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Effect of Spraying with Boric Acid and Potassium Fertilizer on Three Eggplant Hybrids Solanum Melongena L. Under Unheated Plastic House Conditions

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Abstract

The study aimed to determine the response of three hybrids of eggplant, THURAYYA, JAWAHER, and BARCELONA to spraying with boric acid (BO3 H3) (17% B) at a concentration of 25 mg L^{-1} or high potassium fertilizer 3 $g.L^{-1}$ as NPK (50) or a combination of both fertilizers under unheated greenhouse conditions. The experiment was carried out using Randomized Complete Block Design with three replicates. The results showed that the Barcelona hybrid was significantly superior in leaf area, dry weight of the vegetative group, fruit set percentage, leaf chlorophyll content, number of fruits, plant yield and fruit solanine content compared to the two hybrids Thurayya and Jawaher. Spraying with the fertilizer combination of potassium at a concentration of 3 $g.L^{-1}$ and boron 25 $mg.L^{-1}$ was significantly superior in increasing the studied indicators compared to plants treated with one of the factors or not treated. The results showed that the highest measures for all study indicators recorded a significant increase in the treatment of the Barcelona hybrid interaction and spraying with the fertilizer combination of 3 $g.L^{-1}$ potassium and 25 $mg.L^{-1}$ boron compared to all other interaction treatments between the study factors.

Keywords:

Genotype, micro-nutrients, solanine, Solanum.

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Introduction

Eggplant (*Solanum melongena* L.) is a vegetable plant of great importance in Iraq and the world, especially in areas with hot and temperate climates, as it contains many vitamins, proteins and minerals and plays a pivotal role in addressing food security and contributing to food diversity (Wood, 2012). The demand for this crop is increasing in the markets for all its quantities offered in local and international markets in addition to the good

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economic return for its producers. The cultivated area in the world reached 1,864,556 hectares with a productivity of 54,077,210 million tons. As for Iraq, the area cultivated with eggplant was estimated at 12,388 hectares with a productivity of 183,056 thousand tons (FAO, 2020). This level of production is considered very low compared to global production.

One of the most important ways to increase production and improve the quality of fruits is to use new hybrids with high production and good quality (Abdul Rasool et al., 2005). Blends are a new way to farm that has helped grow more and better eggplant. A big part of making industrial blends is using the fact that they are stronger to get better results and do more. It has been shown over and over again that mixing different kinds of eggplant plants produces a lot of good food (Hossain et al., 2024). They also grow grass and other plants, which show that they have power together.

Spraying fertilizer on the green parts of plant leaves helps them get more nutrients and grows them faster (Kuepper, 2003). You can do this by giving plants a lot of nutrients, especially boron. Boron helps plants make more buds and leaves and is important for parts that do work, like root tips. This is more important for meristematic cells than for tissue that is fully grown. This is why boron shortage shows up in new leaves and buds at the end of stems. Boron is important for cells to grow and change. It is easy for meristematic cells to get to these important nutrients when boric acid is added with an overhead spray (Brdar-Jokanavi, 2020). This helps plants sprout and grow (Far, 2017). But potassium is one of the most important things for plants. It helps enzymes do their jobs, controls the production of important chemicals, and many other things in plants. This helps plants get the food and water they need, which is good for growth. When the flowers get more potassium, they get bigger and better (Malešević et al., 2023). This makes the plant make more of both types of food and more of them. Also, potassium helps roots grow, which helps plants get food and water from the ground (Abu Dahi & Al-Younis, 1988). Three kinds of eggplant were grown in a cool yard when it wasn't their regular time to do so. This was the point of the study. And to test the possibility of improving the vegetative growth indicators and the result of spraying with boric acid and potassium fertilizer.

Materials and Methods

Table 1. Some physical and chemical properties of field soil before planting

No.	Analysis		Unit	Value
1	Ph		-------	7.6
2	EC		dSm m^{-1}	1.24
3	Nitrogen N		Ppm	22.875
4	Phosphorus P		Ppm	16.481
5	Potassium Ion K+		Ppm	41.21
6	Sodium Ion + N		Ppm	1.32
7	Calcium Ion + Ca		Ppm	160.00
8	Magnesium Ion + Mg		Ppm	60.00
9	Sulfate Ion SO_4		Ppm	25.652
10	Chloride Ion – CI		Ppm	495.60
11	Bicarbonate Ion HCO_3		Ppm	26.108
12	Carbonate Ion CO_3		Ppm	NIL
13	Organic Matter		%	1.25
14	Soil texture	Clay	17%	Sand-loam
		Silt	15%	
		Sand	68%	

The field experiment was conducted for the spring growing season 2024 at the Agricultural Research Station of the College of Agriculture / University of Kufa to study the response of three hybrids of eggplant plants under unheated greenhouse conditions by spraying with boric acid and high potassium fertilizer (Adriani et al., 2023). Soil analysis tests were conducted before planting with ten random samples of field soil prepared for planting taken at a depth ranging from 0-30 cm after mixing and drying Table 1.

