Journal homepage
www.ajas.uoanbar.edu.iq
Anbar Journal of Agricultural Sciences
(University of Anbar – College of Agriculture)

INFLUENCE OF POTASSIUM, SUGAR ALCOHOL, AND BORON ON GROWTH AND CHEMICAL COMPOSITION OF MELONS UNDER PROTECTED CULTIVATION

M. M. M. Alabdaly* **S. Kh. Abdullah**

College of Agriculture- University of Anbar

***Correspondence to:** Maath M. M. Alabdaly, Department of Horticulture and Landscape Gardening, College of Agriculture, University of Anbar, Ramadi, Iraq.
Email: ag.maath.mohey@uoanbar.edu.iq

Article info

Received: 2024-04-03
Accepted: 2024-05-08
Published: 2024-06-30

DOI-Crossref:
10.32649/ajas.2024.146593.1124

Cite as:
Alabdaly, M. M. M. and Abdullah, S. Kh., (2024). Influence of potassium, sugar alcohol, and boron on growth and chemical composition of melons under protected cultivation. Anbar Journal of Agricultural Sciences, 22(1): 160-172.

Abstract

An experiment was conducted in Polytunnel house at Longitude 43.30, latitude 33.410 the Department of Horticulture, College of Agriculture, University of Anbar, during the spring season of 2023. The experiment was designed to investigate the effects of spraying with potassium, a combination of alcohol sugar (sorbitol), and boron on the vegetative traits and chemical content of melon leaves under protected cultivation conditions. The study included two factors: the first factor was spraying with potassium at three concentrations: 0, 4, and 8 gm L^{-1}, and it was coded as K0, K1, and K2, respectively. The second factor was spraying with a combination of sorbitol and boron at five concentrations: the first treatment was the comparison (0 boron and 0 sorbitol), the second (20 milligrams $liter^{-1}$ boron + 25 grams $liter^{-1}$ sorbitol), the third (20 milligrams/liter boron + 50 grams $liter^{-1}$ sorbitol), the fourth (40 milligrams $liter^{-1}$ boron + 25 grams $liter^{-1}$ sorbitol), and the fifth (40 milligrams $liter^{-1}$ boron + 50 grams $liter^{-1}$ sorbitol To obtain the best growth and yield from it), and it was coded where to T0, T1, T3, , and T4, respectively. Potassium was sprayed when 50% of the flowers appeared and until the fruit ripened at a rate of one spray per week. As for the combination of boron and sorbitol, it was sprayed after the appearance of 6-8 true leaves at a rate of three sprays between sprays every two weeks. The experiment was conducted as a factorial experiment within a complete randomized block design with three replicates. The study showed that the second potassium concentration (K1) achieved the highest vegetative growth traits (plant height, leaf area, number of nodes, and dry weight of the total vegetation, which were 311.98 cm, 95.05 dam^2, 33.71 nodes $plant^{-1}$, and 138.8 g $plant^{-1}$,) compared to the lowest values achieved by K0 comparison plants, which were 297.34 cm, 82.64 cm2, 30.04 nodes $plant^{-1}$, and 118.4 g $plant^{-1}$, respectively. The combination of boron and sorbitol had a significant effect on vegetative growth traits, as treatment T4 significantly outperformed and achieved the highest plant height, leaf area, number of nodes, and dry weight of the total vegetation, which were 317.91 cm, 99.12 dam^2 plant, 35.032 nodes -$plant^{-1}$, and 146.7 g $plant^{-1}$, respectively, compared to the lowest values for vegetative growth traits, which were given by the plants of treatment T0, which were 285.32 cm, 76.95 cm^2, 28.60 nodes $plant^{-1}$, and 107.6 g $plant^{-1}$, respectively.

Keywords: Melon, Potassium, Sorbitol, Foliar Nutrition.

