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The regulative effect of boron treatments on the growth and production of six Egyptian wheat cultivars

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Abstract:

Wheat is one of the important winter cereals in the world. Boron is an important micronutrient for the growth and production of wheat crops, and its deficiency is widespread in many soils. The present investigation was carried out to study the effect of boron treatments (0, 2.5, 5 and 10 ppm) as a fertilizer to six wheat cultivars. The effects of B treatments were studied by detecting some growth parameters (plant height - chlorophyll content - number of tillers per plant) and yield components (spike length - number of grains per spike - grain yield). Also, the effect of B treatments on the uptake of some micronutrients (B, Fe, Mn and Zn) and some macronutrients (N, P, K, Ca, Mg, and Na) was done.

Results showed that tested wheat cultivars responded positively to the first concentration of B (2.5 ppm) by increasing the tested parameters in most cultivars.

On the other hand, the highest concentration of B (10 ppm) showed harmful effect by decreasing the different tested parameters. Also, B treatments increased the uptake of B, N and K, while they decreased the uptake of Fe, Mn, Zn, P, Ca, Mg, and Na).

Moreover, the best responded cultivars were three Gemmeiza ones (7, 9 and 10).

Introduction:

Boron is one of the essential micro nutrients for higher plants, but its biochemical roles are uncertain. Boron (B) required for the normal growth of most plants. Mazher *et. al.* (2006) observed that better growth and good yield were obtained when crops supplied with B, the positive effect of B on the growth parameters can be attributed to the role of boron on cell elongation. Dell and Huang (1997) stated that deficiency of B inhibits root elongation through limiting cell enlargement and cell division in the growing zone of root tips. Leaf expansion is also inhibited by low B and indirectly photosynthesis is decreased. Rarkasem *et. al.* (1993) reported that B deficiency lowered the number of grains per spike and grain yield in wheat. Takano *et. al.* (2008) added that B toxicity is more difficult to manage than its deficiency, which can be prevented by fertilization. However, fertilization with boron to avoid deficiency can result in toxicity.

Plants require a constant supply of B during all phases of plant growth. Even a short period of limitation in B availability can depress plant growth. Yau *et. al.* (1997) reported that the plant height was significantly increased with a soil boron level of 7.1 mg / kg as compared to other levels (0.0, 3.0 and 17.4 mg/kg). Khan *et. al.* (2006) and Ahmad and Irshad (2011) found that boron application has increased plant height compared to control. Also, Mazher *et. al.* (2006) reported that B at all concentration caused an increase in chlorophyll compared with those untreated plant. Prabhu and Muthuchelian (2011) stated that an excess cause negative effects including decrease in leaf chlorophyll contents and inhibition of photosynthesis, they found that photosynthetic pigments and soluble proteins decreased significantly in B-deficient and B-excess. The degree of decrease being greater in B-excess. Metwally *et. al.* (2012)

found that the increase in B level in the culture medium was generally associated with a gradual fall in pigments biosynthesis (e.g. chlorophyll) in all wheat cultivars leaves. Ahmad and Irshad (2011) found that boron application in irrespective of time significantly increased number of tillers/plant over control.

Adequate B nutrition is critical not only for high yields but also for high quality crops.Khan *et. al.* (2006) found that the maximum spike length was recorded by the application of 1 kg B/ha. In addition, Gunes *et. al.* (2003) found that spike length, grain yield and number of grains/spike were responded positively to boron fertilization in the rates of 1.0, 2.0, 3.0, 4.0 and 5.0 kg B /ha. Halder *et. al.* (2007) stated that B application up to 2 kg/ha. significantly increased the grain per spike and the grain yield. Also, Tahir *et. al.* (2009) said that number of grains/spike is an important yield contributing parameter and has a direct effect on the grain yield of wheat; boron application had significant effect on the number of grains per spike. Chhipa and Lal (1989) studied the effect of B application in rates of 0.0, 0.55, 1.1, 1.6, 3.0 and 4.8 mg/kg (sandy clay loam soil). They found that high B treatments like 3.0 and 4.8 mg B/kg released to decrease wheat grain yield. Moreover, Nadimm *et. al.* (2011) found that the use of boron at 2 kg / ha. recorded more grains /spike, higher grain weight and increased grain yield.

Boron (B) play a role in the nutrient interaction within plant, but it is still not clear whether B is directly or indirectly involved in the interaction of certain nutrients. However the nature of these complex interaction are still obscure. Tariq and Mott (2006) suggested that the deficiency or excess of B not only affects the relative values of individual elements, but it also affects the balance among certain elements within plants, causing either an increased or decreased of dry matter production.

From field trail, Gunes *et. al.* (2003) and Mojtaba *et. al.* (2010) found that B concentrations increased with increasing boron levels from 1.0 to 5.0 kg B/ha., the increase of leaf B concentration was higher than root. Singh *et al.* (1990) reported that B soil application to wheat at rates of 2.5, 5.0, 7.5 or 10 mg B/kg significantly increased tissue B concentration and its uptake, while uptakes of Fe, Mn, decreased. Lopez *et. al.* (2002) said that increasing B treatment decline in Fe, Mn and Mg uptake, but increasing N, P and K concentration in tobacco plant. In the absence of B possible Fe became fixed. Ayden and Sevinc (2006) found that Zn concentration of plant decreased while N, P, K and B concentration in plant increased with B application.

