



Yield And Quality Of Potato As Affected By Foliar Spraying Of Boron And Cytokinin

Smaher Malek¹, A. I. A. Ebido¹, G. Abdel-Nasser², M. M. Ziton³ and A. A. A. Gabel¹

1. Plant Production Dept., 2. Soil and Agricultural Chemistry Dept., 3. Food Sciences Dept. Faculty of Agriculture Saba Basha, Alexandria University

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ABSTRACT: Two field experiments were carried out during the summer seasons of 2018 and 2019, at the Experimental Farm of Faculty of Agriculture (Saba- Basha) at Abees area, Alexandria University, Egypt, to study the effect of foliar application of the various levels of both BA as cytokinin and Boron on vegetative growth, yield, and quality of 'Hermes' potato cultivar.

Cut seedy explants were, approximately, 40 g in weight and each seedy explant contained 2 eyes planted on the 20th February during both seasons. Cutting seeds were planted under a drip irrigation system at 30 cm apart in the row and 0.8 m width in dry soil then irrigated. The experimental plot consisted of two rows with 10.00 m long and 0.80 m width; making an area of 16.00 m².

The experimental design was a split-plot- design in a randomized complete block. The main plots allocated for boron levels (0, 10, 20, and 30 mg l⁻¹). Whereas, the sub-plots were occupied by 6-benzyl adenine levels (0, 10, 20, and 30 mg l⁻¹).

The results indicated that foliar application of boron at 30 mg l⁻¹ gave the highest average values of No. of tubers per plant, tuber fresh weight (g plant⁻¹), No. of tubers per 10 kg, total yield per plant (g) as well as total yield; (ton fed⁻¹) compared to control plants during both seasons of the study. On the other side, foliar application of cytokinin at 30 mg l⁻¹ recorded the highest of No. of tubers per plant, tuber fresh weight (g plant⁻¹), No. of tubers per 10 kg, total yield per plant (g) as well as total yield; (ton fed⁻¹ as compared with control treatment and the other treatments, during both seasons.

Results of this characteristic revealed that applying boron at 30 mg l⁻¹ increased significantly the potato chips defect (%), tuber firmness, tuber dry weight (%), and specific gravity compared to the control treatment during both seasons. Besides, applying cytokinin at 30 mg l⁻¹, produced higher potato chips defect (%), tuber firmness, tuber dry weight (%), and specific gravity as compared with untreated plants (control), during both seasons.

Foliar application of boron at 30 mg l⁻¹ recorded the best results of tubers quality content i.e., average values of starch, tuber sugars, TSS, and ascorbic acid of potato tuber as compared with control treatments, during both seasons, also, potato plants treated with 30 mg l⁻¹ of cytokinin gave the highest mean values of the average values of starch, tuber sugars, TSS and ascorbic acid of potato tuber as compared with control treatments, during both seasons.

Keywords: foliar application, potato crop, boron spray, cytokinin, tuber yield, tuber quality

INTRODUCTION

Potato (*Solanum tuberosum* L.) has an important economic role in Egypt, because of its role in the enrichment of the Egyptian economy by exporting potatoes. However, Egypt imports, annually, from 50000 to 55000 tons of potato seeds from the northwest European countries, particularly from Netherland and England planted in the summer season in January up to the middle of February. The fall and the winter plantation seeded with the stored seeds from the summer crop production, besides, a part of the summer crop exported to European and Arabian countries, and the rest of the crop is stored to supply the local market for consumption.

Cytokinins are plant hormones (upon biosynthesized endogenously), and plant growth regulators (upon biosynthesized exogenously), briefly, both promoting cell division and differentiation. Since the discovery of the first cytokinin, kinetin, by Miller *et al.* (1955), the number of chemicals compatible with the definition of cytokinins has grown to include a large array of natural and synthetic compounds, adenine and phenyl urea derivatives. The phenyl ureas constitute a group of synthetic cytokinins, some of which are highly active, e.g. CPPU [N-(2-chloro-4-pyridyl) -N'- phenylurea] (Takahashi *et al.*, 1978) and thidiazuron (Mok *et al.*, 1982).

Boron (B) also plays an important role in cell wall synthesis, sugar transport, cell division, cell development, auxin metabolism, good pollination and fruit set, seed development, synthesis of amino acids and proteins, nodule formation in legumes, and regulation of carbohydrate metabolism (El-Dissoky and Abdel-Kadar, 2013).

The availability of boron in soil affected considerably by soil pH. At low pH, most of the boron compounds are soluble but in the case of sandy soils having low pH, B is lost down the profile by leaching if rainfall is high. It occurs mostly in the organic matter in the surface soil and down the profile B content decreases. Under drought conditions, the deficiency of boron observed due to the lower availability of B in sub-soils (Prasad *et al.*, 2014).

Therefore, the present research was conducted to 1) evaluate the potato cultivar (Hermes) for tuber productivity and quality, 2) find out the optimal doses of cytokinin (6-BA) and boron levels as foliar applications to improve yields and economical returns to potato growers, and 3) examine the interaction effect between 6-BA and boron levels.

2. MATERIALS AND METHODS

2.1. Experimental site and arrangement:

Two field experiments were carried out during the summer seasons of 2018 and 2019, at the Experimental Farm of Faculty of Agriculture (Saba- Basha) at Abees region, Alexandria University, Egypt, to study the effect of foliar application of the various levels of both BA (as cytokinin) and Boron on vegetative growth, yield, and quality of 'Hermes' potato cultivar.

Before planting, random soil samples of 0-30 cm depth from different places of the planting field were collected and analyzed for some important chemical and physical properties as given in Table (1) according to the methods reported by Carter and Gregorich (2008).

2.2. Potato cultivation

The plant material of this investigation was Hermes cultivar which was exported from Scotland. Cut seedy explants were, approximately, 40 g in weight and each seedy explant contained 2 eyes planted on the 20th February during both seasons. Cutting seeds were planted under a drip irrigation system at 30 cm apart in the row and 0.8 m width in dry soil then irrigated. The experimental plot consisted of two rows with 10.00 m long and 0.80 m width; making an area of 16.00 m².

Table (1). Some physical and chemical properties of the experimental site during both seasons of the experimentation (2018 and 2019).

