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ALLEVIATION OF WATER STRESS IN CORIANDER PLANTS BY FOLIAR APPLICATION OF BORON

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ABSTRACT: In order to combat the adverse effects of water stress on coriander plants grown in a semi-arid region, this study was undertaken during 2020 and 2021 seasons. Field experiments were conducted at the Experimental Farm of South Tahrir Research Station in El-Bustan area, El-Beheira Governorate, Agricultural Research Center, Egypt. The influence of different irrigation levels and boron foliar spray on the vegetative growth, yield and essential oil of coriander plant (*Coriandrum sativum* L.) grown in a sandy soil were investigated. The treatments comprised of four-drip irrigation levels (60, 80, 100 and 120%) of crop evapotranspiration (ETc) and four boron rates (0, 50, 100 and 150 ppm) in a split plot design with three replicates. The results revealed that both irrigation and boron foliar application significantly affected growth characteristics, yield and essential oil content of coriander plant. Maximum mean values of growth characteristics and fruit yield were achieved with the highest amount of irrigation water (120% ETc) which showed non-significant differences with the lower irrigation level (100% ETc). The least mean values of growth characteristics and yield parameters were obtained at an irrigation level of (60% ETc) in untreated boron application. The results showed that essential oil yield increased at moderate water stress (80% ETc) with boron foliar application at 150 ppm thereby improving fruit quality. The highest values of crop coefficient (K_c) of coriander were obtained in April with a mean value of 0.64 at the experimental site. The mean values of water consumptive use were 1201 m^3/feddan during the growing season. Therefore, spraying boron at 150 ppm could serve as a promising approach under moderate water stress (80%) conditions to maximize coriander yield and quality in sandy soils.

Keywords: drip irrigation, boron foliar spray, water stress, coriander

INTRODUCTION

Coriander (*Coriandrum sativum* L., Apiaceae Family) is an annual; spice herb originates from the Mediterranean and Middle Eastern areas. The dried fruits are used for nutraceutical and pharmaceutical purposes. The essential oil extracted from fruits possess antioxidant (Reddy *et al.*, 2012), antimicrobial (Casetti *et al.*, 2012), antilipidemic (Kousar *et al.*, 2011) and anti-inflammatory activities (Wu *et al.*, 2010).

Water stress is one of the environmental stresses that affect coriander productivity. Coriander is a sensitive plant to water stress (Ghamarnia and Daichin, 2013). In arid and semi-arid regions, drought causes severe morphological, physiological and biochemical changes that adversely affect plant growth and development. Water stress largely affects the growth and yield of herbs and spice crops and alters their aromatic constituents (Jordan *et al.*, 2009; Hassan and

Ali, 2016). Water stress induces oxidative stress in plants, which leads to formation of free radicals in chloroplasts and mitochondria (de Carvalho, 2008).

Therefore, to maintain high crop yields under water stress, it is necessary to find out alternative approaches that could increase the tolerance of plants to such stress. One of these approaches is by using micronutrients.

Boron is one of the important micronutrients for plants. In the cell wall of higher plants, boron forms a complex with rhamnogalacturonan (B-RG-II), that crosslinks the chains of pectic polysaccharides in cell walls (Matoh, 1997). Boron improves photosynthesis and integrity of membrane, improves sugar transport, maintains carbohydrate, protein and RNA metabolism (Hajiboland, 2012).

Micronutrients play an essential role in improving crop growth as well as mitigating water stress in plants as reported by several authors (Karim *et al*., 2012; Semida *et al*., 2021). However, the impact of boron foliar application to alleviate the adverse effects of water stress on coriander has not been well documented. Therefore, this study aimed to assess the effect of different irrigation levels and boron foliar application on the vegetative growth, yield and essential oil yield as well as to determine crop coefficient values and water consumptive use of coriander plants grown in sandy soils.

MATERIALS AND METHODS

Experimental site:

Field experiments were carried out during two consecutive seasons 2020 and 2021 at South Tahrir Experimental Farm, Horticulture Research Station, El-Bustan area, El-Behiera Governorate, Egypt (latitude 33°30' 1.4"N, longitude 30°19' 10.9"E and altitude 21 m above sea level) to study the influence of four irrigation levels and boron foliar application rates on vegetative growth, yield and oil yield of coriander plants.

Average meteorological data at the site during the two seasons are presented in Table (1). The chemical analysis of the experimental soil was determined prior cultivation according to Chapman and Pratt (1961) and the physical analysis was determined according to Israelson and Hanson (1962) (Table, 2).

