (3.66 cm) and the control (3.00 cm), respectively (Table 3). In this experiment, the effect of potassium on fruit flesh thickness was not significant with the other two treatments T2 and T3. However, it was significant with the control treatment (without adding fertilizer).Kokabi and Tabatabai (2011) found that increasing the potassium concentration in the nutrient solution (increasing the potassium-to-calcium ratio) to 3.5 resulted in a minimum fruit flesh thickness of 3.06 cm, while ratios of 1.5 and 2 resulted in fruit flesh thicknesses of 3.5 cm and 3.53 cm, respectively, in the same study. In another study, Kim et al (1991) reported that increasing potassium concentration in the fruit reduced both the size and weight of the melon. It appears that although polygalacturonic acid in the cell wall complex and calcium compounds such as calcium pectate play a role, potassium is critically important for inducing cellular turgor. The stability of fruit flesh thickness is dependent on the ratio of potassium to calcium (Mignani et al., 1995).

3.4. Fruit weight

Chemical fertilizer treatments had a significant effect on the weight of individual fruits (Table 1). The highest fruit weight (3.16 kg) and the lowest (1.97 kg) were obtained from the potassium fertilizer treatment (T4) and the control (T1), respectively. The difference between the T3 and T4 treatments was only 10 grams. The effect of the urea fertilizer treatment (T2) resulted in a 33% increase in fruit weight compared to the control. A study by Kokabi and Tabatabai (2011) reported different findings regarding the effect of potassium on the weight of individual melon fruits. The results of the correlation table showed that the highest significant positive correlation existed between individual fruit weight and fruit length ($r=0.82^*$) and fruit diameter ($r=0.82^*$) (Table 4). The positive effect of potassium fertilizer on increasing the weight of individual melon fruits (an increase of approximately 38% compared to the control) seems to be related to its physiological characteristics, as potassium enhances phloem loading with assimilates and long-distance transport. Potassium can depolarize the membrane to some extent via H+-antiport, and this depolarization increases ATPase activity, which in turn strengthens membrane transport. Additionally, in the presence of potassium, the ATP and NADPH synthesis systems are enhanced. Therefore, the increase in photosynthesis in the presence of potassium can be attributed to the reduced resistance of stomatal and leaf tissue cells to CO_2 entry, as well as to the increased activity of RUBP carboxylase. When the potassium content in the leaf dry matter was 1.28%, 1.98%, and 3.84%, the CO_2 assimilation rate increased by 11.9, 21.7, and 34 mg m² h⁻¹, respectively (Demming and Gimmler, 1983). In this way, in the presence of potassium, the synthesis of macromolecules such as cellulose, starch, and proteins is enhanced, ultimately leading to an increase in individual fruit weight.

Table 4. Correlation coefficients among melon fruit traits under chemical fertilizer and control treatments

	1	2	3	4	5	6	7	8	9
V1	1								
V2	-0.14^{ns}	1							
V3	-0.08^{ns}	0.82**	1						
V4	0.09^{ns}	0.63*	0.47^{ns}	1					
V5	-0.31^{ns}	0.82**	0.53^{ns}	0.72**	1				
V6	0.13^{ns}	0.69*	0.62*	0.34^{ns}	0.31^{ns}	1			
V7	-0.43^{ns}	0.70*	0.43^{ns}	0.32^{ns}	0.82**	0.33^{ns}	1		
V8	-0.45^{ns}	0.41^{ns}	0.64*	0.27^{ns}	0.34^{ns}	0.17^{ns}	0.21^{ns}	1	
V9	0.39^{ns}	-0.10^{ns}	0.02^{ns}	-0.20^{ns}	-0.15^{ns}	-0.00^{ns}	-0.07^{ns}	0.00^{ns}	1

ns, *, and ** : represent non-significant, significant at 5% and 1% probability level, respectively

V1: number of fruits per plant, V2: weight of single fruit, V3: fruit length, V4: flesh thickness, V5: fruit diameter, V6: Sugar content (%), V7: peel thickness, V8: number of lobes and V9: number of seeds per fruit

3.5. Sugar content

The results of the analysis of variance indicated a significant effect of fertilizer on the sugar content of melon ($p \leq 0.01$) (Table 2). The lowest sugar content was observed in the control treatment, while the highest was recorded in both the potassium and nitrogen fertilizer treatments (Figure 1). However, the three fertilizer treatments did not show statistically significant differences in melon sugar content. A study by Kultur et al. (2001) demonstrated that sugar content and its accumulation in melon are dependent on the photosynthetic assimilation of canopy leaves after ripening. Their findings also indicated that genotype has a significant and notable effect on sugar content, with significant differences observed between genotypes. In their experiment, spatial factors did not significantly affect the increase or change in sugar content. Martuscel et al (2014) found that improvements in melon flesh firmness, soluble solids, and carotenoid content occurred when phosphorus levels were increased from zero to 200 kg per hectare. Another study showed that the adequate application of potassium significantly improved tomato flavor, lycopene content, color, and flesh texture (Gruda et al., 2018). It appears that as melon ripens, the sugar content in each lobe increases. The sugar accumulated in the vacuoles represents a larger proportion compared to other parts of the cell, and the increase in vacuolar sugar serves as a basis for cellular turgor and growth in fruit size. Sucrose begins to accumulate in the fruit 28 to 42 days after planting, and the potential for further sugar increase exists beyond this period, which may occur a week before fruit maturity (Ofosu-Anim and Yamaki, 1994).