Soil properties	Season	
	2018	2019
<u>Mechanical Analysis:</u>		
Clay (%)	50.68	50.30
Silt (%)	10.00	10.70
Sand (%)	39.32	40.00
Textural class	Clay	Clay
pH (1:2 water suspension)	8.10	8.20
EC at 25°C (dS/m)	1.15	1.20
<u>Soluble cations (1:5, soil: water extract) meq/l</u>		
Ca ⁺⁺	3.08	3.02
Mg ⁺⁺	3.00	3.12
K ⁺	0.60	0.65
Na ⁺	4.65	5.01
<u>Soluble anions (1:5, soil: water extract) meq/l</u>		
HCO ₃ ⁻	1.91	2.11
Cl ⁻	8.41	9.15
SO ₄ ⁻	1.03	1.25
CaCO ₃ (%)	31.57	31.60
Available N (mg/kg soil)	98.23	95.50
Available P (mg/kg soil)	18.00	18.25
Available K (mg/kg soil)	1000	1050

2.3. The experimental treatments and design

Treatments consisted of two factors (two independent variables) as a foliar applicants, *i.e.*; four concentrations of Boron (B) as boric acid (H_3BO_3) [MW= 61.83g mol⁻¹] contained 17% B *i.e.* 0 (control), 10, 20 and 30 mg.l⁻¹ and four concentrations of synthetic Cytokinin or 6-benzyl adenine (BA) [MW= 225.255 g mol⁻¹, C₁₂H₁₁N₅] as 0 (control), 10, 20 and 30 mg.l⁻¹ separately and in combinations. Control plants sprayed with distilled water. The BA and Boric acid purchased from El Gomhouria Company for Chemicals, Alexandria, Egypt. All precautions and accuracy followed during weighing, dissolving, spraying of both independent variables. Foliar application of both B and BA was done afternoon during both seasons, to avoid deterioration caused by the effect of higher temperatures and ambient atmosphere on the applied items, at the time of application. Both conducted experiments were factorial experiments layout in a randomized complete block design (RCBD), with four replicates. Each replicate included 16 treatments. All determined treatments distributed randomly within each block. Potato plants sprayed with the allocated or assigned treatments twice during the growing seasons, the first one was at 60 days (at the stage when the plants had approximately 12-15 leaves) after planting. The second application was 15 days after the first one (or when plants had approximately 25-30 leaves). The recommended agricultural practices for commercial potato production followed. Harvesting accomplished after 120 days of planting during both years.

2.4. Experimental data collections

Ten plants from each treatment in each replication taken randomly and tagged for records of the total yield and tubers quality parameters.

2.4.1. Yield and its component measurements

2.4.1.1. Number of tubers per plant was determined just after harvesting time (120 days from planting) using the average number of tubers of 10 plants.

2.4.1.2. Average tuber fresh weight (g) was determined immediately after harvesting, by dividing the weight of tubers yield by tuber's number of 10 plants.

2.4.1.3. The number of tubers/10 kg, was determined by taking a random sample of 10 kg of tubers from the yield of each treatment and then counted. The number of potato tubers / 10 kg is a character of the processing companies to receive potatoes. The accepted range of the number of tubers / 10 kg is 72 – 112 tubers (Frito Lay Company, 1999), more than these numbers mean small tubers and consequently small slides of chips that reduce the chip quality. If it was less than that range it means the presence of over-size large

tubers, which may comprise hallow hart and cracks. Such defects may cause the rejection of the chips after processing.

2.4.1.4. Average tuber yield per plant (g/plant) calculated using the average weight of tubers of 10 plants.

2.4.1.5. Total tubers yield per feddan (ton/fed) was determined *via* the yield of the plot, which weighed, then converted into tons per feddan.

2.4.2. Tubers quality:

2.4.2.1. Chips defect evaluation, was calculated by showing the size limits (1/2 cm) for sugar browning and defects using chip – check chart method to determine the internal, external and undesirable color defects and dividing the defects into three categories; the first green from 0 – 8 % defects are acceptable potato chips, the second yellow 8 – 15 % defects are acceptable potato chips but with discarding the percentage over 8 % and the third red > 15 % defects are rejected and not suitable for processing according to (Frito Lay Company, 1999).

2.4.2.2. Firmness measure (Newton “N”): It was measured using UC. Firmness-tester (Li and Kader, 1999).

Pound-force (lbs) x 4.448 = Newton (N).

2.4.2.3. Tubers dry weight (%) was carried out *via* randomly tuber samples of 100 g of fresh weight which were dried in an electrical oven at 70° C till the constant weight, then the obtained value of tuber dry weight was calculated as a percentage.

2.4.2.4. Total soluble solids (TSS %), or degrees Brix (Bx°) is numerically equal to the percentage of sugar and others dissolved in a solution. This scale used in the food industry for measuring the approximate amount of sugars in fruit juices. Therefore, a solution that is 25 degrees Brix has 25g of sugar per 100 g of solution (Majid *et al.*, 2011). It estimated in the juice of the fresh tubers using a hand refractometer according to AOAC (1992). The calibration of the device done with a drop of distilled water. The reading adjusted to Brix° using the small setscrew on the back. Verifying the accuracy achieved with a drop of 5 or 10% sucrose solution (5 grams' sugar in 100 ml of distilled water). Prism rinsed between samples with distilled water and dried with soft paper tissues. Ten readings recorded per treatment.

2.4.2.5. Vitamin C (Ascorbic acid), the tubers' vitamin C was measured by titration with iodide potassium according to the method of Ranganna (1986) and calculated as mg vitamin C /100 g, f.w.

2.4.2.6. Specific gravity, was determined using the method described by Dinesh *et al.* (2005) and calculated from the equation of Smith (1977) as follows:

$$\text{Specific gravity} = \frac{\text{Weight of tuber in air}}{\text{Weight of tuber in the air} - \text{Weight of tuber underwater}}$$

2.4.3. Starch, reducing, non-reducing and total sugars (% D.W.) were determined for each tuber sample according to the method described by **Malik and Singh (1980)**.

2.4.4. Nutrients content of tubers (N, P, K, and B):

2.4.4.1. Tuber nitrogen content (%) was determined in digested plant material colorimetrically by Nessler's method (**Chapman and Pratt, 1978**) using Nessler solution (35 g KI /100 ml, D.W. + 20 g HgCl₂/500 ml, D.W + 120 g NaOH/250 ml, D.W.).

2.4.4.2. Tuber phosphorus content (%) was determined calorimetrically using the vanadate method from the solution obtained through wet digestion as described by **Singh et al. (2005)**.

2.4.4.3. Tuber potassium content (%) was measured using a flame photometer from the solution obtained through wet digestion as described by **Singh et al. (2005)**.

2.4.4.4. Tuber boron content (%) was determined colorimetrically by the Azomethine-H method at a spectrophotometer at wavelength 420 nm (**Wolf, 1971**).

2.5. Statistical Analysis

All obtained data of the present study were, statistically, analyzed according to the design used by the MSTAT-C computer software program (**Bricker, 1991**) and were tested by analysis of variance. The revised least significant difference test at 0.05 level of probability was used to compare the differences among the means of the various treatment combinations as illustrated by **Duncan (1955)** and **Gomez and Gomez (1984)**.

3. RESULTS AND DISCUSSION

All treatments under study significantly ($p \leq 0.05$) affected with the foliar application of Boron and BA as cytokinin, and their interactions during 2018 and 2019 growing seasons of the study.

Results presented under four main headings as follows: tuber yield characters, tuber physical quality characters, tuber chemical quality characters, and tubers N, P, K, and B contents.