Diab (1992) studied the effect of boron on B, N, P and K contents in wheat plants. His results indicated that N, P and K contents in wheat plant were tended to increase with increasing B concentration from 0.1 to 1.0 mg/L. and observed that applying B at levels of 2.5 and 5 ppm markedly increased N concentration. However, further increase in B level in the growth medium was followed by a significant decrease in N concentration; this decrease may be due to B toxicity. He found also that higher increments of applied B markedly decreased the P concentration. From the results of experiment, Chhipa and Lal (1989) found that N and B concentrations in the plant material of wheat grown on sand loam soil increased when B application increased from 0.0 to 4.8 mg B/kg, while K and Ca concentrations decreased. Khair, *et. al.* (2002) said that B application at 2 kg / ha. increased the K value. Tariq and Mott (2006) approved that increasing in B level in the nutrient solution increased B and K content in shoot, while Ca, Mg and Na content decreased. Mazher, *et. al.* (2006) found that Na decreased by increasing B concentration.

The present work intended to study the effect of boron on some growth parameters, yield and yield component, the uptake of some macro and micro nutrient affected by boron were also studied.

Material and methods:

The experiment was carried out at the Experimental Farm of Faculty of Agriculture, Al-Azhar University- Nasr City- Cairo Governorate. Wheat cultivars were planted in open field on winter seasons of 2009-2010. The experimental design was split plot with three replicates. Cultivars occupied the main plots and boron treatments (0, 2.5, 5 and 10 ppm) were allocated at random in the sub-plots.

-Wheat cultivars: Wheat cultivars newly originated by the Agricultural Research Centre (ARC) were used. They are namely: **V1** = Gemmeiza 7, **V2** = Gemmeiza 9, **V3** = Gemmeiza 10, **V4** = Sakha 93, **V5** = Sakha 94 and **V6** = Giza 168.

- Fertilization: Wheat cultivars were fertilized by super phosphate (15 % P_2O_5) by 200 kg /feddan during sowing, potassium sulphate (48 % K_2O) by50 kg /feddan, and urea (46 % N) by 263 kg /feddan divided into 5 equal splits added one every 10 days after planting.

- Boron treatments:

- Control (The mean native boron in soil was (0.6 ppm).
- 2.5 ppm (Addition of boric acid at rate of 14.7kg/ feddan)
- 5 ppm (Addition boric acid at rate of 29.4 kg/ feddan)
- 10 ppm (Addition boric acid at rate of 58.8 kg/ feddan).

- Field irrigation: Plants were irrigated to the field capacity at 10-15 days intervals.

- Growth parameter measurements:

Plant height: 10 plants/plot was randomly taken at 3 dates intervals (30, 75 and 120 days after sowing), Number of tillers per plant were determined and leaf chlorophyll content was estimated nondestructively in leaves at age 75 days by using {N-Tester calibration-(Minolta, Japan)} with a reading checker, each reading is an average of 30 measurements.

-Yield component measurements:

Spike length (cm) was determined using 10 randomly selected main spikes for each plot, number of grains per spike and grain yield.

- **Concentrations** of boron, micronutrients and macronutrients in shoots and roots were detected.

- Chemical analysis:

Soil analysis: A representative soil sample was taken after soil preparation and before fertilization from the experimental sites (0-30 cm depth). The soil sample was air dried, ground in a wooden mortar and passed throw 2 mm pores sieve to analyze for physical and chemical characteristics. Characteristics were measured according to Page *et. al.* (1982). Texture was Sandy clay loam - E.C 0.98 dS/m – pH 7.8 - Organic Matter 0. 9 %. Boron determination according to Wolf (1974) was 0.6 ppm in the used soil.

Preparation of plant sample to element determinations: Wheat shoot and root samples (75 days after planting) were analyzed for macro and micronutrients.

- Plant organs were washed in sequence with tap water, 0.01 N HCL-acidified bidistilled water and bidistilled water, respectively, and then dried in a ventilated oven at 60 ° C till constant weight was obtained.
- The plant samples were ground, then representative portions were wet digested using a mixture of chromic ($HClO_4$) and sulphoric (H_2SO_4) at a rate of 1:1 to determine, then sieve and kept in plastic containers for chemical analysis according to Chapman and Pratt (1978).

1-Total nitrogen determination by Micro-Kjeldahl method, using boric acid modification as described by Jackson (1973), and distillation was done using Gerhardt apparatus.

2-Macronutrients determined in the wet digested extract previously mentioned.

a)- Phosphorus: was measured in the digested solution using vanadomolybdate color reaction according to the method described by Jackson (1973).

b)- Potassium, Calcium and sodium: were measured in the digested suspension using the Flame photometer, {Eppendorof, DR Lang} according to Page, *et. al.* (1982).

3- Micronutrients and Mg: were measured in the suspension using atomic absorption spectrophotometer {Zeiss PMQ3} apparatus according to Page, *et. al.* (1982).

4- Boron: determined by Inductively Coupled Spectrometry Plasma (ICP) Model Ultima2 – Jobin Yvon according to Page, *et. al.* (1982).

- Statistical analysis:

The obtained data were subjected to split plot analysis of variance as described by Snedecor and Cochran (1967). Means were compared using the least significant difference (L.S.D) test developed by Waller and Duncan (1969) at the 5 % level.

Results and discussion:

Wheat cultivars were growing in split plot to study the effect of boron treatments at three concentrations on the growth parameters, yield components, micro and macro nutrients concentration.

Effect of boron treatments (B) on growth parameters of wheat cultivars (V):

Table (1) shows the effect of B treatments growth parameters: (plant height (cm) - chlorophyll content (mg/g fw) - number of tillers per plant) of wheat cultivars.