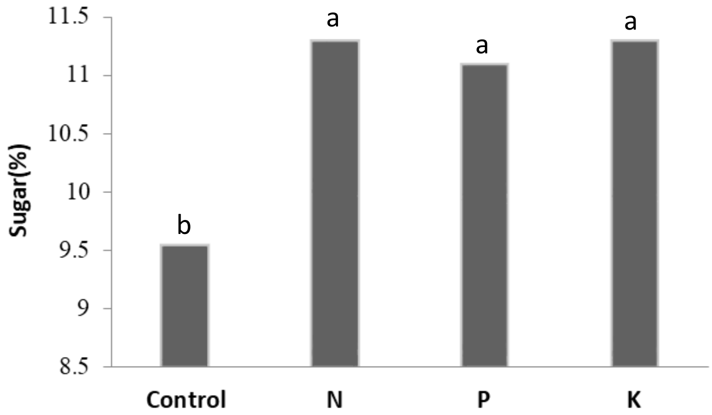

Figure 1. Impact of chemical fertilizer treatments on sugar content in Khatouni melon ecotype.

In general, the results of this study demonstrated that chemical fertilizers had a significant impact on improving vegetative, reproductive, and quality traits of melon. Potassium fertilizer resulted in the highest values for traits such as individual fruit weight, fruit length, and the number of seeds per fruit. In contrast, urea fertilizer had a greater effect on the number of fruits per plant, fruit thickness, and the number of lobes in the fruit compared to the other treatments. Phosphate fertilizer had an intermediate effect between urea and potassium. Therefore, the variations observed in the examined traits due to the fertilizer treatments can be attributed to the specific effects of each fertilizer. Based on these findings, the integration of these fertilizers along with essential micronutrients seems necessary to enhance the centric characteristics of the fruit.

4. Discussion

The yield of cucurbit crops is closely related to the development of vegetative plant biomass. Thus, by making the nutrients needed by the plant readily available, chemical fertilizers accelerate the physiological processes of the plant to improve growth and fertility, which has an impact on increasing the vegetative and reproductive tissues, such as leaves and fruit. The leaves of cucurbits serve as the primary source of nutrient translocation to the developing fruits. As such, the longevity and health of the leaves, particularly their ability to remain green and functional, directly influence the fruit's size, quality, and flavor (Aitbayeva et al., 2022). Poonam et al. (2014) demonstrated that the fruit yield of watermelons significantly increased with all levels of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) applications, owing to the water-soluble quality and the effectiveness of conventional fertilizers. These results were more pronounced when compared to the generally recommended dose and control treatments.

The findings from this study underscore the significant impact that different chemical fertilizers have on some growth characteristics and quality of Khatouni melon fruits. By assessing the centric dimensions (e.g., length, diameter, weight, and flesh thickness) of the fruits under the influence of nitrogen, phosphate, and potassium fertilizers, we gain insights into how these nutrients alter both the physical and biochemical properties of the melon.

4.1. Implications for agricultural practices

The results of this experiment highlight the importance of selecting the appropriate type and quantity of chemical fertilizers for maximizing yield and quality in melon cultivation. While nitrogen is essential for enhancing flesh thickness and overall fruit size, potassium plays a crucial role in boosting fruit length, weight, and sugar content. Phosphorus, on the other hand, appears to have a more moderate effect, primarily influencing fruit diameter and seed production.

Given the significant increase in fruit length, diameter, and weight with the use of potassium and nitrogen fertilizers, farmers in arid and semi-arid regions, such as those cultivating Khatouni melons, may benefit from targeted fertilization strategies. The findings also reinforce the importance of soil nutrient management, as the availability of essential elements like potassium and nitrogen directly impacts the metabolic processes associated with fruit development.

Conclusion

This study evaluated the effects of chemical fertilizers (nitrogen, phosphorus, and potassium) on some growth and yield characteristics of Khatouni melon, a notable cultivar in arid regions. The results demonstrate that the use of these fertilizers significantly influenced several key traits, such as fruit length, middle diameter, flesh thickness, number of seeds per fruit, and overall fruit weight. Potassium fertilizer led to the greatest increase in fruit length (17% increase) and overall fruit weight (3.16 kg). Nitrogen and phosphorus also contributed to improvements, with nitrogen showing a notable impact on flesh thickness and fruit weight, and phosphorus enhancing middle diameter and other growth characteristics.

Moreover, the use of these fertilizers significantly increased the sugar content of the fruits, particularly with the nitrogen and potassium treatments. The positive correlation between fruit weight and other physical attributes such as length and middle diameter further highlights the critical role of chemical fertilizers in optimizing melon yield. These findings emphasize the importance of selecting appropriate fertilizers for improving both the quantity and quality of melon production, particularly in regions where maximizing agricultural output is essential for economic and food security reasons.

The study concludes that potassium, nitrogen, and phosphorus fertilizers play crucial roles in enhancing the growth and quality of melon fruit. This knowledge can inform future cultivation practices, aiming to improve yield and the nutritional content of melons grown in similar climatic conditions. The study provides valuable insights for farmers and agricultural scientists seeking to improve melon production through informed fertilizer management. Further research may be needed to explore the long-term effects of these fertilizers on soil health and sustainability.

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