Field Preparation and Planting Methods

The field was divided into three equal sectors, each sector containing 12 experimental units, thus the number of experimental units was 36 (12 experimental units × replicates). The area of the experimental unit was 25.5 m (5.3 length × 5.1 width). A distance of 1 m was left between the experimental units to prevent mixing between treatments. Each experimental unit contained seven plants, and the distance between one plant and another was 50 cm. The seeds were planted in plastic dishes in the nursery on 9/13/2023. When the seedlings reached 4-5 true leaves and a height of $10^{-1}5$ cm, they were transferred to the plastic house prepared for cultivation. The field was watered immediately after planting by drip irrigation, and watering was repeated whenever the plant needed it, with all the required operations carried out (Matloub et al., 1989).

Experiment General Procedure

The treatments were distributed in a factorial experiment using Randomized Compled Block Design (R.C.B.D) using three sectors with three replicates. The first factor included three hybrids of eggplant: Thuraya, Jawaher and Barcelona. The second factor included spraying with high potassium fertilizer 3 gm. L^{-1} in the form of NPK fertilizer (50,0,0) produced by Grow MoRE or the American company or with boron in the form of boric acid (H3Bo3) (17% B) or a combination of both fertilizers in addition to the control treatment (spraying with distilled water only). The application was carried out at a rate of three sprays, the first after 15, 30, and 45 days from transplanting in the field.

Experiment Measurements

Leaf Area Per Leaf (cm^2. $Leaf^{-1}$): Leaf area was measured by cutting three full-width leaves from each plant for each treatment in each replicate and measured according to the method described (Sadik et al., 2011) using a scanner using the Digimizer program loaded on a computer, then the leaf area was calculated.

Shoot Dry Weight (g): At the end of the season, the plants were uprooted and the vegetative group was separated from the root from the crown area using tree pruning shears and weighed using a sensitive balance, then the vegetative group was cut and placed in perforated paper bags, then placed in an electric oven at 65-70°C. After the weight stabilized, its dry weight was measured using a sensitive balance.

Leaf Content of Chlorophyll (mg 100 g^{-1} FW): This indicator was measured in five random samples of plant leaves for each experimental unit, where the fifth leaf was selected from the bottom of the growing tip (Goodwin, 1976). Spectrophotometer was used to measure light absorption at wavelengths of 645 and 663 nm.

Percentage of Fruit Set %: The total number of flowers and the number of fruit set were calculated from the beginning of their appearance until the end of the growing season for all plants of the experimental unit of 3 plants in each experimental unit.

Number of Fruits Per Plant (Fruit $Plant^{-1}$): this was calculated by the number of fruits per experimental unit cumulatively divided by the number of plants in that experimental unit.

Yield Per Plant (g. fruit^{-1}): According to the yield per plant by calculating the yield of the experimental unit (Kg) cumulatively divided by the number of plants of the experimental unit.

Solanine Content of Fruits (mg. Kg^{-1}): Solanine was estimated using HPLC device with a C18 separation column with dimensions of 250 mm length, 4.6 mm diameter and 5 micrometer particle size, equipped by (Knuaer Germany) company. The separation was based on the method of (Maurya et al., 2013).

The averages were compared according to the Least Significant Differences Test (LSD) at a probability level of 0.05 (Al-Rawi & Khalaf Allah, 2006).