Effect of (B) on plant height (cm):

It was observed from the results in table (1) that the 2.5 ppm of B treatments showed nearly the highest effect on plant height when compared with the other treatments and control at all ages. That was true for all cultivars except Giza 168 after 30 days. The other treatments of B (5 and10 ppm) decreased gradually the plant height at all ages of plants. Reid *et. al.*, (2004) reported that B toxicity inhibition of cell division and elongation then depressed vegetative growth. Gemmeiza cultivars showed a good response to 2.5 ppm of B treatment than other cultivars. It is clear from data mentioned that boron played an important role for normal plant growth and development because it controlling the carbohydrate transport and regulate auxin supply which led to increased cell elongation then plant height. These results are in agreement with Khan *et. al.* (2006) and Alam (2007) as they found that the plant height increased by B treatment up to 4 kg B/ha. and decreased gradually with increase of B levels. This decrease due to B toxicity. The adverse concentration effects of B toxicity stress on growth criteria were clearly demonstrated by wheat cultivars treated with the higher B level.

Effect of (B) on chlorophyll content (mg/g fw):

The increase in B level in the culture medium was generally associated with high increase fall in chlorophyll content in all genotypes leaves. Moreover, chlorophyll content was highly inhibited at 10 ppm B in Sakha 94 (V5) as compared with other genotype cultivars. The 2.5 ppm B treatment gave the best effect on chlorophyll content, all cultivars showed an increase in chlorophyll content when treated by 2.5 ppm except Gemmeiza 9 (V2). Gemmeiza 10 (V3) and Giza 168 (V6) as they gave an increase when treated by 5 ppm B. These results are in accordance with Aydn and Sevinc (2006) and Metwally *et. al.*, (2012) they observed that chlorophyll amount decreased with increasing B application at 4.6 and 9.2 mg B/kg. while 2.3 mg B/kg increased it.

Table (1): Effect of boron (B) treatments on wheat (V) cultivars growth parameters {Plant height (cm) – Chlorophyll ratio (mg/g fw) - Number of tillers per plan)}.

Growth parameters		Treatment B ppm	Field experiment (2009-2010) Results/ cultivars						
			V1	V2	V3	V4	V5	V6	Mean
Plant height (cm)	٣٠ day	٠	٢٩.٧	٣٠.٦	٢٦.٨	٢٧.٥	٢٨.٧	٢٩.٩	٢٨.٩
		٢.٥	٣١.٠	٣٢.١	٢٧.٣	٢٩.٦	٢٩.٧	٢٩.٦	٢٩.٩
		٥	٢٦.٥	٢٨.٦	٢١.٣	٢٥.٦	٢٥.٧	٢٧.٦	٢٥.٩
		١٠	٢٤.٦	٢٤.٨	٢٠.٨	٢٣.٠	٢٤.٥	٢٦.٦	٢٤.١
		Mean	٢٧.٩	٢٩.٠	٢٤.١	٢٦.٤	٢٧.١	٢٨.٤	
	٧٥ day	٠	٨٧.٢	٧٨.٨	٦٩.٣	٧٥.٠	٨١.٤	٧٨.٧	٧٨.٤
		٢.٥	٩١.٨	٨٠.٨	٧٢.٧	٨١.١	٨٨.٠	٨٤.٩	٨٣.٢
		٥	٨١.٢	٧٥.١	٦٦.٠	٧٦.٠	٧٨.٩	٨٠.٦	٧٦.٣
		١٠	٧٠.٢	٦٨.٣	٥٧.٣	٦٨.٨	٧١.٥	٧٠.٤	٦٧.٧
		Mean	٨٢.٦	٧٥.٧	٦٦.٣	٧٥.٢	٧٩.٩	٧٨.٦	
	١٢٠ day	٠	٩٩.٥	١٠١.٩	٨٨.٦	٩٣.٢	١٠٢.٨	٩٥.٥	٩٦.٩
		٢.٥	١١٠.١	١٠٨.٦	٩٦.٩	٩٨.٨	١١٠.١	٩٩.٧	١٠٤.٠
		٥	١٠٠.١	٩٢.٤	٩٢.٦	٩٢.٥	١٠٤.٩	٩٣.٤	٩٦.٠
		١٠	٩٠.٩	٨٩.٩	٨٩.٦	٨٩.١	٩٧.١	٩٠.٢	٩١.١
		Mean	١٠٠.١	٩٨.٢	٩١.٩	٩٣.٤	١٠٣.٧	٩٤.٧	
chlorophyll content (mg/g fw)		٠	٢.٤٩	٢.٠٩	٢.٠٤	٢.٤٢	٢.٤٥	٢.٢٤	٢.٣٠
		٢.٥	٢.٥٧	٢.٠٨	2.10	٢.٥٠	٢.٤٩	٢.٢٨	٢.٢٨
		٥	٢.٥٣	٢.٠٩	٢.١٢	٢.٤١	٢.٢٩	٢.٣٦	٢.٣٠
		١٠	2.42	٢.٠٩	2.06	٢.٣٧	٢.١٠	٢.٢٧	٢.٢٧
		Mean	٢.٥٠	٢.٠٩	٢.٠٨	٢.٤٢	2.26	٢.٢٩	
Number of tillers per plant		٠	٥.٩	٧.٤	٦.٤	٤.٨	٥.٧	٦.٤	٦.١
		٢.٥	٩.١	٨.٣	٦.٩	٦.٥	٦.٣	٧.٠	٧.٣
		٥	٨.٣	٨.٤	٧.٥	٥.٣	٤.٧	٥.٦	٦.٦
		١٠	٧.٣	٧.٨	٧.٣	٥.٢	٤.١	٥.٣	٦.٢
		Mean	٧.٦	٧.٩	٧.٠	٥.٤	٥.٢	٦.١	