تأثير الرش بالبوتاسيوم والسكر الكحولي والبورون في صفات النمو الخضري والمحتوى الكيميائي للبطيخ تحت الزراعة المحمية

معاذ محي محمد شريف العبدلي* **سعيد خالد عبدالله**

جامعة الانبار – كلية الزراعة

***المراسلة الى:** معاذ محي العبدلي، قسم البستنة وهندسة الحدائق، كلية الزراعة، جامعة الانبار ، الرمادي، العراق.

البريد الالكتروني: ag.maath.mohey@uoanbar.edu.iq

الخلاصة

نفذت الدراسة في أحد البيوت البلاستيكية التابعة لقسم البستنه وهندسة الحدائق – كلية الزراعة جامعة الانبار خلال الموسم الربيعي 2023 لمعرفه تأثير الرش بالبوتاسيوم وتوليفة السكر الكحولي (سوربيتول) والبورون في الصفات الخضرية والمحتوى الكيميائي لأوراق البطيخ تحت ظروف الزراعة المحمية. تضمنت الدراسة عاملين الأول الرش بالبوتاسيوم بثلاثة تراكيز 0 و4 و8 غم/ لتر ورمز لها بالرمز K0 وK1 وK2 بالتتابع، والعامل

الثاني هو الرش بتوليفة السوربيتول والبورون وبخمسة تراكيز الأول معاملة المقارنة (0 بورون و0 سوربيتول) والثاني (20 ملغم/ لتر بورون + 25 غم/ لتر سوربيتول) والتركيز الثالث (20 ملغم/ لتر بورون +50 غم /لتر سوربيتول) والتركيز الرابع (40 ملغم/ لتر بورون +25 غم/ لتر سوربيتول) والتركيز الخامس (40 ملغم/ لتر بورون +50 غم/ لتر سوربيتول) ورمز لها T1 وT2 وT3 وT4 وT5 بالتتابع. تم رش البوتاسيوم عند ظهور 50% من الازهار وحتى نضج الثمار وبواقع رشة واحدة أسبوعيا، اما توليفة البورون والسوربيتول فقد تم رشها بعد ظهور 6–8 أوراق حقيقية بواقع ثلاث رشات بين رشة وأخرى أسبوعين. نفذت الدراسة كتجربة عامليه ضمن تصميم القطاعات العشوائية الكاملة بثلاثة مكررات. أوضحت الدراسة تفوق تركيز البوتاسيوم الثاني K1 وحقق اعلى صفات للنمو الخضري (ارتفاع النبات والمساحة الورقية وعدد العقد والوزن الجاف للمجموع الخضري وبلغت 311.98 سم و95.05 دسم^{2} و33.71 عقدة نبات$^{-1}$ و138.8 غم نبات$^{-1}$ بالتتابع) مقارنة بأقل قيم حققتها نباتات المقارنة K0 والتي بلغت (297.34 سم. و82.64 دسم^{2}و30.04 عقدة نبات$^{-1}$ و118.4 غم نبات$^{-1}$ وبالتتابع للصفات ذاتها).

كان لتوليفة البورون والسوربيتول اثرا معنويا في صفات النمو الخضري اذ تفوقت المعاملة T4 معنويا وحققت اعلى ارتفاع نبات ومساحة ورقية وعدد عقد ووزن جاف للمجموع الخضري وبلغت (317.91 سم و99.12 دسم^{2} و32 35.0 عقدة نبات$^{-1}$ و146.7 غم نبات$^{-1}$ وبالتتابع)، plant^{-1} مقارنة باقل قيم لصفات النمو الخضري والتي اعطتها نباتات معاملة المقارنة T0 وبلغت (285.32 سم و76.95 دسم^{2} و28.60 عقدة نبات$^{-1}$ و107.6 غم نبات$^{-1}$ بالتتابع لنفس الصفات). حققت معاملة التداخل T4K1 اعلى صفات للنمو الخضري متفوقة معنويا على معاملة المقارنة T0K0. حقق الرش بالبوتاسيوم وتوليفة البورون والسوربيتول زيادة معنوية في المحتوى الكيميائي لأوراق النبات وكان ذلك واضحا في المعاملات الفردية ومعاملات التداخل بين عاملي الدراسة اذ تفوقت المعاملة T4K1 واعطت اعلى نسبة من النتروجين والفسفور والبوتاسيوم واعلى محتوى من البورون بلغت (1.948% و0.549% و1.891% و43.223 ميكروغرام غم$^{-1}$ وبالتتابع) فيما حققت معاملة المقارنة اقل نسبة من العناصر النتروجين والفسفور والبوتاسيوم واقل محتوى من البورون بلغ (1.803% و0.526% و1.813% 30.757 مايكرو غرام وبالتتابع).

كلمات مفتاحية: البطيخ، البوتاسيوم، السوربيتول، التغذية الورقية.