3.1. Tuber yield characters

Yield components of potato tubers in the expression of No. of tubers per plant, tuber fresh weight

(g plant⁻¹), No. of tubers per 10 kg, total yield per plant (g) as well as total yield (ton fed⁻¹) as affected by foliar application with BA as cytokinin, boron and their interaction are presented in Table (2) for both seasons. Statistical analysis showed that using B at 30 mg l⁻¹ was superior and associated with the highest mean values of all the aforementioned traits compared to the control treatment. For example the increasing of tuber fresh weight was (19.37 and 18.34%) and for total yield, ton/fed was (107.29 and 123.25%), respectively in 2018 and 2019 growing seasons. The same trend realized for the other yield components during both seasons.

This positive effect of B in tuber yield parameters due to the low concentrations of B availability and low organic matter % in the soil before planting as shown in Table (1), in addition to the important roles of B in the plant (cell division, sugar transport, synthesis of amino acids and proteins,...etc). Moreover, these results are following that obtained by **Awad and Mansour (2007)**; **El-Dissoky and Abdel-Kadar (2013)**, and **Muthanna et al. (2017)**.

Concerning the effect of foliar application of BA as cytokinin on the mean values of yield and yield components of potato plants, data of Table (2) showed significant increases in all parameters under the study for the plants treated with any levels compared with the untreated plants, and the mean values of such traits still over than that obtained from the control treatment. In this respect, the highest mean values (8.67, 115.67, 87.24, 1002.86, and 16.71) were realized for the treatment of 30 mg.l⁻¹ cytokinin, while the lowest one (5.75, 99.66, 100.56, 573.05, and 9.55) were recorded for the untreated plants for No. of tubers per plant, tuber fresh weight (g plant⁻¹), No. of tubers per 10 kg, yield per plant (g), and total yield (ton fed⁻¹), respectively during the season of 2018. The same trend obtained in the season of 2019

Table (2). Average values of some yield characters of potato plants cv. 'Hermes' as affected by foliar application with Boron (B), Cytokinin (6-BA) and their combinations during the summer seasons of 2018 and 2019 .

Treatments	No. of tubers/plant		Tuber fresh weight (g)		Number of tubers/ 10 kg.		Yield/plant (g)		Total yield (ton/fed)		
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	
Main effect of B (mg l⁻¹)											
Control	4.75 ^c	5.08 ^c	95.24 ^d	85.88 ^d	105.00 ^a	116.49 ^a	452.39 ^c	436.27 ^c	7.54 ^c	7.27 ^c	
10	7.58 ^b	8.92 ^b	109.70 ^c	98.33 ^c	91.59 ^b	102.07 ^b	831.53 ^b	877.10 ^b	13.86 ^b	14.62 ^b	
20	7.92 ^{ab}	9.33 ^{ab}	111.50 ^b	99.88 ^b	90.09 ^c	100.46 ^c	883.08 ^{ab}	931.88 ^{ab}	14.72 ^{ab}	15.53 ^{ab}	
30	8.25 ^a	9.58 ^a	113.69 ^a	101.63 ^a	88.33 ^d	98.75 ^d	937.94 ^a	973.62 ^a	15.63 ^a	16.23 ^a	
Main effect of 6-BA (mg.l⁻¹)											
Control	5.75 ^b	6.50 ^c	99.66 ^d	89.79 ^d	100.56 ^a	111.59 ^a	573.05 ^d	583.64 ^d	9.55 ^d	9.73 ^d	
10	6.42 ^b	7.83 ^b	104.87 ^c	94.58 ^c	95.71 ^b	106.11 ^b	673.27 ^c	740.56 ^c	11.22 ^c	12.34 ^c	
20	7.67 ^a	9.00 ^a	109.93 ^b	98.61 ^b	91.55 ^c	101.93 ^c	843.16 ^b	887.49 ^b	14.05 ^b	14.79 ^b	
30	8.67 ^a	9.58 ^a	115.67 ^a	102.73 ^a	87.24 ^d	98.15 ^d	1002.86 ^a	984.15 ^a	16.71 ^a	16.40 ^a	
Interaction effects											
B (mg l⁻¹)	6-BA (mg l⁻¹)										
Control	Control	4.00 ⁱ	4.33 ⁱ	92.53 ⁿ	83.41 ^l	108.09 ^a	119.91 ^a	370.12 ^k	361.17 ^k	6.17 ^k	6.02 ^k
	10	4.33 ⁱ	4.67 ⁱ	94.76 ⁿ	85.37 ^{kl}	105.54 ^b	117.15 ^b	410.31 ^k	398.68 ^k	6.84 ^k	6.64 ^k
	20	5.00 ^{hi}	5.33 ^{hi}	95.64 ^{mn}	87.11 ^{jk}	104.57 ^b	114.82 ^c	478.20 ^{kl}	464.30 ^{jk}	7.97 ^{jk}	7.74 ^{jk}
	30	5.67 ^{gh}	6.00 ^{gh}	98.03 ^{lm}	87.65 ^j	102.02 ^c	114.10 ^c	555.83 ^{ij}	525.90 ^{ij}	9.26 ^{ij}	8.76 ^{ij}
10	Control	6.00 ^{fgh}	6.67 ^{fg}	100.10 ^{kl}	90.15 ⁱ	99.91 ^{cd}	110.93 ^d	600.60 ^{hij}	601.30 ^{hi}	10.01 ^{hij}	10.02 ^{hi}
	10	7.00 ^{def}	8.33 ^{de}	106.42 ^{hi}	96.14 ^g	94.02 ^{fg}	104.02 ^f	744.94 ^{fg}	800.85 ^{fg}	12.42 ^{fg}	13.35 ^{fg}
	20	8.00 ^{cd}	10.00 ^{abc}	112.59 ^{ef}	101.27 ^e	88.83 ^{ij}	98.76 ^h	900.72 ^{de}	1012.70 ^{cd}	15.01 ^{de}	16.88 ^{cd}
	30	9.33 ^{ab}	10.67 ^a	119.68 ^{bc}	105.75 ^{bc}	83.58 ^{lm}	94.57 ^{jk}	1116.61 ^{abc}	1128.35 ^{abc}	18.61 ^{abc}	18.81 ^{abc}
20	Control	6.33 ^{efg}	7.33 ^{ef}	101.78 ^{jk}	92.16 ^h	98.25 ^{de}	108.51 ^e	644.27 ^{ghi}	675.53 ^h	10.74 ^{ghi}	11.26 ^h
	10	7.00 ^{def}	9.00 ^{cd}	108.05 ^{gh}	97.59 ^{fg}	92.57 ^{gh}	102.48 ^{fg}	756.35 ^{fg}	878.31 ^{ef}	12.61 ^{fg}	14.64 ^{ef}
	20	8.67 ^{bc}	10.33 ^{ab}	114.93 ^{de}	102.17 ^{de}	87.01 ^{jk}	97.88 ^{hi}	996.44 ^{cd}	1055.42 ^{bc}	16.61 ^{cd}	17.59 ^{bc}
	30	9.67 ^{ab}	10.67 ^a	121.23 ^{ab}	107.61 ^b	82.52 ^{mn}	92.94 ^k	1172.29 ^{ab}	1148.20 ^{ab}	19.54 ^{ab}	19.14 ^{ab}
30	Control	6.67 ^{efg}	7.67 ^{ef}	104.21 ^{ij}	93.46 ^h	95.98 ^{ef}	107.00 ^e	695.08 ^{fgh}	716.84 ^{gh}	11.58 ^{fgh}	11.95 ^{gh}
	10	7.33 ^{de}	9.33 ^{bcd}	110.25 ^{fg}	99.24 ^f	90.71 ^{hi}	100.77 ^g	808.13 ^{ef}	925.91 ^{de}	13.47 ^{ef}	15.43 ^{de}
	20	9.00 ^{abc}	10.33 ^{ab}	116.58 ^{cd}	103.90 ^{cd}	85.79 ^{kl}	96.26 ^{ij}	1049.22 ^{bc}	1073.29 ^{bc}	17.94 ^{bc}	17.89 ^{bc}
	30	10.00 ^a	11.00 ^a	123.72 ^a	109.93 ^a	80.83 ⁿ	90.98 ^l	1237.20 ^a	1209.23 ^a	20.62 ^a	20.15 ^a

- Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

The present results are in agreement with those obtained by several authors (**Roumeliotis *et al.*, 2012; Kolachevskaya *et al.*, 2015 and 2017**) who declare that cytokinin can accelerate and improve potato tuberization. In addition, **Liu and Xie (2001)** declared that various concentrations of cytokinin increased the size and weight of mini-tuber potato. The results also in agreement with those obtained by **El-Shraiy and Hegazi (2010)** who reported that the highest mean values of tubers fresh and dry weights, obtained by CPPU as cytokinin at 20-ppm treatment, which led to an increase in yield values. In the same arrangement, **Njogu *et al.* (2015)** reported that an increase in the level of cytokinin as BA, led to, significant, increase in the number of tubers per plant and yield (ton/ha).

The interaction effect between boron and cytokinin was significant in both seasons (Table 2). Spraying both boron and cytokinin at 30 mg l⁻¹, resulted in the highest mean values of no. of tuber/plant, tuber fresh weight, no. of tuber/10 kg, yield/plant, and total yield (ton/fed) in both seasons.

3.2. Tuber physical quality characters

Data in Table (3) indicated the quality of the tubers, which, were expressed as potato chips defect (%), tuber firmness, tuber dry weight (%), and specific gravity as affected by foliar application with boron, BA as cytokinin, and their interactions in the growing seasons of 2018 and 2019.

Table (3) illustrated the effect of boron as a foliar application on the tuber physical quality characters as potato chips defect (%), tuber firmness, tuber dry weight (%), and specific gravity. Foliar application of boron increased significantly all tuber morphological parameters with increasing boron levels. All traits recorded a highly significant increase over control treatment and the highest mean values achieved at 30 mg.l⁻¹ from boron. The rate of increase was 85.79, 17.09, 14.18, and 2.03% for potato chips defect (%), tuber firmness (N/mm), tuber dry weight (%), and specific gravity, respectively during the season of 2018. The same trend obtained in the season of 2019. The enhanced dry matter production may attribute to the greater accumulation of photosynthesis products by vegetative parts. These effects of boron foliar spray on the previous parameters of potato quality may refer to the role of boron on sugar transport to parts of storage (tubers), also to its role in the synthesis of proteins and regulation of carbohydrate metabolism. These results are following that obtained by those **El-Banna and Abd El-Salam (2005), Awad and Mansour (2007), El-Dissoky and Abdel-Kadar (2013)**. All of them studied the effect of boron on potato plant and they found that the quality of potato tuber parameters (i.e. dry matter, specific gravity, and tuber firmness) significantly increased with foliar B application

Table (3). Average values of some quality determination of potato tubers cv. 'Hermes' characteristics as affected by foliar application with Boron (B), Cytokinin (6-BA) and their combinations during the summer seasons of 2018 and 2019.

Treatments	Potato chips defect (%)		Tuber firmness (N/mm)		Tuber dry matter (%)		Specific gravity		
	2018	2019	2018	2019	2018	2019	2018	2019	
Main effect of B (mg l⁻¹)									
Control	5.70 ^c	5.73 ^c	11.82 ^b	11.74 ^b	14.95 ^d	17.32 ^d	1.034 ^d	1.048 ^c	
10	9.59 ^b	9.94 ^b	11.77 ^b	11.71 ^b	16.62 ^c	19.82 ^c	1.051 ^c	1.062 ^b	
20	10.84 ^a	10.94 ^a	12.18 ^b	12.13 ^b	16.85 ^b	20.17 ^b	1.053 ^b	1.067 ^a	
30	10.59 ^a	10.94 ^a	13.84 ^a	13.82 ^a	17.07 ^a	20.59 ^a	1.055 ^a	1.069 ^a	
main effect of 6-BA (mg l⁻¹)									
Control	7.09 ^c	7.14 ^c	11.32 ^c	11.27 ^c	15.50 ^d	18.16 ^d	1.038 ^d	1.054 ^c	
10	8.09 ^c	8.40 ^{bc}	12.08 ^b	12.04 ^b	16.12 ^c	19.06 ^c	1.045 ^c	1.060 ^b	
20	9.87 ^b	9.94 ^b	12.42 ^b	12.34 ^b	16.65 ^b	19.91 ^b	1.051 ^b	1.065 ^a	
30	11.68 ^a	12.09 ^a	13.79 ^a	13.75 ^a	17.22 ^a	20.76 ^a	1.058 ^a	1.067 ^a	
Interaction effects									
B (mg l⁻¹)		6-BA (mg l⁻¹)							
Control	Control	3.67 ^g	3.81 ^h	10.47 ^{gh}	10.30 ^{gh}	14.55 ⁿ	16.86 ^p	1.029 ^j	1.045 ⁱ
	10	5.67 ^{fg}	5.58 ^{gh}	11.33 ^{fg}	11.25 ^{fg}	14.85 ^m	17.23 ^o	1.033 ⁱ	1.048 ⁱ
	20	6.57 ^{ef}	6.63 ^{fg}	11.40 ^{fg}	11.30 ^{fg}	15.08 ^l	17.44 ⁿ	1.035 ⁱ	1.049 ^{hi}
	30	6.90 ^{ef}	6.91 ^{e-g}	14.07 ^{ab}	14.10 ^{ab}	15.34 ^k	17.76 ^m	1.038 ^h	1.051 ^{ghi}
10	Control	7.87 ^{d-f}	7.97 ^{d-g}	10.27 ^h	10.25 ^h	15.65 ^j	18.21 ^l	1.039 ^h	1.055 ^{gh}
	10	8.70 ^{de}	9.23 ^{c-e}	11.67 ^{ef}	11.60 ^{ef}	16.24 ^h	19.34 ⁱ	1.046 ^f	1.062 ^{ef}
	20	9.57 ^{cd}	9.72 ^{cd}	11.80 ^{ef}	11.70 ^{ef}	16.94 ^f	20.35 ^f	1.054 ^{de}	1.068 ^{cde}
	30	12.20 ^b	12.85 ^b	13.33 ^{bcd}	13.30 ^{bcd}	17.63 ^c	21.37 ^c	1.063 ^b	1.064 ^{ef}
20	Control	8.40 ^{de}	8.38 ^{d-f}	11.53 ^f	11.50 ^f	15.84 ⁱ	18.55 ^k	1.042 ^g	1.057 ^{fg}
	10	9.00 ^{de}	9.39 ^{c-e}	11.93 ^{ef}	11.90 ^{ef}	16.55 ^g	19.64 ^h	1.048 ^f	1.065 ^{de}
	20	11.67 ^{bc}	11.70 ^{bc}	12.60 ^{de}	12.50 ^{de}	17.13 ^e	20.74 ^e	1.056 ^{cd}	1.071 ^{bcd}
	30	14.30 ^a	14.29 ^a	12.67 ^{de}	12.60 ^{de}	17.86 ^b	21.74 ^b	1.064 ^{ab}	1.076 ^{ab}
30	Control	8.40 ^{de}	8.38 ^{d-f}	13.00 ^{cd}	13.01 ^{cd}	15.96 ⁱ	19.03 ^j	1.043 ^g	1.058 ^{fg}
	10	9.00 ^{de}	9.39 ^{c-e}	13.40 ^{bcd}	13.42 ^{bcd}	16.83 ^f	20.05 ^g	1.052 ^e	1.066 ^{de}
	20	11.67 ^{bc}	11.70 ^{bc}	13.87 ^{bc}	13.86 ^{bc}	17.44 ^d	21.12 ^d	1.058 ^c	1.073 ^{abc}
	30	13.30 ^a	14.29 ^a	15.07 ^a	15.00 ^a	18.06 ^a	22.16 ^a	1.066 ^a	1.079 ^a

-Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

Data presented in Table (3) indicated that foliar application with BA as cytokinin gave higher values for previous parameters than those obtained for the untreated plants. The highest mean values obtained with the treatment of 30 mg.l⁻¹ cytokinin. Comparing with the control treatment, which recorded the lowest values. The highest value was (11.68, 13.79, 17.22, and 1.058) for potato chips defect (%), tuber firmness, tuber dry weight (%), and specific gravity, respectively during both seasons.

As for the interaction between various concentrations of both variables under the study, the results tabulated in Table (3) demonstrated that the treated plants with 30 mg.l⁻¹ boron combined with 30 mg.l⁻¹ BA, showed the highest mean values for all

characters (*i.e.* potato chips defect (%), tuber firmness, tuber dry weight (%), and specific gravity) compared to the other treatments during both seasons of the study. Potato chips defect (%) recorded 13.30 and 14.29%, tuber firmness recorded 15.07 and 15.00 N/mm, tuber dry matter recorded 18.06 and 22.16%, and specific gravity were 1.066 and 1.079 during both seasons.

3.3. Tuber chemical quality characteristics

The comparison among the means of the various combined treatments of boron and BA as shown in Table (4) has reflected significant differences between the average values of starch, tuber sugars, TSS, and ascorbic acid of potato tuber during both seasons of 2018 and 2019.

Regarding the effect of foliar application of boron, the data in Table (4) revealed that the addition of all levels significantly increased the mean values of starch, tuber sugars, TSS, and ascorbic acid in potato tubers as compared to the control treatment. In other words; the highest values (42.82 and 45.29%) for starch, (2.82 and 3.12%) for reducing sugar, (4.30 and 4.12%) for non-reducing sugar, (7.12 and 7.24%) for total sugars, (7.48 and 7.59%) for TSS% and (19.62 and 21.61 mg/100g) for ascorbic acid, respectively during 2018 and 2019 seasons realized for the 30 mg.l⁻¹. In the plant, boron plays a major role in the translocation and production of sugars. In the presence of boron, simple organic sugars (Glucose 1-P) will form

carbohydrates and complex sugar molecules. In the absence of boron, these simple sugars will form phenols (Quinone phenols), which will accumulate, attract insects and increase disease pressure. When boron is deficient in tissue cambial cells cease to divide but cell elongation continues in growing zones, and as a result, phloem and xylem cells are displaced from their original position so which will leads to the inactivation of vascular tissue. Inactivation of phloem cells leads to a failure of translocation of carbohydrates and sugars to tubers. These results are in agreement with **Manjunath et al. (2018)**, who indicated that using boron increased reducing, non-reducing, total sugar and TSS%.

Table (4). Average values of some quality determination of potato tubers cv. 'Hermes' characteristics as affected by foliar application with Boron (B), Cytokinin (6-BA) and their combinations during the summer seasons of 2018 and 2019.