Experimental design:

The experimental design was a split plot with three replicates. The irrigation treatments included; I1 at 60% crop evapotranspiration (ETc), I2 at 80% ETc, I3 at 100% ETc and I4 at 120% ETc as the main plot and foliar application of boron (B) at four concentrations (0, 50, 100 and 150 ppm) as the sub-plot, while the control plants were sprayed with tap water.

Coriander seeds (*Coriandrum sativum* L.) were obtained from Medicinal and Aromatic Plants Research Department, Horticulture Research Institute, ARC, Egypt. The seeds were directly sown in the experimental area on October 15th and October 20th in the first and second seasons, respectively. Thinning was done 3 weeks after sowing. Phosphorus was applied and mixed with the soil before sowing at a rate of 200 kg/fed as calcium super phosphate (15.5% P_2O_5). Potassium was applied at the rate of 100 kg/fed as potassium sulphate (48% K_2O) and nitrogen was applied at a rate of 300 kg /fed as ammonium nitrate (33.5% N). The soluble fertilizers were injected into the fertilizer tank (fertigation). The drip irrigation system was applied with 4 l/h discharge. The irrigation treatments started after plant establishment at 2 days interval. The chemical analysis of the well irrigation water is shown in Table (3).

Boron application:

Coriander plants were sprayed four times with boron levels (0, 50, 100 and 150 ppm) during the growing season. The first application was carried out 30 days after sowing and repeated at 15 days interval. Foliar application was done uniformly using a hand pump sprayer.

Table 1. Average weather conditions at the site.

Month		Average of 2020 and 2021 seasons						
		October	November	December	January	February	March	April
Temperature °C	Max.	27.88	21.02	17.94	19.90	22.35	27.00	36.74
	Min.	15.95	11.69	7.02	8.07	9.97	12.73	22.73
RH_AVG %		58.64	57.73	65.50	58.44	61.43	58.93	49.23
Wind speed (m/sec)		2.82	2.50	3.31	3.37	2.82	3.12	3.24
Radiation (MJ/m^2)		18.12	14.78	13.01	11.66	14.82	19.22	25.14
Et_o mm day^{-1}		4.85	3.64	2.42	2.37	3.25	4.26	5.87

Table 2. The chemical and physical analysis of the soil.

Physical properties	Soil layer depth (cm)		
	00-20	20-40	40-60
Texture	Sandy	Sandy	Sandy
Course sand (%)	48.66	55.71	37.76
Fine sand (%)	48.83	40.58	58.43
Silt + clay (%)	2.51	3.71	3.81
Field capacity (%)	13.0	13.3	10.1
Wilting point (%)	4.6	4.5	4.4
Available water (%)	8.3	8.1	8.0
Bulk density (t m^{-3})	1.69	1.68	1.67
Chemical properties			
$EC_{1:5}$ (dS m^{-1})	0.45	0.53	1.00
pH (1:2.5)	8.60	8.70	9.32
Total $CaCO_3$ (%)	7.00	2.34	4.66

Table 3. Irrigation water analysis at the experimental site.

pH	Ecw		Soluble anions (meq/l)			Soluble cations (meq/l)			
	ppm	dS/m	CO_3^{--}	HCO_3^{-}	Cl^-	Ca^{++}	Mg^{++}	Na^+	K^+
7.78	1664	2.6	-	5.20	17.20	4.00	3.60	18.01	0.32

Measurements:

1. Water Relations

a. Water consumptive use (ETc):

Water consumptive use (ETc) was determined by using the direct methods of monitoring soil water content after and before irrigation. The amount of water within the active root zone was determined by a portable soil moisture meter and the moisture tester sensor was calibrated by using gravimetric method described by Gardner (1965).

b. Reference evapotranspiration (ET_o):

Reference evapotranspiration (ET_o) mm/day was determined by using modified Penman equation according to the following equations:

ET_o= C[W. Rn (1-w) -F (u) (ea-Ed)]… mm/day

Where:

ET_o= The rate of evapotranspiration (mm/day)

W= Temperature-related weighting factor, which depends on temperature and altitude

Rn= Net radiation in equivalent evaporation in mm/day

F (u) = Wind related function

ea-Ed= Difference between the saturation of air vapor pressure (bar)

C= Adjustment factor to compensate the effect of day and night weather conditions

c. Crop coefficient (K_c):

Daily crop coefficient values (K_c) was estimated by using the equation according to Doorenbos and Pruitt (1984) as follows:

$K_c = ET_c/ET_o$

Where:

K_c = Crop coefficient value

ET_c= daily crop evapotranspiration .… mm/day

ET_o= daily reference evapotranspiration …. mm/day

2. Vegetative growth and yield characters:

At harvest in mid-April, the plant height (cm), number of shoots/plant, fresh weight/plant, dry weight/plant, fruit yield/plant (g) and per feddan (kg) as well as seed index were recorded. The essential oil content (%) was determined in the seeds and oil yield (kg/feddan) was calculated.