L.S.D at 0.05 level for:	Plant height at			Chlorophyll content	Number tillers/ plant
	30day	75day	120day		
B	٠.٢	١.٣	١.٧	0.04	٠.١٦
V	٠.٣	١.٦	٢.١	٠.٠٦	٠.١٩

Effect of (B) on number of tillers per plant:

The results from table (1) indicated that in tested wheat cultivars increased number of tillers/plant with all B treatments except Sakha 94 (V5) and Giza 168 (V6) when treated by 5 and 10 ppm. Meantime, 2.5 ppm B treatment gave a good increase in all cultivars; Gemmeiza 10 (V3) gave a good response with 5 ppm B. This increase may be happened because of role of boron in cell division and elongation Mazher *et. al.*, (2006). These results are in agreement with Ahmad and Irshad (2011) who found that maximum number of tillers per plant was observed in treatment where 3 kg B/ha. was applied at sowing time.

Effect of boron treatments (B) on yield component of wheat cultivars (V):

Table (2) showed the results of wheat cultivars yield components as affected by B treatment.

Table (2): Effect of boron treatments (B) on wheat cultivars (V) yield component {Spike length (cm) - Number of grains per spike - Grain yield (Ardab/fed.)}.

Yield component	Treatment B ppm	Field experiment (2009-2010)						
		Results/ cultivars						
		V1	V2	V3	V4	V5	V6	Mean
Spike length (cm)	٠	١١.٧	١٢.٥	١١.٣	١٠.٧	١٠.٩	١١.٠	١١.٣
	٢.٥	١٢.٦	١٣.٥	١١.٨	١١.٧	١١.٤	١١.٧	١٢.١
	٥	١٢.٤	١٣.١	١١.٥	١١.٣	١١.٤	١١.٥	١١.٩
	١٠	١٢.٢	١٢.٧	١٠.٥	١٠.٧	١٠.٩	١١.١	١١.٣
	Mean	١٢.٢	١٢.٩	١١.٣	١١.١	١١.١	١١.٣	
Number of grains per spike	٠	٥٥.٣	٦٣.٧	٥٨.٥	٥٧.٢	٥٦.٩	٥٧.٤	٥٨.٢
	٢.٥	٥٩.٣	٧٠.١	٦٣.٤	٦١.١	٥٨.٦	٥٨.٤	٦١.٨
	٥	٥٤.٨	٦٦.٧	٦٢.٨	٥٦.٥	٥٨.٠	٥٥.٠	٥٨.٩
	١٠	٥١.٥	٥٨.٨	٥٥.١	٤٦.٥	٥٥.٠	٥٢.٢	٥٣.٢
	Mean	٥٥.٢	٦٤.٨	٥٩.٩	٥٥.٣	٥٧.١	٥٥.٨	
Grain yield (Ardab/fed.)	٠	٢٦.٠	٢٥.٦	٢٢.٥	٢١.٦	٢١.٦	٢٣.٨	٢٣.٥
	٢.٥	٣١.٤	٣٠.٢	٢٣.٨	٢٣.٩	٢٧.٢	٢٥.٦	٢٧.٠
	٥	٢٢.٨	٢٠.٣	٢٠.٩	٢٠.٩	١٨.٧	٢٢.٩	٢١.١
	١٠	١٩.٨	١٧.١	١٤.٧	١٨.٧	١٦.٩	١٧.٨	١٧.٥
	Mean	٢٥.٠	٢٣.٣	٢٠.٤	٢١.٢	٢١.١	٢٢.٥	

L.S.D at 0.05 level for:	Spike length	Number of grain/spike	Grain yield
B	٠.١٤	٠.٥	١.٠
V	٠.١٧	٠.٦	١.٢

Effect of (B) on spike length (cm):

Data recorded in table (2) indicated that the 2.5 ppm of B treatment gave the tallest spike length as compared with control or other treatment. 5 ppm of B treatments showed a low increased in spike length compared with 2.5 ppm of B, while 10 ppm of B showed a decrease in spike length for all cultivars affected by increasing boron concentration which caused inhibition of cell division and elongation except V1 and V2 cultivars. Similar results found by Khan *et. al.*, (2006) and Gunes *et. al.*, (2003) as they found that spike length were responded positively to boron fertilization in the rates of 1.0, 2.0, 3.0, 4.0 and 5.0 kg B /ha.

Effect of (B) on number of grains per spike:

Our results showed that the 2.5 ppm of B treatment resulted in the higher number of grains per spike than the other treatments. This may be attributed to boron efficiency in the addition of more fertile-spikelets. Further treatment of B than 2.5 ppm showed a decreased in number of grains per spike except Gemmeiza cultivars and Sakha 94 when treated by 5 ppm of B. This result is in agreement with Halder *et. al.*, (2007) and Ahmad and Irshad (2011) as they found that B application 3 kg B/ha. at sowing has significantly increased number of grains/spike more about 11% when compared to control.

Effect of (B) on grain yield (Ardab/fed.):

It is obvious from the results that the 2.5 ppm of B treatment showed the only increasing yield per fadden than all other treatments in all cultivars. The increase reached (20.7% - 17.9% - 5.5% - 10.9% - 25% - 9.2%) respectively for the tasted cultivars treated by 2.5 ppm B. Significantly increasing in grain yield may be due to the reason that the application of boron enhanced pollen tube germination and grain setting, and maximum chlorophyll content and 2.5 ppm of B led to increased yield and Gemmeiza 7 genotype exhibited highest chlorophyll contents with maximum yield. This result is similar to Chhipa and Lal (1989); Halder *et. al.*, (2007) and Nadimm *et. al.*, (2011) as they found that application of 2 kg B/ha. recorded more grains /spike, higher grain weight and increased grain yield. Meantime, the 5 and 10 ppm B treatments resulted in of lees yield than the control. Murat *et. al.*, (2009) stated that B toxicity symptoms strongly occurred at 5 and 10 mg B /kg levels. They added that B toxicity resulted in depressed vegetative growth, lower leaf chlorophyll contents and finally a substantial reduction in crop yield.