Treatments	Tuber quality												
	Starch		Reducing sugars		Non-reducing sugars		Total sugars		TSS %	Ascorbic acid (mg/100g)			
	2018	2019	2018	2019	2018	2019	2018	2019					
B mg.l⁻¹ (main effect)													
Control	40.28 ^d	41.73 ^d	2.10 ^d	2.29 ^d	3.73 ^d	3.81 ^c	5.83 ^d	6.10 ^d	6.57 ^d	6.77 ^d	17.82 ^d	18.96 ^d	
10	42.18 ^c	44.50 ^c	2.67 ^c	2.93 ^c	4.16 ^c	4.03 ^b	6.83 ^c	6.97 ^c	7.25 ^c	7.34 ^c	19.21 ^c	21.06 ^c	
20	42.50 ^b	44.93 ^b	2.74 ^b	3.00 ^b	4.24 ^b	4.06 ^b	6.98 ^b	7.06 ^b	7.40 ^b	7.47 ^b	19.42 ^b	21.34 ^b	
30	42.82 ^a	45.29 ^a	2.82 ^a	3.12 ^a	4.30 ^a	4.12 ^a	7.12 ^a	7.24 ^a	7.48 ^a	7.59 ^a	19.62 ^a	21.61 ^a	
6-BA mg.l⁻¹ (main effect)													
Control	40.87 ^d	42.63 ^d	2.29 ^d	2.47 ^d	3.88 ^d	3.90 ^d	6.16 ^d	6.37 ^d	6.97 ^c	7.18 ^c	18.26 ^d	19.63 ^d	
10	41.70 ^c	43.60 ^c	2.48 ^c	2.72 ^c	4.05 ^c	3.95 ^c	6.53 ^c	6.68 ^c	7.04 ^b	7.24 ^c	18.74 ^c	20.41 ^c	
20	42.22 ^b	44.60 ^b	2.68 ^b	2.96 ^b	4.21 ^b	4.04 ^b	6.89 ^b	6.99 ^b	7.32 ^a	7.52 ^b	19.29 ^b	21.12 ^b	
30	42.99 ^a	45.61 ^a	2.89 ^a	3.20 ^a	4.30 ^a	4.13 ^a	7.19 ^a	7.33 ^a	7.36 ^a	7.59 ^a	19.78 ^a	21.81 ^a	
Interaction effects													
B (mg.l⁻¹)		6-BA (mg.l⁻¹)											
Control	Control	39.76 ^l	41.13 ^p	1.99 ^o	2.14 ^m	3.63 ^l	3.76 ^j	5.62 ^o	5.90 ^o	6.48 ^l	6.72 ^o	17.55 ^o	18.16 ^p
	10	40.35 ^k	41.52 ^o	2.06 ⁿ	2.23 ^l	3.71 ^{kl}	3.78 ^{ij}	5.77 ⁿ	6.00 ⁿ	6.54 ^k	6.76 ^o	17.71 ⁿ	18.96 ^o
	20	40.34 ^k	41.93 ⁿ	2.14 ^m	2.35 ^k	3.76 ^{jk}	3.84 ^{hi}	5.90 ^m	6.19 ^m	6.57 ^k	6.84 ⁿ	17.92 ^m	19.21 ⁿ
	30	40.65 ^{jk}	42.33 ^m	2.22 ^l	2.44 ^j	3.83 ^{jk}	3.85 ^h	6.04 ^l	6.29 ^l	6.68 ^j	6.90 ^m	18.11 ^l	19.51 ^m
10	Control	40.91 ^j	42.73 ^l	2.33 ^k	2.50 ^{ij}	3.88 ⁱ	3.91 ^{gh}	6.20 ^k	6.41 ^k	6.97 ^{de}	7.20 ^l	18.29 ^k	19.84 ^l
	10	41.85 ^h	43.93 ⁱ	2.54 ⁱ	2.80 ^g	4.10 ^{fg}	4.00 ^{def}	6.64 ^h	6.80 ⁱ	7.10 ^h	7.25 ^k	18.88 ^h	20.61 ⁱ
	20	42.55 ^{ef}	45.09 ^f	2.78 ^f	3.08 ^e	4.28 ^{cd}	4.06 ^{cd}	7.06 ^e	7.14 ^f	7.48 ^{de}	7.60 ^f	19.57 ^e	21.48 ^f
	30	43.43 ^{bc}	46.24 ^c	3.03 ^c	3.37 ^c	4.40 ^b	4.15 ^b	7.43 ^c	7.51 ^c	7.45 ^e	7.69 ^e	20.09 ^c	22.31 ^c
20	Control	41.25 ⁱ	43.13 ^k	2.37 ^k	2.53 ⁱ	3.97 ^h	3.94 ^{fg}	6.34 ^j	6.47 ^k	7.23 ^g	7.32 ^j	18.51 ^j	20.13 ^k
	10	42.17 ^g	44.33 ^h	2.62 ^h	2.87 ^g	4.16 ^{ef}	4.00 ^{def}	6.78 ^g	6.88 ^h	7.21 ^g	7.39 ⁱ	19.09 ^g	20.89 ^h
	20	42.86 ^{de}	45.53 ^e	2.87 ^e	3.15 ^e	4.37 ^{bc}	4.12 ^{bc}	7.24 ^d	7.27 ^e	7.60 ^{bc}	7.75 ^d	19.79 ^d	21.77 ^e
	30	43.70 ^b	46.73 ^b	3.11 ^b	3.45 ^b	4.46 ^{ab}	4.19 ^b	7.57 ^b	7.63 ^b	7.54 ^{cd}	7.80 ^c	20.27 ^b	22.57 ^b
30	Control	41.55 ^{ef}	43.52 ^j	2.46 ^j	2.70 ^h	4.02 ^{gh}	3.97 ^{efg}	6.48 ⁱ	6.68 ^j	7.18 ^g	7.47 ^h	18.68 ⁱ	20.37 ^j
	10	42.42 ^{fg}	44.64 ^g	2.70 ^g	2.99 ^f	4.23 ^{de}	4.03 ^{de}	6.94 ^f	7.02 ^g	7.30 ^f	7.54 ^g	19.28 ^f	21.18 ^g
	20	43.13 ^{cd}	45.86 ^d	2.93 ^d	3.26 ^d	4.41 ^b	4.12 ^{bc}	7.35 ^c	7.38 ^d	7.64 ^b	7.88 ^b	19.89 ^d	22.04 ^d
	30	44.17 ^a	47.13 ^a	3.20 ^a	3.53 ^a	4.51 ^a	4.35 ^a	7.71 ^a	7.88 ^a	7.75 ^a	7.95 ^a	20.64 ^a	22.85 ^a

-Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

Data in Table (4) detected that all treatments had a pronounced positive effect on the mean values on tuber quality under investigation as compared to the untreated plants. All traits increased with increasing levels of BA until to 30 mg.l⁻¹. Foliar application of boron at 30 mg.l⁻¹, recorded the highest mean values offer mentioned tuber chemical parameters during both seasons. These results are following that obtained by **Rosin *et al.* (2003)** on potato, who indicated that increasing of cytokinin concentration owing to antisense suppression of potato box gene, brought about the higher increments of starch accumulation. In addition, **El-Shraiy and Hegazi (2010)** reported that cytokinin at 10 ppm treatment, significantly increased the total soluble sugars of potato tubers. Moreover, On tomato, **Mousawinejad *et al.* (2014)** reported that foliar application of CPPU as cytokinin at 10 and 20 mg l⁻¹ on the fruit affected, significantly, biochemical characteristics such as sugar, treatable acids, and vitamin C contents.

Concerning interaction effects between both variables of the present study, the tabulated results (Table 4) reflected that as both independent variable concentrations increased; the given traits, average values increased significantly ($p \leq 0.05$) in a direct proportionate relationship, especially when potato plants were foliar treated with 30 mg.l⁻¹ of boron in combination with 30 mg.l⁻¹ of BA as cytokinin; the

particular treatment gave rise to the highest significant average values for fruit content of starch as 44.17 and 47.13%, reducing sugar as 3.20 and 3.53 %, non-reducing sugars as 4.51 and 4.35%, total sugars as 7.71 and 7.88%, TSS as 7.75 and 7.95%, and ascorbic acid as 20.64 and 22.85 mg/100g compare with average values of control plants measurements, which were 39.76 and 41.13% for starch, 1.99 and 2.14 % for reducing sugar, 3.63 and 3.76 (%) for non-reducing sugar, 5.62 and 5.90 (%) for total sugar, and 6.48 and 6.72 % for TSS and finally 17.55 and 18.16 mg/100g for ascorbic acid during both seasons of the study 2018 and 2019, each in turn.