Statistical analysis:

The significant differences between treatments were analyzed using analysis of variance (ANOVA) using COSTAT statistical package. The difference among treatment means were compared using least significant difference (L.S.D.) test at a probability level of 0.05 (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Vegetative growth and yield parameters:

The influences of different amounts of irrigation water and boron foliar application on growth characteristics of coriander plants were significant. The results revealed that growth and yield parameters progressively increased with increasing irrigation levels (Tables, 4 and 5). The highest mean values of plant height, number of shoots, fresh weight/plant, dry weight/plant, fruit yield/plant and fruit yield/feddan were attained with the highest irrigation level (I4), followed by full irrigation treatment (I3) with non-significant differences between both treatments during the first and second seasons. Foliar application of boron enhanced coriander growth traits. Boron at 150 ppm improved the investigated parameters compared to the lower rates and control, resulting in maximum mean values of plant height, number of shoots, fresh weight/plant, dry weight/plant, fruit yield/plant and fruit yield/feddan in the first and second growing seasons.

Furthermore, the interaction between irrigation levels and boron foliar application was significant. The least mean values of growth characteristics and yield parameters were obtained at irrigation level 60% ETc in untreated boron application (I1 × B1). This treatment decreased fresh weight/plant by 18.62%, dry weight/plant by 16.18%, 1000 seed weight (g) by 36.23% and fruit yield/feddan by 10.09%, respectively compared to (I4 × B1) treatment in the first season. A similar trend was observed in the second season.

It was noticed that plants irrigated at 60 or 80% ETc and sprayed with boron at 150 ppm had higher values than that of untreated boron plants at an irrigation level of 100 or 120% ETc). This indicates that foliar application of boron could increase the plants resistance to drought. These results are in accordance with Karim *et al*. (2012) on wheat and Semida *et al.* (2021) on eggplant.

The effects of water stress on coriander growth and yield parameters were in agreement with those reported by Hassan and Ali (2016) on cumin plants. Ghamarnia and Daichin (2013) found that increasing water stress up to 40% of coriander water requirements significantly decreased all vegetative and yield parameters.

The adverse effects of water stress on coriander growth and yield is due to the fact that drought causes changes in turgor pressure, cell wall elasticity, carbon assimilation and stomata opening and closing. In addition, it increased photorespiration and free radicals generation

Table 4. Effect of irrigation levels and boron foliar application on growth characteristics of coriander during 2020 and 2021 seasons.