Results and Discussion

From one cross to the next, one leaf is a very different size. There were 47.162 cm^2 of Barcelona hybrid leaves, which was a lot more than the 31.156 cm^2 and 30.152 cm^2 of Thuraya and Jawaher hybrid leaves. The plant was sprayed with a fertilizer mix that had 3 grams of potassium and 25 milligrams of boron per liter. The leaves got bigger. All of the other ways of feeding didn't work as well as this did. The leaf area was largest when the Barcelona blend and a mix of 3 grams of potassium per liter and 25 milligrams of boron per liter were used together. Barcelona mix leaves had 82.79 g of dry weight, which were the most of any green group and 77.25 mg of chlorophyll. Thuraya and Jawaher, on the other hand, were 67.67 grams dry and had 42.92 grams of chlorophyll for every 100 grams of fresh weight. There was more chlorophyll and more green dry weight on the leaves after the fertilizer mix was spread on them. This wasn't like the control group at all. There was a big difference between the three treatments. The fertilizer mix of potassium 3 g was very different from the other two. L-1 and 25 mg of boron.L-1 had the driest weight and the greenest percentage Table 2.

Table 2. Effect of hybrid type and fertilization with potassium and/or boron on vegetative growth indicators of eggplant

Treatments	**Leaf area cm^2**				**Shoot dry weight g**				**Leaf content of Chlorophyll**			
	Eggplant hybrids (B)				**Eggplant hybrids (B)**				**Eggplant hybrids (B)**			
Fertilizer (A)	Br	J	Th	Average	Br	J	Th	Average	Br	J	Th	Average
0	158.85	149.43	154.61	154.30	78.88	38.54	57.54	58.32	74.41	34.52	52.63	53.85
K	160.90	151.84	154.97	155.90	81.54	39.88	61.55	60.99	76.03	36.52	57.06	56.54
B	163.96	153.35	156.94	158.08	83.87	44.40	74.21	67.49	77.61	41.35	63.61	60.86
K/B	166.18	154.57	158.71	159.82	86.87	48.88	77.39	71.05	80.94	47.58	71.30	66.61
Average	162.47	152.30	156.31		82.79	42.92	67.67		77.25	39.99	61.15	
LSD 0.05	A=0.756 B=0.873 A/B=1.512				A=1.536 B=1.774 A/B=3.073				A=1.556 B=1.797 AB=3.113			

It is noted from the results Table 2 that the percentage of fruit set and fruit formation were affected in a similar way to the previous standards, as the difference between hybrids in the percentage of fruit set was recorded, with the Barcelona hybrid being superior with a fruit set percentage of 71.16% compared to 63.93 and 56.14% of the Thuraya and Jawaher hybrids, respectively. Similarly, the fruit set percentage was affected by the type of fertilization, especially the highest fruit set percentage was recorded with the potassium fertilizer combination at a concentration of 3 g L^{-1} and boron at a concentration of 25 mg L^{-1}, significantly increasing the percentage to 66.05 compared to the control, which recorded 61.20%.

Table shows that the number of flowers that each mix made was very different. The types Thuraya and Jawaher each had 7.20 and 6.16 times as many fruits, while the Barcelona combination had 8.26 times as many fruits. This table shows the mix of 25 milligrams of boron and 3 grams of potassium fertilizer per liter. The plants that were given L-1 had 7.57 fruits, while the plants that were not given L-1 only had 6.68 fruits. There wasn't a big difference between the fertilizer and cross types when it came to flower count.

Table 3 shows that the Barcelona eggplant type produced the most, 1353.0 g per plant. These mixes only made 1097.0 kg and 838.3 kg, respectively, which was a lot less than what Thuraya and Jawaher did. It worked best for them to use a fertilizer mix that had 3 grams of potassium per liter and 25 milligrams of boron per liter. When L-1 was added, each plant made a lot more, 1202.2 g. It only got 1008.6 g when clean water was used to wash. Also, it was found that the hybrid Barcelona plant produced the most, 1466.9 g, when it was mixed with a fertilizer mix of 3 g. L-1 potassium and 25 mg. L-1 boron. With only 773.9 g of plants, the combination Jawaher treatment combined with the control treatment had the lowest output.

The fruit solanine content was also significantly higher in Barcelona cultivar, which recorded 72.90 $mg.kg^{-1}$ compared to significantly lower values in Thuraya and Jawaher, which recorded solanine content of 34.17 and 29.88 $mg.kg^{-1}$, respectively.