3.4. Tubers N, P, K, and B contents

Nutritional elements of potato tubers; Nitrogen, Phosphorus, Potassium, and Boron concentrations as affected by the treatments under investigations presented in Table (5). Results in Table (5) demonstrated that; foliar application of boron with different levels significantly increased the mean values of all nutritional elements over those obtained for the control treatment. The highest mean values of all nutrients content recorded at the level of 30 mg.l⁻¹. Comparing with the control treatment, the rate of increases was accounted to be 66.94, 43.83, 42.24, and 12.77 (%) over the control treatment for N, P, K, and B, respectively in the season of 2018, and the same trend happened in the second season.

Table (5). Average values of some chemical determination of potato tubers cv. 'Hermes' characteristics as affected by foliar application with Boron (B), cytokinin (6-BA) and their combinations during the summer seasons of 2018 and 2019.

Treatments		Nutrient contents of tubers (d.w.)							
		N%		P%		K%		B (mg/kg)	
		2018	2019	2018	2019	2018	2019	2018	2019
B mg.l⁻¹ (main effect)									
Control		1.21 ^d	1.47 ^d	0.162 ^d	0.189 ^d	1.87 ^d	1.97 ^d	16.92 ^d	18.50 ^d
10		1.84 ^c	2.10 ^c	0.218 ^c	0.239 ^c	2.48 ^c	2.69 ^c	17.73 ^c	19.34 ^c
20		1.92 ^b	2.19 ^b	0.226 ^b	0.246 ^{cb}	2.58 ^b	2.79 ^b	18.59 ^b	20.28 ^b
30		2.02 ^a	2.27 ^a	0.233 ^a	0.252 ^a	2.66 ^a	2.88 ^a	19.08 ^a	20.83 ^a
6-BA mg.l⁻¹ (main effect)									
Control		1.41 ^d	1.66 ^d	0.181 ^d	0.205 ^d	2.06 ^d	2.20 ^d	17.68 ^d	19.26 ^d
10		1.63 ^c	1.90 ^c	0.200 ^c	0.222 ^c	2.28 ^c	2.46 ^c	18.02 ^c	19.67 ^c
20		1.85 ^b	2.12 ^b	0.220 ^b	0.242 ^b	2.51 ^b	2.71 ^b	18.21 ^b	19.90 ^b
30		2.09 ^a	2.35 ^a	0.239 ^a	0.258 ^a	2.74 ^a	2.97 ^a	18.41 ^a	20.11 ^a
Interaction effects									
B (mg.l⁻¹)	6-BA (mg.l⁻¹)								
Control	Control	1.08 ^p	1.30 ^p	0.151 ^p	0.177 ^k	1.73 ^p	1.79 ^p	16.64 ⁱ	18.15 ^o
	10	1.17 ^o	1.43 ^o	0.159 ^o	0.182 ^k	1.82 ^o	1.89 ^o	16.84 ^k	18.43 ⁿ
	20	1.25 ⁿ	1.51 ⁿ	0.167 ⁿ	0.198 ^j	1.92 ⁿ	2.04 ^m	16.96 ^k	18.60 ^m
	30	1.34 ^m	1.62 ^m	0.174 ^m	0.201 ^{ij}	2.00 ^m	2.15 ⁿ	17.22 ^j	18.82 ^l
10	Control	1.43 ^l	1.70 ^l	0.182 ^l	0.208 ^{hi}	2.08 ^l	2.25 ^l	17.42 ⁱ	19.04 ^k
	10	1.70 ⁱ	1.98 ⁱ	0.206 ⁱ	0.228 ^f	2.35 ⁱ	2.55 ⁱ	17.62 ^h	19.22 ^j
	20	1.98 ^f	2.22 ^f	0.229 ^f	0.249 ^d	2.60 ^f	2.82 ^f	17.81 ^h	19.45 ⁱ
	30	2.24 ^c	2.50 ^c	0.254 ^c	0.271 ^b	2.90 ^c	3.14 ^c	18.05 ^g	19.65 ^h
20	Control	1.52 ^k	1.78 ^k	0.191 ^k	0.214 ^{gh}	2.18 ^k	2.34 ^k	18.23 ^g	19.83 ^e
	10	1.79 ^h	2.05 ^h	0.214 ^h	0.237 ^e	2.43 ^h	2.64 ^h	18.55 ^{ef}	20.18 ^f
	20	2.04 ^e	2.32 ^e	0.237 ^e	0.257 ^c	2.71 ^e	2.94 ^e	18.74 ^{de}	20.44 ^e
	30	2.33 ^b	2.59 ^b	0.260 ^b	0.277 ^{ab}	2.99 ^b	3.24 ^b	18.86 ^d	20.65 ^d
30	Control	1.62 ^j	1.86 ^j	0.198 ^j	0.221 ^{fg}	2.26 ^j	2.43 ^j	18.42 ^f	20.03 ^f
	10	1.88 ^g	2.13 ^g	0.221 ^g	0.241 ^e	2.52 ^g	2.74 ^g	19.06 ^c	20.85 ^c
	20	2.15 ^d	2.41 ^d	0.245 ^d	0.262 ^c	2.81 ^d	3.03 ^d	19.33 ^b	21.09 ^b
	30	2.42 ^a	2.68 ^a	0.268 ^a	0.284 ^a	3.06 ^a	3.34 ^a	19.53 ^a	21.34 ^a

-Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

The increase of N content maybe returns to the role of B in the synthesis of amino acids and proteins, while the increase in P content may be attributed to the role of B in root tips, whereas membrane-bound ATPase activity influenced by Boron levels in the root (Canada 2002). The increase in K content may related to the synergism relationship between K and B at sugar and carbohydrate transport (Mengele and Kirkby 1978). The increase in B content certainly due to the increase of boron levels in the media. Similar results were obtained by El-Banna and Abd El-Salam (2005) who indicated that treated potato plants with different foliar spraying rates of B (50 and 75 ppm) significantly, recorded the highest concentrations of N, K, and B in

plants. Also, El-Mahdy (2007) showed that foliar spray of B at a rate of 75 ppm increased pepper N, P, K, and B and its uptake. Moreover, El-Said (2009) showed that foliar application of boron at 100 ppm significantly increases N, P, and K contents in sweet pepper plant leave. In the same line, El-Dissoky and Abdel-Kadar (2013) found that the uptake of N, P, and K significantly increased by foliar B application in the potato plant.

The different comparisons tabulated in Table (5) indicated that the average values of all nutritional elements in potato tubers significantly increased because of spray potato plant with the different levels of BA as cytokinin. The highest mean values for the

previously mentioned traits found to be associated with the addition of 30 mg.l⁻¹ for N, P, K, and B elements. The average mean values of all nutritional elements of potato for both seasons significantly increased over those obtained for the control treatment. The highest mean values recorded as (2.09 and 2.35%) for N content, (0.239 and 0.258%) for P content, (2.74 and 2.97%) for K content and (18.41 and 20.11 mg/kg) for B content, respectively during 2018 and 2019 seasons.