Boron (B)	First season (2020)					Second season (2021)				
	Irrigation levels (I)									
	I1	I2	I3	I4	Mean	I1	I2	I3	I4	Mean
	Plant height (cm)									
B1 (0 ppm)	64.32	75.27	90.83	94.03	81.11	66.89	79.03	96.28	99.67	85.47
B2 (50 ppm)	77.12	90.70	93.57	96.60	89.50	80.20	95.24	99.18	102.40	94.26
B3 (100 ppm)	82.58	94.70	102.47	101.50	95.31	85.88	99.44	108.62	109.62	100.89
B4 (150 ppm)	94.83	103.12	105.37	106.08	102.35	98.62	108.28	111.69	113.51	108.02
Mean	79.71	90.95	98.06	99.55		82.90	95.49	103.94	106.30	
LSD (0.05)										
I			4.14					4.06		
B			3.13					3.76		
I × B			6.27					7.17		
	Number of shoots									
B1 (0ppm)	7.62	11.08	11.38	12.65	10.68	8.61	12.63	13.09	14.55	12.22
B2 (50 ppm)	10.78	14.40	20.12	20.92	16.55	12.18	16.42	23.14	24.06	18.95
B3 (100 ppm)	13.88	17.25	24.68	26.78	20.65	15.68	19.67	28.38	30.80	23.63
B4 (150 ppm)	17.35	20.05	28.76	27.17	23.33	19.61	22.86	31.06	30.43	25.99
Mean	12.41	15.70	21.24	21.88		14.02	17.89	23.92	24.96	
LSD (0.05)										
I			1.33					1.74		
B			1.68					1.18		
I × B			3.37					3.55		
	Fresh weight (g/plant)									
B1 (0ppm)	0.83	1.00	1.01	1.02	0.96	0.90	1.06	1.09	1.13	1.05
B2 (50 ppm)	0.85	1.09	1.14	1.14	1.06	0.93	1.16	1.23	1.27	1.14
B3 (100 ppm)	0.9	1.13	1.19	1.17	1.10	0.98	1.20	1.29	1.30	1.19
B4 (150 ppm)	1.04	1.22	1.29	1.29	1.21	1.13	1.29	1.39	1.43	1.31
Mean	0.91	1.11	1.16	1.16		0.99	1.18	1.25	1.28	
LSD (0.05)										
I			0.05					0.08		
B			0.04					0.05		
I × B			0.09					0.11		
	Dry weight (g/plant)									
B1 (0ppm)	166.77	185.62	192.37	198.97	185.93	186.78	207.89	215.45	222.85	208.24
B2 (50 ppm)	182.60	208.12	218.60	220.05	207.34	204.51	233.09	244.83	246.46	232.22
B3 (100 ppm)	194.52	222.18	230.12	228.98	218.95	217.86	248.84	257.73	256.46	245.22
B4 (150 ppm)	204.58	233.75	248.72	247.75	233.70	229.13	261.80	278.57	275.00	261.12
Mean	187.12	212.42	222.45	223.94		209.57	237.91	249.15	250.19	
LSD (0.05)										
I			6.01					7.42		
B			4.44					4.31		
I × B			8.88					9.70		

Table 5. Effect of irrigation levels and Boron foliar application on 1000 seed weight (g), fruit yield/plant (g) and fruit yield/feddan (kg) of coriander during 2020 and 2021 seasons.

Boron (B)	First season (2020)					Second season (2021)				
	I1	I2	I3	I4	Mean	I1	I2	I3	I4	Mean
	1000 seed weight (g)									
B1 (0 ppm)	6.16	7.64	9.25	9.66	8.18	6.47	8.56	10.27	9.85	8.79
B2 (50 ppm)	6.55	9.44	12.60	11.45	10.01	6.88	10.57	13.99	11.68	10.78
B3 (100 ppm)	8.44	12.66	15.61	12.09	12.20	8.86	14.18	17.33	12.33	13.18
B4 (150 ppm)	9.49	14.74	16.31	13.69	13.56	9.96	16.51	18.10	13.96	14.64
Mean	7.66	11.12	13.44	11.72		8.04	12.45	14.92	11.96	
LSD (0.05)										
I			0.92					1.22		
B			1.01					1.15		
I × B			2.02					2.35		
	Fruits yield/plant (g)									
B1 (0ppm)	77.75	79.27	82.58	86.48	81.52	82.42	84.03	87.53	91.67	86.41
B2 (50 ppm)	80.37	86.23	93.51	91.78	87.97	85.19	91.40	99.12	97.29	93.25
B3 (100 ppm)	85.85	93.33	94.53	94.08	91.95	91.00	98.93	100.20	99.72	97.46
B4 (150 ppm)	88.35	95.70	104.12	102.57	97.68	93.65	101.44	110.37	105.65	102.78
Mean	83.08	88.63	93.69	93.73		88.06	93.95	99.31	98.58	
LSD (0.05)										
I			5.60					4.11		
B			3.43					2.96		
I × B			6.87					5.08		
	Fruits yield/fed (kg)									
B1 (0ppm)	1010.75	1030.51	1073.54	1124.24	1059.76	1071.40	1092.34	1137.95	1191.69	1123.35
B2 (50 ppm)	1044.81	1120.99	1215.63	1193.14	1143.64	1107.50	1188.25	1288.57	1264.73	1212.26
B3 (100 ppm)	1116.05	1213.29	1228.89	1223.04	1195.32	1183.01	1286.09	1302.62	1296.42	1267.04
B4 (150 ppm)	1148.55	1244.10	1353.56	1333.41	1269.91	1217.46	1318.75	1434.77	1373.41	1336.10
Mean	1080.04	1152.22	1217.91	1218.46		1144.84	1221.36	1290.98	1281.56	
LSD (0.05)										
I			53.76					44.17		
B			57.64					36.82		
I × B			115.28					117.54		