Introduction

Melon (*Cucumis melo* L.) belongs to the Cucurbitaceae family and is grown in Iraq in open fields and protected environments in the spring and autumn seasons. It is one of the important vegetable crops due to its high nutritional value, as it is characterized by a high content of protein, fat, carbohydrates, fiber, calcium, phosphorus, iron, sodium, zinc, copper, vitamin A, thiamin, riboflavin, niacin, pyridoxine (B6), biotin, and ascorbic acid (9).

The production of melon in protected environments has become common in Iraq in the last decade. This type of agriculture requires advanced technical expertise and trained personnel to provide the crop with its many and complex requirements, including plant growing methods, modern irrigation systems, preventive control programs, as well as soil fertilization and integrated foliar nutrition programs in order to obtain the best growth, yield, and fruit quality. Protected agriculture requires intensive fertilization programs to meet the plants' nutritional needs due to the high plant density per unit area, as well as the role of the major elements (potassium in particular) in improving the quality of the fruits produced by increasing the total soluble solids content represented by the total sugars in the fruits, as well as increasing the fruit hardness, which positively reflects on extending the shelf life of the fruits (11). Potassium has an active role in the process of photosynthesis, the formation of carbohydrates, and the transportation of the materials produced by this process. When potassium nutrition levels are good, this stimulates the formation of energy compounds (ATP) that the plant needs to increase the phloem load with the materials produced by the process of photosynthesis (3). Potassium is one of the major nutrients that plays a major role in plant growth and the completion of its life cycle. It is no less important than nitrogen and phosphorus, despite the fact that it does not enter into any organic compound, but its role stands out through the work of enzymes, as potassium participates in the work of 88 enzymes inside the plant by combining with organic acids to form organic salts (20). Potassium encourages the growth of meristematic tissue and then the formation of good vegetative and root growth, which increases the efficiency of water absorption and ready nutrients in the soil. A deficiency of potassium element leads to cracking of the floral tip of watermelon fruits, which causes high economic losses (9).

Alcoholic sugars (which are carbohydrates) are one of the most important natural products of the process of photosynthesis. They are called alcoholic because of their chemical composition, and they move easily inside the plant. Alcohol is formed when the aldehyde group (CHO) is reduced to an alcohol (OHCH2) (12). One example of alcoholic sugars is sorbitol (C6H14O6), which facilitates the transport of boron and other minor elements that are present inside the phloem tubes, which improves growth, flowering, and increases the vitality of pollen grains, improves fruit set, and increases plant yield. Sorbitol is made in the leaves by the process of photosynthesis and is one of the alcoholic sugars that belong to carbohydrates; It can be transported in many plants, as it contributes to the metabolism of essential carbohydrates (3 and 5). Boron is one of the minor nutrients that are essential for plant growth. It plays a major and positive role in cell development, increasing cell division, and building cell walls. Insufficient boron reduces the formation of the growth hormone cytokinin, which is responsible for delaying plant aging (13). Good boron nutrition maintains the water balance in plant cells, which may be due to its importance in increasing the plant's efficiency in absorbing potassium (19). Boron has a crucial role in the growth of the pollen tube in flowers, completing the process of pollination and fertilization inside the flower, and forming fruits. It also has a role in the germination of pollen grains, as well as its importance in the process of fruit production and the formation of seeds inside the fruits. It has been observed that a deficiency of the boron element increased the sterility of flowers and led to a decrease in the growth of the pollen tubes and a decrease in the amount of seeds produced.

The study aims to: Study the effect of each of potassium, sorbitol, and boron on the characteristics of the vegetative growth of melon plants grown in a protected environment and to identify the best level of them. Determine the best level of potassium, sorbitol, and boron in the chemical content of watermelon plants grown under protected agriculture conditions (10).

Materials and Methods

The experiment was carried out in one of the unheated greenhouses at the Department of Horticulture, College of Agriculture, University of Anbar, in the spring season of 2023. One of the first-generation hybrids of melon, called (Galia Hybrid specifications), was planted on February 4, 2023. The seeds were planted in plastic plates after being sterilized with a fungicide in a peat moss medium. All planting care processes were carried out carefully under recommended guideline (1). After reaching the age of two true leaves, they were transplanted to the greenhouse. The polytunnel was prepared by plowing the soil of the greenhouse and smoothing it well.