Nutritional element concentrations in potato tuber as affected by the interaction between all treatments under study tabulated in Table (5). Data of this table revealed that the mean values of the most nutritional elements in potato tuber tended to increase over the control treatment because of the interaction between the studied treatments. In this respect, the most suitable treatment which realized the highest values (2.42, 0.268, 3.06, and 19.53 for N %, P, K % and B mg/kg) during 2018 season were connected with 30 mg.l⁻¹ boron+ 30 mg.l⁻¹ BA. Besides, these mean values tended to increase than those obtained for the control treatment (1.08, 0.151, 1.73, and 16.64 for N, P, and K (%), and B mg/kg, respectively in 2018). The same trend was true during the 2019 season.

Generally, the foliar application of both boron and cytokinin solution had a significant effect on potato yield, tuber physical and chemical quality and nutritional content. Therefore, the present study recommend a foliar application of boron plus cytokinin at rate of 30 mg l⁻¹ to obtain the highest yield of potato and good quality tubers.

RECOMMENDATIONS

Practically, from the above-mentioned results and under the conditions of this research, it could concluded that foliar application of boron at 30 mg l⁻¹ and cytokinin at 30 mg l⁻¹, is the appropriate combination of both independent variables for the best growth characters, yield, and its components and chemical composition.

Further research on cytokinin as 6-benzyl adenine is important because of its high content of unprocessed natural nutrients necessary for plant growth and quality; also, it protects the environment from pollution.

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الملخص العربي

إنتاجية وجودة البطاطس متأثرة بالرش الورقي للبورون والسيتوكينين

سماهر مالك^١ - على إبراهيم على عبيدو^١ - جمال عبد الناصر خليل^٢ -محمد عبد الحميد زيتون^٣ - على عدنان عوض جبل^١

١ قسم الإنتاج النباتي - كلية الزراعة ساجا باشا - جامعة الإسكندرية

٢ قسم الأراضي والكيمياء الزراعية - كلية الزراعة ساجا باشا - جامعة الإسكندرية

٣ قسم علوم الأغذية - كلية الزراعة ساجا باشا - جامعة الإسكندرية

تم إجراء تجربتين حقليتين خلال الموسمين الصيفيين ٢٠١٨ و ٢٠١٩ ، في المزرعة الخاصة بكلية الزراعة ساجا باشا، في منطقة أبيض ، محافظة الاسكندرية، مصر، لدراسة تأثير الرش الورقي بمستويات مختلفة من البورون و السيتوكينين على محصول البطاطس ، وجودة البطاطس صنف 'Hermes'.

تمت زراعة البطاطس باستخدام قطع التقاوى في ٢٠ فبراير في كلا الموسمين تحت نظام الري بالتقطيع على مسافة ٣٠ سم بين النباتات في خطوط طولها ١٠ متر وعرضها ٠.٨ متر في تربة جافة ثم تم ريها.

تكونت المعاملات من عاملين الرش الورقي وكان العامل الأول هو البورون (حمض البوريك B) بأربعة تركيزات هي: صفر (كنترول)، ١٠ ، ٢٠ ، و ٣٠ مجم /لتر. اما العامل الثاني فكان السيتوكينين BA بأربعة تركيزات هي: صفر (كنترول)، ١٠ ، ٢٠ ، و ٣٠ مجم /لتر. وكانت المعاملات التجريبية عددها ١٦ معاملة وتم تنفيذها في تجربة عاملية بتصميم القطاعات كاملة العشوائية بأربع مكررات. تم رش نباتات البطاطس بالمعاملات المذكورة مرتين اثناء موسم النمو - الأولى بعد ٦٠ يوم من الزراعة والثانية بعدها ب ١٥ يوم.

يمكن تلخيص النتائج التي تم الحصول عليها على النحو التالي:

اعطى الرش الورقي بالبورون بتركيز ٣٠ مجم/لتر اعلى متوسطات قيم لكل من عدد الدرنات/نبات، والوزن الطازج للدنة، عدد الدرنات/١٠كجم، محصول الدرنات جرام/نبات، المحصول الكلي للدرنات (طن/فدان) مقارنة بمعاملة الكنترول (عدم الرش) خلال موسمي الدراسة. على الجانب الاخر، سجل الرش الورقي بالسيتوكينين بتركيز ٣٠ مجم/لتر اعلى عدد درنات/نبات، الوزن الطازج للدنة، عدد الدرنات/١٠ كجم ، المحصول/نبات (جم) ، المحصول الكلي(طن/فدان) مقارنة بمعاملة الكنترول والمعاملات الأخرى خلال كلا الموسمين.

أوضحت النتائج ان الرش الورقي بالبورون عند تركيز ٣٠ مجم/لتر أدى الى زيادة ملحوظة لكلا من رقائق البطاطس %، صلابة الدرنات، الوزن الجاف للدنة و الكثافة النوعية مقارنة بمعاملة الكنترول خلال كلا الموسمين. كما ان الرش الورقي بالسيتوكينين بتركيز ٣٠ مجم/لتر اعطى اعلى رقائق للبطاطس %، صلابة الدرنات، الوزن الجاف للدنة، الكثافة النوعية مقارنة بمعاملة الكنترول خلال كلا الموسمين.

سجل الرش الورقي بالبورون عند تركيز ٣٠ مجم/لتر افضل النتائج لجودة الدرنات من النشا، السكريات الكلية ، المواد الصلبة و فيتامين سي مقارنة بمعاملة الكنترول خلال كلا الموسمين. أعطت نباتات البطاطس الى تم رشها بالسيتوكينين بتركيز ٣٠مجم/لتر اعلى متوسط قيم النشا، السكريات الكلية والمواد الصلبة وفيتامين سي خلال كلا الموسمين. سجل محتوى الأوراق من النيتروجين، الفوسفور ، البوتاسيوم والبورون اعلى قيم عند الرش بتركيز ٣٠ مجم/لتر من البورون والسيتوكينين مقارنة بمعاملة الكنترول في كلا الموسمين.

المعاملة المشتركة من البورون بتركيز ٣٠ مجم/لتر مع السيتوكينين بتركيز ٣٠ مجم/لتر أعطت اعلى القيم للنمو والمحصول وصفات جودة الدرنات. وقد كانت الزيادة في المحصول تعادل ١٢٢.٧ و ١٣٠٪ مقارنة بمعاملة الكنترول لكلا الموسمين.

وعلى هذا توصي الدراسة الحالية بالرش الورقي للبطاطس بالبورون بتركيز ٣٠ مجم/لتر مع السيتوكينين بتركيز ٣٠ مجم/لتر لاعطاء اعلى محصول وصفات جودة للبطاطس.