Table 3. Effect of hybrid type and fertilization with potassium and/or boron on eggplant yield indicators and quality

Treatments	Fruit formation %				No. of fruits/plant				Plant yield Kg				Fruit content of Solanine			
	Eggplant hybrids (B)				Eggplant hybrids (B)				Eggplant hybrids (B)				Eggplant hybrids (B)			
Fertilizer (A)	Br	J	Th	Average	Br	J	Th	Average	Br	J	Th	Average	Br	J	Th	Average
0	68.90	54.15	60.55	61.20	7.73	5.47	6.85	6.68	1262.1	773.9	989.7	1008.6	32.08	25.69	28.42	28.73
K	71.03	55.85	63.29	63.39	8.17	6.42	7.24	7.28	1319.2	797.1	1050.0	1055.4	33.14	26.66	29.51	29.77
B	71.26	56.42	65.31	64.33	8.38	6.19	7.34	7.30	1363.8	851.1	1141.7	1118.9	34.87	27.95	30.58	31.13
K/B	73.46	58.13	66.56	66.05	8.75	6.57	7.38	7.57	1466.7	931.0	1209.0	1202.2	36.59	27.98	31.02	31.86
Average	71.16	56.14	63.93		8.26	6.16	7.20		1353.0	838.3	1097.6		72.90	29.88	34.19	
LSD 0.05	A=0.556 B=0.654 A/B=1.132				A=0.212 B=0.245 AB=N.S				A=16.77 B=19.37 AB=33.55				A=0.488 B=0.563 AB=0.976			

Spraying with the potassium and boron fertilizer combination also resulted in higher fruit solanine contents of 31.86 $mg.kg^{-1}$ compared to the control, which recorded 28.73 $mg.kg^{-1}$. The cross-breeding treatment Barcelona and the fertilizer combination of 3 $g.l^{-1}$ potassium and 25 $mg.l^{-1}$ boron recorded 36.59 compared to Jawaher treatment sprayed with water only, which decreased to 25.69 $mg.kg^{-1}$.

The Barcelona type did better than the others. That makes it clear that the things that were being looked at for plant growth change when they are mixed. It's because hybrid power, plants growing the same way, and plants having more nitrogen and chlorophyll, which help them grow faster (Jassim & Abdel-Hadi Saadoun, 2012; Abdul Rahman et al., 2019 and Al-Asadi, 2020; Tawab et al., 2015; Al-Shammari, 2015) say that the mix might make more things grow and do them better in some places than other genes. The earth got more boron and potassium, which made more leaves grow and each leaf get bigger. The green group had more dry weight, and there were more nodes. This is mostly because these nutrients are necessary for many of the plant's processes that keep it alive and make food (Hatwar et al., 2003). Boron is needed by plants to make cell walls, turn on membranes, and move products of photosynthesis from the leaves to other parts of the plant (Haque et al., 2011). Potassium is not found in cells, but it is needed for many things, like making proteins and photosynthesis (Taiz & Zeiger, 2003). Stomata can't open and close, enzymes can't work, and osmotic pressure can't be changed just by potassium. Green growth signs show that cells are getting better and longer (FM et al., 2013).

The Barcelona mix also did better in terms of quality and output. Most likely, this is because of the hybrid's genes and its ability to do well in some places (Novella et al., 2008). It could also be because of genes in the mix that make it set more fruit (Jassim & Abdel-Hadi Saadoun, 2012). In other words, each plant makes more food and output. There is a chemical called boiron that helps plant hormones like gibberellin work and for pollen to grow into seeds. This helps flowers grow and develop (Yassin, 2001). This could be the reason why the spray treatments that used the fertilizer mix showed signs of making more crops. More flowers opened because of this, which meant there were more flowers on each plant. Also, it is clear that potassium fertilizer speeds up photosynthesis by making the plant's surface area bigger, which lets it store more sugars (Al-Sahaf, 1989). A lot of enzymes work faster when potassium is present. They help plants split up carbs and proteins and make food.

Conclusion

In summary, the research found that the Barcelona hybrid produced better results than the Thurayya and Jawaher hybrids in terms of plant yield, fruit solanine content, leaf area, vegetative dry weight, fruit set %, chlorophyll content, fruit count, and overall growth and yield. When compared to treatments with either potassium fertilizer alone or untreated plants, the combination of boric acid (25 mg L^{-1}) and potassium fertilizer (3 g.L^{-1}) considerably improved all measured parameters. In unheated greenhouse conditions, the Barcelona hybrid's interaction with the combined fertilizer treatment produced the best results across all research labels, demonstrating its better sensitivity to nutrient supplementation. In order to increase eggplant yields, our results highlight the significance of hybrid selection and optimal nutrient management.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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