The plastic house was divided into five Terraces with a width of 85 cm, and the distance between one ridge and another was 60 cm Experimental unit area 1.6 m^2. 50 kg of decomposed animal manure was added per Terrace (1). The soil was sterilized with the Beltanol fungicide at a concentration of 1.0 ml/l watering. Drip irrigation was used as a method of irrigation. The greenhouse was divided into three replicates, the treatments were distributed randomly inside it, each replicate contained 15 experimental units with 10 plants in each experimental unit. The distance between one plant and another was 40 cm. All recommended crop care operations were carried out, including weeding, irrigation, and training the plants on one stem, as mentioned by (1). The fertilizer recommendation for the greenhouse was added according to the recommendation of (21).

Table 1: Some of the physical and chemical properties of the study soil before planting to a depth of 0 - 30 cm.

Property		Measurement Unit	Value	Property	Measurement Unit	Value
Sand		g/kg^{-1}	249	PH	-	7.86
Gravel			560	EC	dcm m^{-1}	3.4
Clay			191	OM	g/kg^{-1}	1.64
Texture			Mixture of gravel	CaSO4		56.88
Apparent density		μg m^{-3}	1.33	CaCO3		167.13
Soil volumetric moisture at tension (kPa)	0	%	62.76	CEC	$cmol/kg^{-1}$	11.77
	33		39.54	N	mg/kg^{-1}	71.00
	100		30.82	P		42.00
	500		22.31	K		143.00
	1500		21.77			
Ready water		%	17.77			

The study was conducted as a factorial experiment within a complete randomized block design with three replicates The means were compared according to LSD test at the 0.05 probability level with two factors:

The first factor is spraying with three levels of potassium (0, 4, and 8 g l^{-1}). The spraying was done with potassium sulfate 48% K20. It was sprayed after 50% of the plants bloomed weekly to maturity (14).

The second factor is spraying with a combination of sugar alcohol (sorbitol) and boron at five concentrations. The first 0 and 0 is the comparison treatment, the second concentration (20 mg l^{-1} boron + 25 g l^{-1} sorbitol Based on previous studies), the third concentration (20 mg l^{-1} boron + 50 g l^{-1} sorbitol), the fourth concentration (40 mg l^{-1} boron + 25 g l^{-1} sorbitol), and the fifth concentration (40 mg boron + 50 g l^{-1} sorbitol). They were coded T0, T1, T2, T3, and T4, respectively. The spraying was done after the formation of 6-8 true leaves, with three sprays between each spray every two weeks until maturity (12).

Studied Traits:

- Plant height (cm): The height of the plant was measured from the point of contact with the soil to the top of the main stem at the end of the growing season.
- Leaf area (dm^2 $plant^{-1}$): Three leaves were selected from the top, middle, and bottom of each plant and photographed on a white board. The leaf area was then measured using the Digimizer leaf area measurement software on a computer. The total area was calculated by multiplying the average leaf area by the total number of leaves on the plant (8).
- Number of nodes (node $plant^{-1}$): The number of nodes was counted on the main stem from the point of contact with the soil to the top of the growing tip at the end of the growing season.
- Mass of dried biomass (g): The shoot of five plants from each experimental unit was harvested and cut into small pieces. The samples were placed in paper bags and dried in an electric oven at 65 °C until the weight was constant. The dry weight was then calculated, and the average was extracted (18).
- Nitrogen content in leaves (%): The nitrogen content was determined using the Semi-micro Kjeldahl method (4).
- Phosphorus content in leaves (%): The phosphorus content was determined using sodium molybdate blue and ascorbic acid. The measurement was carried out using a spectrophotometer at a wavelength of 620 nm, as described by (6).
- Potassium content in leaves (%): The potassium content in leaves was determined using a flame photometer according to the method of (16).
- Boron content in leaves: The boron content in leaves was estimated using Garmins method, as described by (17).

Results and Discussion

Vegetative Growth Characteristics:

Plant height (cm): The results of Table 2 showed that treatment K1 had a significant advantage, increase a plant height of 311.98 cm, compared to the lowest plant height of 297.34 cm achieved by plants in the comparison treatment. Spraying with a combination of boron and alcohol sugar had a significant effect, with treatment T4 achieving a plant height of 317.91 cm, compared to the lowest plant height of 285.32 cm achieved by plants in the comparison treatment. The interaction between the study factors had a significant effect on plant height, plants in treatment K1T4 generated highest plant of 324.41 cm, compared to the lowest plant height of 280.52 cm achieved by the comparison treatment.