Effect of boron treatments (B) on shoot content of micronutrients (μg/g dw.) of wheat cultivars (V):

Table (3) shows the results of wheat shoot content of micronutrients (μg/g dw.) as affected by B treatments.

Table (3): Effect of boron treatments (B) on wheat cultivars (V) shoot content of micronutrients (μg/g dw.) grown in field after 75 days planting.

Micronutrients μg/g dw.	Treatment B ppm	Field experiment (2009-2010)						
		Results/ shoot cultivars						
		V1	V2	V3	V4	V5	V6	Mean
B	٠	٥.٩	٣.٠	٧.٨	٧.٢	٥.٤	٩.٧	٦.٥
	٢.٥	٧.٧	٩.٧	١٠.٢	٩.٠	٥.٦	٩.٦	٨.٦
	٥	١٧.٤	١٥.٠	١١.٢	١٤.٦	١٨.١	١٥.٧	١٥.٣
	١٠	٢٥.١	٣٦.٣	١٨.١	١٦.٥	٢١.٢	٢٩.٤	٢٤.٤
	Mean	١٤.٠	١٦.٠	١١.٨	١١.٨	١٢.٦	١٦.١	
Fe	٠	36.6	33.2	38.8	39.2	38.2	37.2	٣٧.٢
	٢.٥	32.2	31.9	32.4	36.2	34.3	33.8	٣٣.٥
	٥	28.6	30.4	29.6	32.3	30.6	29.8	٣٠.٢
	١٠	25.2	26.1	30.8	29.2	28.6	26.6	٢٧.٨
	Mean	٣٠.٧	٣٠.٤	٣٢.٩	٣٤.٢	٣٢.٩	٣١.٩	
Mn	٠	١٧.٤	١٥.١	١٩.٧	١٧.٨	١٧.٧	١٨.١	١٧.٦
	٢.٥	١٤.٧	١٣.٥	١٨.٧	١٦.٩	١٧.٠	١٥.٤	١٦.٠
	٥	١٣.٦	١٢.٩	١٧.١	١٦.٠	١٦.٢	١٤.٩	١٥.١
	١٠	١٢.٩	١٢.٤	١٥.٦	١٥.٢	١٤.٧	١٣.٧	١٤.١
	Mean	١٤.٧	١٣.٥	١٧.٨	١٦.٥	١٦.٤	١٥.٥	
Zn	٠	25.7	28.6	29.6	24.8	27.6	26.6	٢٧.٢
	٢.٥	25.1	27.4	26.3	23.2	26.7	25.3	٢٥.٧
	٥	23.3	25.3	26.7	22.2	24.9	24.1	٢٤.٤
	١٠	22.4	21.6	23.4	21.3	23.1	22.1	٢٢.٣
	Mean	٢٤.١	٢٥.٧	٢٦.٥	٢٢.٩	٢٥.٦	٢٤.٥	

L.S.D at 0.05 level for	B	Fe	Mn	Zn
B	0.16	0.15	0.11	0.15
V	0.20	0.18	0.14	0.18

Effect of (B) on B content in wheat shoots:

Table (3) shows that B content was significantly increased by increasing B treatments when compared with control plants. The 10 ppm treatment showed the largest content of B. This result is in agreement with Singh *et. al.*, (1990); Cangiani Furlani *et. al.*, (2003) and Mojtaba *et. al.*, (2010) they stated that wheat cultivars showed that the leaf-B-content increased with the increasing of B added treatments.

Effect of (B) on Fe, Mn and Zn content in wheat shoots:

All of the tested cultivars exhibited a significantly gradual decreased in Fe, Mn and Zn content by increasing B treatment than control plants. These results are in accordance with Singh *et. al.*, (1990) and Lopez *et. al.*, (2002) as they showed that increasing B treatment leads to a decrease in uptake of Fe and Mn as B may be involved in changing the valence of Fe. Ayden and Sevinc (2006) found that with increasing B application Zn concentration of plant decreased. Zn efficiency enhanced tissue tolerance to B toxicity because the role of Zn in controlling permeability of roots cell membranes.

Effect of boron treatments (B) on root content of micronutrients (µg/g dw.) of wheat cultivars (V):

Table (4) shows the results of wheat root content of micronutrients (µg/g dw.) as affected by B treatments.

Table (4): Effect of boron treatments (B) on wheat cultivars (V) root content of micronutrients (µg/g dw.) grown in field after 75 days planting.