as reported by Wang *et al.* (2012) in leaves of apple rootstocks. On the other hand, the promoting effect of boron foliar spray on coriander growth is due to the key role of boron in plants. Boron is an essential element for cell wall formation, improves photosynthesis and integrity of membrane, improves sugar transport, maintains carbohydrate, protein and RNA metabolism (Hajiboland, 2012), which consequently increases growth and yield parameters. Further, the promotion of boron in alleviating the negative effects of water stress on coriander could be due to the role of boron in stomatal opening in stressed plants (Sarwar *et al.*, 2019). Boron improved net photosynthetic rate, relative leaf water content and upregulated antioxidant enzymes in heat and water stressed lentil plants (Venugopala *et al*., 2022). Another explanation could be due to the role of boron in the uptake of other elements such as K^+ and solutes that are involved in water uptake, and cell turgidity (Hajiboland, 2012).

Essential oil content (%) and yield:

The essential oil content and yield significantly varied in different irrigation levels (Table, 6). The highest values were obtained in the irrigation treatment at 80% ETc. The increase in essential oil content under water stress is in agreement with Bettaieb *et al.* (2011) on cumin plants. The essential oil content significantly increased with increasing boron application. Boron at 150 ppm resulted in the highest mean values of essential oil content and yield. Similarly, Khalid (2015) reported an increase in the essential oil content and yield of coriander with micronutrients foliar spray. Moreover, Sugier *et al.* (2017) reported that foliar boron increased the essential oil content and yield from flower heads of two *Arnica* species. The interaction between both factors was significant. The highest mean values of essential oil yield were obtained in plants irrigated at 80% ETc and sprayed with boron at 150 ppm during both seasons. Improvement of the essential oil content and yield in response to micronutrient application under water stress was reported by Afshari *et al*. (2021) who found an increase in coriander essential oil percentage and yield when exposed to moderate drought stress and sprayed with silicon.

Crop coefficient values (K_c):

Crop coefficient is an important parameter for estimating crop water requirements. Crop coefficient (K_c) values depend on several factors such as irrigation method, developmental stage of plant, climate and soil conditions. The values of coriander crop coefficient (K_c) were calculated by using actual evapotranspiration (ET_c) measured by soil water balance and presented as a function of days after planting (Table, 7). Data shown in this table represent monthly crop coefficient (K_c) values. The highest values were obtained in April (0.90) with a mean value of 0.64 at the experimental site in El-Bustan area. Ghamarnia *et al.* (2013) reported crop coefficient values of coriander grown in a semi-arid region as 0.66, 1.19, 1.36, 0.98 for the developmental stages of the plant. Silva *et al.* (2018) reported different Kc values for coriander grown in a tropical environment with a mean value of 0.86.

Water consumption use:

The determination of water consumptive use (m^3/feddan) of coriander plants was obtained by soil water content after and before irrigation, which gave indication about soil water balance in the active root zone. This item was affected by plant developmental stages and climatic conditions as well as the plant canopy area. The effect of various irrigation levels on the water consumptive use is shown in Table (8). The total monthly amount of water consumptive use gradually increases with the progress of the plant age until the top of the maximum developmental stages and continues steady with plant's progress till the end of the growing season. In general, the monthly actual water values varied according to climatic conditions and plant growth that covered the soil within plant canopy area.

CONCLUSION

The current study revealed that boron foliar application at 150 ppm improved growth, and fruit yield under severe (60% ETc) water stress conditions and increased essential oil yield at moderate water stress (80% ETc) thereby improving fruit quality. Therefore, applying boron foliar spray at 150 ppm could serve as a promising approach under moderate water stress (80%) conditions to maximize coriander yield and quality in sandy soils.

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Table 6. Effect of irrigation levels and Boron foliar application on essential oil content (%) and yield of coriander during 2020 and 2021 seasons.