Table 2: Effect of spraying with potassium, sorbitol, boron, and their interaction on plant height (cm plant^{-1}).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	280.52	286.34	289.10	285.32
T1	288.92	311.85	303.53	301.46
T2	306.03	316.65	289.23	303.94
T3	301.41	320.63	317.50	313.23
T4	309.80	324.41	319.58	317.97
Avg K	297.30	311.90	303.75	
LSD K		5.080		0.05
LSD T		6.558		
LSD KT		11.358		

Leaf area (dm^2 plant^{-1}): The results in Table 3 showed that there were significant differences between potassium levels, with the first treatment giving 95.05 dam^2 plant^{-1}, compared to the lowest leaf area given by plants in the comparison treatment of 82.64 dm^2 plant^{-1}. Spraying with a combination of alcohol sugar and boron had a significant effect, with the fourth treatment giving the highest leaf area of 99.12 dm^2 plant^{-1}, compared to the lowest area given by plants in the comparison treatment of 76.95 dm^2 plant^{-1}. The interaction between the study factors had a significant effect, with treatment K1T4 giving the highest leaf area of 105.15 dm^2 plant^{-1}, compared to the lowest leaf area given by plants in the comparison treatment of 72.93 dm^2 plant^{-1}.

Table 3: Effect of spraying with potassium, sorbitol, boron, and their interaction on leaf area (dm^2 plant^{-1}).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	72.93	77.83	81.63	76.93
T1	73.63	96.13	95.37	88.38
T2	89.92	94.25	94.78	92.85
T3	87.67	102.82	96.87	95.82
T4	90.15	105.15	102.07	99.12
Avg K	82.64	95.50	94.10	
LSD K		3.554		0.05
LSD T		4.588		
LSD KT		7.947		

Number of nodes (node plant^{-1}): The results in Table 4 showed that treatment K1 had a significant advantage, achieving the highest number of nodes of 33.71 nodes plant^{-1}, compared to the lowest number of nodes of 30.04 nodes plant^{-1} achieved by plants in the comparison treatment. Spraying with a combination of alcohol sugar and boron had a significant effect on this trait, with treatment T4 achieving the highest number of nodes of 35.032 nodes plant^{-1}, compared to the lowest number of nodes of 28.60 nodes per plant-1 achieved by the comparison treatment. The interaction between the study factors had a significant effect on the number of nodes, with plants in treatment K1T4 significantly outperforming the others, giving the highest number of nodes of 38.05 nodes plant^{-1}, compared to the lowest number of nodes of 27.22 nodes plant^{-1} achieved by plants in the comparison treatment.

Table 4: Effect of spraying with potassium, sorbitol, boron, and their interaction on number of nodes on main stem (node plant^{-1}).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	27.22	29.19	29.35	28.64
T1	28.71	32.61	30.41	30.63
T2	31.03	32.87	32.66	32.19
T3	30.97	35.88	33.84	33.53
T4	32.23	38.02	34.81	35.02
Avg K	30.09	33.73	32.23	
LSD K		0.513		0.05
LSD T		0.662		
LSD KT		1.146		

Dry weight of the vegetative mass (g plant^{-1}): Table 5 showed that there were significant differences between treatments, K1 giving the highest dry weight of the vegetative mass of 138.8 g plant^{-1}, compared to the lowest weight of 118.4 g plant^{-1} given by the K0. Spraying with a combination of boron and alcohol sugar had a significant effect, with treatment T4 giving the highest dry weight of 146.7 g plant^{-1}, compared to the lowest dry weight of 107.6 g plant^{-1} given by the comparison treatment. The interaction between the study factors had a significant effect on the dry weight, with treatment K1T4 giving the highest dry weight of the plant of 158.0 g plant^{-1}, compared to the lowest dry weight of 101.7 g plant^{-1} given by the comparison treatment.

Table 5: Effect of spraying with potassium, sorbitol, boron, and their interaction on dry weight of the vegetative mass (g plant^{-1}).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	101.7	107.5	113.4	107.6
T1	106.4	141.0	141.9	129.8
T2	127.3	136.3	139.6	134.4
T3	122.8	151.1	146.9	140.3
T4	133.7	158.0	148.6	146.7
Avg K	118.4	138.8	138.1	
LSD K		5.4		0.05
LSD T		6.9		
LSD KT		12.0		

Chemical content of the leaves:

Nitrogen content (%): The data in Table 6 show that treatment K1 had the highest nitrogen content, at 1.914%, compared to the lowest nitrogen content of 1.861% in the control plants. Treatment T4 had the highest nitrogen content in the leaves, at

1.937%, compared to the control treatment, which had the lowest nitrogen content of 1.818%. The interaction between the study factors had a significant effect, with treatment K1T4 having the highest nitrogen content in the leaves, at 1.948%, compared to the lowest nitrogen content of 1.803% in treatment K0T0.