Micronutrients µg/g dw.	Treatment B ppm	Field experiment (2009-2010)						
		Results/ root cultivars						
		V1	V2	V3	V4	V5	V6	Mean
B	٠	٥.٠	٥.٠	٢.٢	٣.٩	٣.٨	٣.٣	٣.٩
	٢.٥	٥.٧	٨.٩	٢.٨	١١.٨	٤.٢	٦.٥	٦.٦
	٥	٨.١	٦.٢	٣.٩	٧.٠	٧.٢	٨.٢	٦.٨
	١٠	١١.٤	٥.٧	٤.٣	١٤.٥	٧.٣	١٠.٨	٩.٠
	Mean	٧.٦	٦.٤	٣.٣	٩.٣	٥.٦	٧.٢	
Fe	٠	59.4	54.1	52.6	50.2	54.6	56.1	٥٤.٥
	٢.٥	56.6	50.6	47.2	43.1	49.8	50.4	٤٩.٦
	٥	52.2	48.5	40.2	45.4	43.8	46.8	٤٦.٢
	١٠	48.8	39.8	41.7	39.8	40.1	41.4	٤١.٩
	Mean	٥٤.٣	٤٨.٣	٤٥.٤	٤٤.٦	٤٤.٨	٤٨.٧	
Mn	٠	٢١.١	١٩.٤	٢٢.٣	٢٠.٦	١٩.١	٢١.٨	٢٠.٧
	٢.٥	١٩.٧	١٨.٥	٢٠.٧	١٨.٧	١٧.٣	٢١.٠	١٩.٣
	٥	١٨.٣	١٧.٠	١٩.٢	١٨.١	١٦.٧	١٧.١	١٧.٧
	١٠	١٦.٢	١٤.٨	١٥.٣	١٦.٨	١٥.٠	١٦.٣	١٥.٧
	Mean	١٨.٨	١٧.٤	١٩.٤	١٨.٦	١٧.٠	١٩.١	
Zn	٠	36.9	30.1	32.5	33.3	32.5	31.1	٣٢.٨
	٢.٥	33.6	29.6	30.1	30.9	29.8	30.6	٣٠.٨
	٥	31.9	28.7	27.2	27.7	27.6	29.7	٢٨.٨
	١٠	27.8	25.8	25.6	26.7	26.3	26.6	٢٦.٥
	Mean	٣٢.٦	٢٨.٦	٢٨.٩	٢٩.٧	٢٩.١	٢٩.٥	

L.S.D at 0.05 level for	B	Fe	Mn	Zn
B	0.12	0.15	0.15	0.16
V	0.15	0.18	0.19	0.20

Effect of (B) on B content in wheat roots:

Results from table (4) showed that B content increased significantly and gradually by increasing B treatments when compared with control. The increase of leaf B concentration was higher than root (Mojtaba *et. al.* 2010). 10 ppm B treatment gave a higher B content and led to toxicity then affect at the growth and yield. Gemmeiza 9 did not appear high boron content in 5 and 10 ppm B treatment because translocation of B to shoots.

Effect of (B) on Fe, Mn and Zn content in wheat roots:

It is observed from the table (4) that Fe, Mn and Zn content decreased significantly and gradually by increasing B treatments when compared with control. Singh *et. al.*, (1990) and Ayden and Sevinc (2006) observed that when roots increased in B uptake Fe and Mn content decreased. And they added that Zn can exert an inhibitory effect on excess B uptake by roots.

Effect of boron treatments (B) on shoot content of macronutrients (%) of wheat cultivars (V) :

Table (5) shows the results of wheat shoot content of macronutrients (%) as affected by boron treatments.

Effect of (B) on N content in wheat shoots:

Results in table (5) shows the effect of boron treatments on N content in shoot. Nearly the N content was increased by all B treatments. Meanwhile, the 5 ppm B treated plants showed the higher N content when compared with the other treatments and that was true for all tasted cultivars. 10 ppm B treatment showed a decrease in N content compared with the 5 ppm B treatment. These results are in agreement with Chhipa and Lal (1989); Diab (1992) and Ayden and Sevine (2006) as they found N concentration was increased by increasing B application. Also, added that the increasing in B led to NO_3-accumulation due to the decrease in the activity of the N-Rase enzyme suggesting a specific effect of B on N-Rase activity.

Effect of boron treatments (B) on K content in wheat shoots:

The highest K content was observed when Gemmeiza cultivars (V1, V2 and V3) were treated by 10 ppm B, while 5 ppm B treatment showed the highest K content in Sakha 94 (V5) and Giza 168 (V6). These results are agreement with Khair, *et. al.*, (2002) and Tariq and Mott (2006) they found K content was increased with increasing B treatment.

Effect of (B) on P, Ca, Mg and Na content in wheat shoots:

Result shows that P, Ca, Mg and Na content of wheat plants shoot was decreased significantly by increasing B treatment when compared with control sample. the depressed Ca content may be due to antagonism with B. These results are in accordance with Diab (1992); Tariq and Mott (2006) and Mazher, *et. al.*, (2006) as they found the same results. This decrease could be related to the observed lower rate of plant growth at higher B levels.

Table (5): Effect of boron treatments (B) on wheat cultivars (V) shoot content of macronutrients (%) grown in field after 75 days planting.