Boron (B)	First season (2020)					Second season (2021)				
	Essential oil percentage (%) Irrigation levels (I)									
	I1	I2	I3	I4	Mean	I1	I2	I3	I4	Mean
B1 (0 ppm)	0.32	0.46	0.38	0.32	0.37	0.33	0.48	0.40	0.34	0.39
B2 (50 ppm)	0.58	0.62	0.47	0.39	0.52	0.60	0.65	0.50	0.41	0.54
B3 (100 ppm)	0.70	0.85	0.65	0.61	0.70	0.73	0.89	0.69	0.65	0.74
B4 (150 ppm)	0.89	1.00	0.80	0.80	0.87	0.93	1.05	0.85	0.85	0.92
Mean	0.62	0.73	0.57	0.53		0.65	0.77	0.61	0.56	
LSD (0.05)										
I			0.02					0.03		
B			0.03					0.03		
I × B			0.06					0.06		
	Essential oil yield/plant (ml)									
B1 (0ppm)	0.25	0.37	0.31	0.27	0.30	0.27	0.41	0.35	0.31	0.34
B2 (50 ppm)	0.46	0.53	0.44	0.37	0.45	0.51	0.60	0.49	0.40	0.50
B3 (100 ppm)	0.60	0.82	0.61	0.57	0.65	0.66	0.88	0.69	0.64	0.72
B4 (150 ppm)	0.79	0.95	0.83	0.82	0.85	0.87	1.07	0.94	0.90	0.94
Mean	0.52	0.67	0.55	0.51		0.58	0.74	0.62	0.56	
LSD (0.05)										
I			0.02					0.04		
B			0.03					0.03		
I × B			0.07					0.08		
	Essential oil yield/fed (l)									
B1 (0ppm)	3.50	4.78	4.03	3.50	3.95	3.57	5.28	4.58	4.04	4.37
B2 (50 ppm)	6.03	6.90	5.75	4.78	5.87	6.68	7.74	6.42	5.23	6.52
B3 (100 ppm)	7.77	10.65	7.95	7.41	8.45	8.61	11.48	8.97	8.38	9.36
B4 (150 ppm)	9.72	12.38	12.90	12.39	11.85	11.27	13.85	12.17	11.65	12.23
Mean	6.76	8.68	7.66	7.02		7.53	9.58	8.04	7.32	
LSD (0.05)										
I			0.68					0.72		
B			0.46					0.56		
I × B			0.92					1.12		

Table 7. Crop coefficient values (Kc) during growth months.

Months	October	November	December	January	February	March	April
Crop coefficient	0.22	0.47	0.59	0.66	0.76	0.85	0.90

Table 8. Monthly crop water requirement values for coriander (average of 2 seasons).

Water consumption use (m^3/feddan) at 100% ETc							
October	November	December	January	February	March	April	Total
40.3	129.3	107.0	118.3	240.2	294.3	271.8	1201

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تخفيف آثار الإجهاد المائي في نباتات الكزبرة عن طريق الرش الورقي بعنصرالبورون

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تم إجراء تجارب حقلية في محطة بحوث البساتين بمنطقة جنوب التحرير، محافظة البحيرة خلال موسمين متتالين (٢٠٢٠ و ٢٠٢١) وذلك لدراسة تأثير مستويات مختلفة من الري والرش الورقي بعنصر البورون على النمو والمحصول والزيت الطيار في نباتات الكزبرة المنزرعة في أرض رملية. اشتملت التجربة على ٤ مستويات من الري بالتنقيط (٦٠، ٨٠، ١٠٠، ١٢٠٪ من بخر نتح المحصول) وأربعة مستويات من الرش الورقي لعنصر البورون (٠، ٥٠، ١٠٠، ١٥٠ جزء في المليون). أظهرت النتائج تأثيرا معنويا لكل من مستويات الري والرش الورقي بعنصر البورون على النمو والمحصول والزيت الطيار في نباتات الكزبرة. أدى الري عند ١٢٠٪ من بخر النتح إلى الحصول على أعلى قيم لصفات النمو والمحصول الثمري للنباتات مع عدم وجود فروق معنوية بين هذه المعاملة والمعاملة عند ١٠٠٪ بخر نتح. وأدى الري عند ٦٠٪ من بخر النتح مع الكنترول إلى أقل قيم لصفات النمو والمحصول الثمري. أظهرت النتائج أن الري عند ٨٠٪ من بخر النتح مع الرش الورقي بعنصر البورون عند ١٥٠ جزء في المليون إلى الحصول على أعلى قيم لمحصول

الزيت الطيار ومن ثم تحسين جودة الثمار. تم الحصول على أعلى قيم معامل المحصول للكزبرة في شهر أبريل بمتوسط ٠,٦٤ وبلغ متوسط الاستهلاك المائي ١٢٠١ م٣/فدان خلال موسمي النمو. وبالتالي يمكن استنتاج أن الرش بعنصر البورون عند تركيز ١٥٠ جزء في المليون يؤدي إلى تعظيم الإنتاجية وجودة ثمار الكزبرة تحت ظروف الاجهاد المائي المتوسط (٨٠٪ من بخر النتح) تحت ظروف الأراضي الرملية.