Table 6: Effect of spraying with potassium, sorbitol, boron, and their interaction on nitrogen content in the leaves (%).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	1.803	1.810	1.841	1.818
T1	1.826	1.937	1.871	1.878
T2	1.872	1.939	1.932	1.914
T3	1.881	1.935	1.939	1.919
T4	1.922	1.948	1.942	1.937
Avg K	1.861	1.914	1.905	
LSD K		0.019		0.05
LSD T		0.024		
LSD KT		0.042		

Phosphorus in leaves (%): The data in Table 7 show that treatment K2 had the highest phosphorus content in the leaves, at 0.536%, compared to the lowest phosphorus content of 0.519% in the control plants. Treatment T4 had the highest phosphorus content in the leaves, at 0.543%, compared to the lowest phosphorus content of 0.515% in the control plants. The interaction between the study treatments had a significant effect, with treatment K2T4 having the highest phosphorus content in the leaves, at 0.549%, compared to the lowest phosphorus content of 0.497 in the control plants.

Table 7: Effect of spraying with potassium, sorbitol, boron, and their interaction on phosphorus content in the leaves (%).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	0.497	0.522	0.526	0.515
T1	0.510	0.529	0.526	0.522
T2	0.524	0.531	0.533	0.530
T3	0.532	0.542	0.545	0.540
T4	0.531	0.548	0.549	0.543
Avg K	0.519	0.534	0.536	
LSD K		0.004		0.05
LSD T		0.005		
LSD KT		0.008		

Potassium content in leaves (%): Table 8 shows that treatment K2 had the highest potassium content in the leaves, at 1.870%, compared to the lowest potassium content of 1.783% in the control plants. Treatment T4 had the highest potassium content in the leaves, at 1.854%, compared to the control treatment, which had the lowest potassium content of 1.813%. The interaction between the study treatments had a significant effect on the potassium content in the leaves, with treatment K2T4 having the highest potassium content in the leaves, at 1.891%, compared to the lowest potassium content of 1.813% in the control treatment.

Table 8: Effect of spraying with potassium, sorbitol, boron, and their interaction on potassium content in the leaves (%).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	1.762	1.828	1.848	1.813
T1	1.766	1.848	1.865	1.826
T2	1.792	1.838	1.863	1.831
T3	1.782	1.845	1.885	1.837
T4	1.813	1.858	1.891	1.854
	1.783	1.844	1.870	
LSD K		0.007		0.05
LSD T		0.009		
LSD KT		0.016		

Boron content in leaves: The results in Table 9 showed that treatment K2 had the highest boron content in the leaves, at 39.18 micrograms g^{-1}, compared to the lowest boron content of 37.954 micrograms g^{-1} in the control treatment. Treatment T4 had the highest boron content in the leaves, at 42.74 micrograms g^{-1}, compared to the control treatment, which had the lowest boron content of 31.07 micrograms g^{-1}. The interaction between the study treatments had a significant effect, with treatment K2T4 having the highest boron content, at 43.23 micrograms g^{-1}, compared to the control treatment, which had the lowest boron content of 30.77 micrograms g^{-1}.

Table 9: Effect of spraying with potassium, sorbitol, boron, and their interaction on boron content in leaves (micrograms g^{-1} fresh weight).