Macronutrients %	Treatment B ppm	Field experiment (2009-2010) Results/ shoot cultivars						
		V1	V2	V3	V4	V5	V6	Mean
N	٠	2.4	2.1	2.4	2.3	2.2	2.4	**2.3**
	٢.٥	2.7	2.6	2.5	2.5	2.6	2.7	**2.6**
	٥	2.7	2.9	2.8	2.8	2.7	2.9	**2.8**
	١٠	2.5	2.8	2.8	2.6	2.6	2.9	**2.7**
	Mean	**2.6**	**2.6**	**2.6**	**2.6**	**2.5**	**2.7**	
P	٠	0.38	0.44	0.43	0.42	0.44	0.43	٠.٤٢
	٢.٥	0.40	0.42	0.37	0.35	0.38	0.37	٠.٣٨
	٥	0.35	0.39	0.37	0.41	0.40	0.31	٠.٣٧
	١٠	0.35	0.31	0.32	0.31	0.32	0.25	٠.٣١
	Mean	٠.٣٧	٠.٣٩	٠.٣٧	٠.٣٧	٠.٣٩	٠.٣٤	
K	٠	2.0	2.1	2.1	2.1	1.9	2.1	٢.١
	٢.٥	2.1	2.3	2.2	2.4	2.0	2.3	٢.٢
	٥	2.5	2.5	2.3	2.4	2.4	2.4	٢.٤
	١٠	2.7	2.7	2.6	2.3	2.1	2.2	٢.٤
	Mean	٢.٣	٢.٤	٢.٣	٢.٣	٢.١	٢.٣	
Ca	٠	0.35	0.34	0.37	0.34	0.32	0.34	٠.٣٤
	٢.٥	0.32	0.32	0.35	0.31	0.30	0.30	٠.٣٢
	٥	0.29	0.27	0.34	0.30	0.28	0.29	٠.٣٠
	١٠	0.26	0.25	0.30	0.27	0.26	0.26	٠.٢٧
	Mean	٠.٣١	٠.٣٠	٠.٣٤	٠.٣١	٠.٢٩	٠.٣٠	
Mg	٠	0.24	0.25	0.26	0.22	0.26	0.29	٠.٢٥
	٢.٥	0.21	0.23	0.25	0.21	0.22	0.26	٠.٢٣
	٥	0.20	0.20	0.22	0.20	0.21	0.26	٠.٢٢
	١٠	0.19	0.18	0.18	0.18	0.19	0.22	٠.١٩
	Mean	٠.٢١	٠.٢٢	٠.٢٣	٠.٢٠	٠.٢٢	٠.٢٦	
Na	٠	٠.٨٠	١.١٦	١.٠٣	٠.٨٢	١.٠٦	٠.٨٠	٠.٩٤
	٢.٥	٠.٦٥	٠.٨٥	٠.٦٨	٠.٥٥	٠.٧٨	٠.٤٨	٠.٦٦
	٥	٠.٥٠	٠.٥٥	٠.٦٠	٠.٥٢	٠.٤٣	٠.٣٥	٠.٤٩
	١٠	٠.٤٣	٠.٤٠	٠.٥٣	٠.٤٧	٠.٣٧	٠.٢٧	٠.٤١
	Mean	٠.٥٩	٠.٧٤	٠.٧١	٠.٥٩	٠.٦٦	٠.٤٧	

L.S.D at 0.05 level for:	N	P	K	Ca	Mg	Na
B	0.11	0. 12	0.08	0. 13	0. 12	٠.٠٢
V	0.13	0. 15	0.10	0. 16	0. 16	٠.٠٢

Effect of boron treatments (B) on root content of macronutrients (%) of wheat cultivars (V):

Table (6) which show the results of root content of macronutrients (%) as affected by boron treatments.

Effect of boron treatments (B) on N content in wheat roots:

Results from table (6) showed that cultivars varied in their response to B treatment. All tested plants showed an increase in N content when tested with all B concentrations in particular with 5 and 10 ppm. Tariq and Mott (2006) stated that B toxicity resulted in NO_3-accumulation due to the decrease in the activity of the N-Rase enzyme.

Table (6): Effect of boron treatments (B) on wheat cultivars (V) root content of macronutrients (%) grown in field after 75 days planting.

Macronutrients %	Treatment B ppm	Field experiment (2009-2010)						
		Results/ root cultivars						
		V1	V2	V3	V4	V5	V6	Mean
N	٠	1.8	1.9	2.0	1.7	1.6	1.9	**1.8**
	٢.٥	2.0	2.2	2.2	1.9	1.8	2.1	**2.0**
	٥	2.1	2.1	2.2	2.0	2.0	2.0	**2.1**
	١٠	1.9	2.3	2.1	2.1	2.0	2.1	**1.9**
	Mean	**2.0**	**2.1**	**2.1**	**1.9**	**1.9**	**2.0**	
P	٠	0.43	0.38	0.44	0.43	0.39	0.38	٠.٤١
	٢.٥	0.37	0.36	0.38	0.41	0.34	0.31	٠.٣٦
	٥	0.28	0.31	0.32	0.34	0.32	0.26	٠.٣١
	١٠	0.26	0.29	0.27	0.30	0.27	0.24	٠.٢٧
	Mean	٠.٣٤	٠.٣٤	٠.٣٥	٠.٣٧	٠.٣٣	٠.٣٠	
K	٠	2.2	2.5	2.1	2.0	2.1	2.2	٢.٢
	٢.٥	2.4	3.0	2.2	2.5	2.4	2.7	٢.٥
	٥	2.5	3.0	2.3	2.4	2.5	2.4	٢.٥
	١٠	2.8	2.9	2.5	2.7	2.3	3.1	٢.٧
	Mean	٢.٥	٢.٨	٢.٣	٢.٤	٢.٣	٢.٦	
Ca	٠	0.44	0.43	0.41	0.36	0.37	0.43	٠.٤١
	٢.٥	0.40	0.41	0.39	0.34	0.35	0.41	٠.٣٨
	٥	0.37	0.37	0.37	0.33	0.33	0.38	٠.٣٦
	١٠	0.32	0.34	0.33	0.31	0.32	0.37	٠.٣٣
	Mean	٠.٣٨	٠.٣٩	٠.٣٨	٠.٣٤	٠.٣٤	٠.٤٠	
Mg	٠	0.25	0.23	0.26	0.26	0.27	0.28	٠.٢٦
	٢.٥	0.23	0.22	0.24	0.25	0.25	0.26	٠.٢٤
	٥	0.21	0.20	0.21	0.20	0.22	0.22	٠.٢١
	١٠	0.17	0.19	0.19	0.18	0.19	0.18	٠.١٨
	Mean	٠.٢٢	٠.٢١	٠.٢٣	٠.٢٢	٠.٢٣	٠.٢٤	
Na	٠	٠.٣٧	٠.٣٤	٠.٣٢	٠.٣٠	٠.٢٧	٠.٣٢	٠.٣٢
	٢.٥	٠.٣٦	٠.٣١	٠.٣٠	٠.٢٨	٠.٢٤	٠.٣٠	٠.٣٠
	٥	٠.٣٣	٠.٣٠	٠.٢٧	٠.٢٥	٠.٢٣	٠.٢٧	٠.٢٧
	١٠	٠.٢٩	٠.٢٧	٠.٢٥	٠.٢٣	٠.١٨	٠.٢٤	٠.٢٤
	Mean	٠.٣٤	٠.٣٠	٠.٢٨	٠.٢٦	٠.٢٣	٠.٢٨	