Sorbitol & boron	potassium			Avg T
	K0	K1	K2	
T0	30.77	30.77	31.77	31.07
T1	38.10	38.23	39.30	38.51
T2	37.10	38.13	38.27	37.83
T3	41.80	43.23	43.13	42.79
T4	41.93	43.27	43.23	42.74
Avg K	37.94	38.71	39.18	
LSD K		0.627		0.05
LSD T		0.809		
LSD KT		N.S		

Discussion: The results in Tables 2, 3, 4, and 5 showed that potassium has a positive role in increasing the vegetative growth indicators (plant height, leaf area, dry weight of the vegetative mass, and number of nodes on the main stem). This can be attributed to the role of potassium in stimulating the growth of meristematic tissue and then forming good vegetative and root growth, which increases the efficiency of water and nutrient absorption from the soil. This has had a positive impact on the development of the plant and the improvement of its vegetative traits (7). Potassium also plays a role in stimulating photosynthesis, carbohydrate formation, and the transport of materials produced by this process. In addition, it stimulates the formation of ATP, which increases plant activity and improves vegetative growth traits (3). The results in Tables 2, 3, 4, and 5 also showed the role of a combination of boron and sorbitol in increasing the vegetative growth indicators. This can be attributed to the role of boron in cell development, increased cell division, and cell wall formation. In addition, it plays a role in the formation of the growth hormone cytokinin, which is responsible for improving vegetative growth and delaying plant senescence (13). The role of sorbitol in increasing the vegetative growth indicators can also be attributed to its role in facilitating the transport of boron and other trace elements in the phloem. This improves the vegetative growth of the plant. In addition, sorbitol is easily and quickly transported within plant tissues from its production sites (leaves) to other parts of the plant, causing an increase and improvement in the vegetative growth traits of the plant (12).

The results in Tables 6, 7, 8, and 9 indicate that the plants sprayed with potassium had a higher content of major elements and boron in their leaves. This may be due to the enzymatic role of potassium in stimulating the activity of a large number of enzymes within the plant, as well as the regulatory role of potassium in osmotic pressure, which increases the availability of elements and their absorption by the root system, increasing the chance of accumulation of elements in the leaves of the plant (15).

The spraying with a combination of boron and alcohol sugar increased the concentration of nitrogen, phosphorus, potassium, and boron, as shown in the results in Tables 6, 7, 8, and 9. This may be due to the nature of the structure of alcohol sugars, which are carbohydrates and one of the most important natural products of photosynthesis. In addition, they are quickly transported through plant tissues, which increases the chance of accumulation of elements, especially nitrogen, in the leaves of the plant. The important role of alcohol sugars in transporting major and minor nutrients, especially slow-moving elements such as calcium and boron, through the phloem is also a possible reason. Alcohol sugars move freely and easily within the plant. Sorbitol, one form of alcohol sugar, helps to facilitate the transport of boron within the phloem in a complex form. Sorbitol is easily transported within the plant because its particle size is very small, and it can pass through the stomata in the cuticle layer (2).

Conclusions

The results of the study indicate that the following conclusions can be drawn:

•It is necessary to spray watermelon plants with potassium (with a concentration of no more than 4 g/L) due to its effective role in improving plant growth and increasing its vegetative traits, which will inevitably reflect on increasing the yield and improving the quality.

•Alcohol sugars and boron had a positive role in improving the vegetative growth indicators of watermelon plants, which will reflect positively on increasing the yield.

From the research results, we recommend spraying plants with potassium of 4 mg/L and studying higher concentrations of sugar alcohol.

Supplementary Materials:

No Supplementary Materials.

Author Contributions:

Author S. Kh. Abdullah; methodology, writing—original draft preparation, Author M.

M. M. Alabdaly writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding:

This research received no external funding.

Institutional Review Board Statement:

Non.

Informed Consent Statement:

No Informed Consent Statement.

Data Availability Statement:

No Data Availability Statement.

Conflicts of Interest:

The authors declare no conflict of interest.

Acknowledgments:

The authors are thankful for the help of the College of Agriculture - University of Anbar for their valuable help and technical assistance in conducting this research.

Disclaimer/Journal's Note:

The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of AJAS and/or the editor(s). AJAS and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