L.S.D at 0.05 level for:	N	P	K	Ca	Mg	Na
B	0.11	0.012	0.09	0.011	0.014	٠.٠١
V	0.14	0.015	0.11	0.014	0.017	٠.٠٢

Effect of (B) on K content in wheat roots:

The K content in all cultivars was increased with increasing B treatments. The 10 ppm of B treatment significantly increased K content in all cultivars. Meantime, the 5 ppm of B treatment showed the highest K content in Gemmeiza 9 (V2) and Sakha 94 (V5). The stimulation of K accumulation by the ATPase proton pumps be may account for positive correlation between K and B.

Effect of (B) on P, Ca, Mg and Na content in wheat roots:

Results showed that P, Ca, Mg and Na content was decreased by increasing B treatments, that was true for all cultivars when compared with control sample. The higher increments of applied B (5 and 10 ppm) markedly decreased the P concentration; this decrease could be related to the observed lower rate of growth at higher B levels (Diab, 1992). Increasing K content occurred due to B toxicity led to decreased Ca and Na because of antagonism (Tariq and Mott 2006).

Conclusions:

Wheat is the most important winter cereal so that, we should improve the best element nutrients in soil to gave a good seeds. Undetected deficiency of micronutrients such as B would probably restrict wheat production. The experiments clearly demonstrated that the application of B was effective in improving wheat performance. It is clear from the results in this investigation that:

- 2.5 ppm B treatment led to the best effects on growth parameters like (plant height– chlorophyll content - number of tillers per plant) because of availability of N which led to cell division, elongation and increase in chlorophyll.
- 2.5 ppm B treatment gave the best effects on yield and yield components like (spike length - number of grains per spike- grain yield) because of availability of N which led to elongation cell and enhanced pollen tube germination and grain setting.
- 5 ppm B treatment did not show a good effect with cultivars as compared by 2.5 ppm B treatment. Sometimes this treatment shows a significant parameter but, this was not meaning that it's better than 2.5 ppm B treatment.
- 10 ppm B treatment gave a harmful effect on the different tested parameters because of the stress of toxicity.
- The high concentration of B treatment led to an increase in the content of B, N and K, but the content of Fe, Mn, Zn, P, Ca, Mg, and Na was decreased.
- The present results showed that Gemmeiza cultivars were more responded with B fertilizer as compared with other cultivars Giza 168 or Sakha.

The results suggested that 2.5 ppm B treatment is suitable for wheat to give better growth and yield because the good effect of this treatment on plant growth, chlorophyll content, yield components and concentration of N which refract on increase yield.

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التأثير المنظم لمعاملات البورون على نمو وإنتاجية ست أصناف قمح مصرية

يعتبر القمح واحدا من أهم محاصيل الحبوب فى العالم. وعنصر البورون واحداً من العناصر المغذية الصغرى الهامة لنمو وإنتاجية محصول القمح، ونقصه فى التربة منتشر فى الاراضى الزراعية.

أجرى هذا البحث لدراسة تأثير أربع معاملات لعنصر البورون (٠ ، ٢,٥ ، ٥ ، ١٠ جزء فى المليون) لتسميد ستة من أصناف القمح المحلية. ودرس تأثير المعاملات بالبورون على بعض قياسات النمو مثل (طول النبات - محتوى الكلوروفيل - عدد الاشطاء/النبات) وعلى صفات المحصولية مثل (طول السنبلة - عدد الحبوب/السنبلة – وزن محصول الحبوب للحقل). كما درس أيضا تأثير المعاملات بالبورون على انتقال بعض العناصر الغذائية الصغرى مثل (البورون ، الحديد ، المنجنيز ، الزنك) والكبرى مثل (النيتروجين ، الفوسفور ، البوتاسيوم ، الكالسيوم ، المغنسيوم ، الصوديوم) إلى النبات.

وأوضحت النتائج أن أصناف القمح محل الدراسة أظهرت نتائج ايجابية للتركيز الأول للبورون (٢,٥ جزء فى المليون) بزيادة قياسات النمو و الصفات المحصولية لغالبية الأصناف فى نفس الوقت.

ومن ناحية أخرى أظهر التركيز الأعلى للبورون (١٠ جزء فى المليون) تأثيرات ضارة بتقليل الصفات المدروسة. كما زادت معاملات البورون من تركيز بعض العناصر مثل (النيتروجين و البوتاسيوم و البورون)، بينما خفضت تركيز عناصر أخرى مثل (الحديد و المنجنيز و الزنك و الفوسفور و الكالسيوم و المغنسيوم و الصوديوم).

وكانت أفضل الأصناف فى الاستجابة للمعاملات هى مجموعة أصناف الجميزة (٧ و ٩ و ١٠).