References

1. Alabdaly, M. M., and Gar, L. F. (2023). Breeding of some cucumber hybrids according to some water stress criteria under plastic houses conditions. Journal of Aridland Agriculture, 9: 150-156. DOI: 10.25081/jaa.2023.v9.8643.
2. Al-Hasani, F. A. M. (2012). The effect of acrylic cover, silver soil cover, nitrogen, and potassium spraying on the quantitative and qualitative yield of melon under unheated plastic house conditions. Master's thesis, College of Agriculture, University of Baghdad
3. Al-Nuaimi, S. M. T. (2013). The effect of potassium spraying and cultivation method on the growth and yield of two melon hybrids under protected agriculture. Master's thesis, College of Agriculture, University of Anbar.
4. Al-Sahaf, F. H. (1989). Applied Plant Nutrition. Baghdad University - Ministry of Higher Education and Scientific Research. Iraq.
5. Al-Shammari, M. F. M. (2018). The role of boron spraying and sugar alcohols (sorbitol and mannitol) in the growth, yield, and seeds of pepper plants. Doctoral thesis, College of Agriculture, University of Baghdad, Republic of Iraq.
6. Association of Official Analytical Chemists, and Sotoloff, L. (1980). Mycotoxins Methodology: From Chapter 26... Official Methods of Analysis 13th Ed., 1980 of the Association of Official Analytical Chemists. Association of Official Analytical Chemists.
7. Black, C. A., Evans, D. D., and Ensminger, L. E. (1965). Methods of soil analysis. Agronomy, 9 Amer. Soc. Agron. Inc. Publisher, Madison, Wisconsin.

USA.
8. Dizayee, A. S. A. . (2023). Optimal Plant Spacing Effects On Phenology And Growth Metrics Of Corn (Zea Mays L.). Journal of Life Science and Applied Research, 4(2), 68–74. https://doi.org/10.59807/jlsar.v4i2.87.
9. Hassan, A. A. M. (2004). Production of secondary and non-traditional vegetables. Part One, first edition, Arab House for Publishing and Distribution.
10. Khamwaree, N., and Khurnpoon, L. (2016). Effect of calcium boron solution and non-irrigation before harvesting on growth and quality in muskmelon (Cucumis melo L. var. recticulatus). International Journal of Agricultural Technology, 12(7.1): 1299-1307.
11. Khorshed, A. N., & S. Ahmed, A. (2023). Cultivation Of Reishi Mushroom (Ganoderma Lucidum) On Different Local Substates In Kurdistan Region, Iraq. Anbar Journal Of Agricultural Sciences, 21(1), 158-173. doi: 10.32649/ajas.2023.179727.
12. Marschner, H. (2009). Response of Sweet Melon to Different Levels of Nitrogen and Potassium Fertigation. Biennial Agricultural Research Report. 35.
13. Merghany, M. M., Ahmed, Y. M., and El-Tawashy, M. K. F. (2015). Response of some melon cultivars to potassium fertilization rate and its effect on productivity and fruit quality under desert conditions. Journal of Plant Production, 6(10): 1609-1618. https://dx.doi.org/10.21608/jpp.2015.52039.
14. Mohammed, I. A., and Alabdaly, M. M. (2023). Production and Performance Evaluation Hybrids of Gynoecious Cucumber Cucumis sativus L. for Greenhouses in West Iraq. Iraqi Journal of Desert Studies, 13(1): 25-32.
15. Mostofa, M. G., Rahman, M. M., Ghosh, T. K., Kabir, A. H., Abdelrahman, M., Khan, M. A. R., ... and Tran, L. S. P. (2022). Potassium in plant physiological adaptation to abiotic stresses. Plant Physiology and Biochemistry, 186: 279-289. https://doi.org/10.1016/j.plaphy.2022.07.011.
16. Page, A. L. (Ed.). (1982). Methods of soil analysis. Part 2. Chemical and microbiological properties, pp. 1159.
17. Ryan, J., Estefan, G., and Rashid, A. (2001). Soil and plant analysis laboratory manual. ICARDA.
18. Sadik, S. K., Al-Taweel, A. A., Dhyeab, N. S., and Khalaf, M. Z. (2011). New computer program for estimating leaf area of siveral vegetable crops. American-Eurasian Journal of Sustainable Agriculture, 304-310.
19. Sarwar, A. K. M., Chanda, S. C., and Khatun, M. M. (2021). Boron and sulfur application on growth and yield of Khira (short cucumber, Cucumis sativus). Research on Crops, 22(4): 901-906. DOI: 10.31830/2348-7542.2021.147.
20. Taiz, L., and Zeiger, E. (2006). Plant physiology sinauer associates. Inc., Publisher. Sunderland, Massachussetts.
21. Yousif, F. K., and Esho, K. B. (2023). Estimating The Genetic Parameters For Vegetative And Flower Growth In Muskmelon (Cucumis Melo L.) And Spraying With The Amino Acid Of The Proline And Boron Cultivated In Dry Erea In The Al-Qosh Region. Journal of Pharmaceutical Negative Results, 14(3): 2157-2175. https://doi.org/10.47750/pnr.2023.14.03.280.