J. Agric. Sci. Mansoura Univ., 25 (3): 1873 - 1882, 2000

EFFECT OF FOLIAR SPRAY WITH ZINC AND BORON ON YIELD AND SOME CHEMICAL CONSTITUENTS OF FABA BEAN.

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ABSTRACT

Two field trials were carried out at the experimental farm of Gemmeiza Agricultural Research Station during the two successive seasons 1997/98 and 1998/99 to study the response of faba bean plants, cultivar Giza-2, to foliar spray with Zn and B at concentrations of 250, 500 and 750 ppm.

The obtained data showed that leaves of plants sprayed with Zn or B contained more amounts of chlorophyll and carotene than untreated plants. In general, the differences in total chlorophyll among Zn or B levels were not significant after 60 days from sowing and significant at the late stage of growth (90 days after sowing).

All studied levels of Zn and B significantly increased plant height, No. of branches / plant, straw and seed yield, 100 seed weight and protein yield. The mid rate of Zn i.e 500 ppm and the high one of B i.e 750 ppm were the most effective treatments in this respect.

Concentrations of N,P and K in plants responded differentially (at the two stages of growth i.e 60 and 90 days after sowing) to the foliar spray with Zn or B. The highest values of N and P concentrations at 60 days from sowing were for plants sprayed by 500 ppm Zn or 750 ppm B. At the late stage of growth, 90 days after sowing, N concentration reached to maximum values with application of high level of either Zn or B while the highest P concentrations were obtained with the mid rate of Zn or B. The high level of Zn and the mid level of B reflected highest K concentrations at the late stage of growth

Seeds and straw of plants sprayed with either Zn or B contained high amounts of N, P and K compared to untreated plants. Generally the highest relative increases in N, P and K uptake in seeds were obtained with application of Zn and B at 500 and 750 ppm respectively.

Keywords: Faba bean, micro-nutrient, zinc, boron, NPK uptake, chlorophyll, carotene , protein.

INTRODUCTION

Faba bean is one of the most important leguminous crop grown in Egypt. The production was insufficient to provide the needs of local demand, so many efforts are made in Egypt to increase faba bean yield and improved its nutritional value. The decrease in mud of the river nile, which contained sufficient amounts of micro-nutrients, after the construction of Aswan High Dam led to exhaustion of the supply in the available micro-nutrients of soil. Recently interest has been manifested to micro-nutrients, which caused various physiological and biochemical effects on the growth and development of plants. Zinc play an important role in auxin metabolism, activation of many enzymes such as carbonic anhydrase, dehydrogenases and phosphodiesterase, stabilizers ribosomal fractions, zinc deficiency restrict RNA synthesis which in turn inhibits protein synthesis. Boron play an important role in RNA metabolism, translocation of carbohydrates through the plant and activity of GA and α amylase (Rains, 1976).

There were many attempts by several investigators to study the effect of micro-nutrients on growth, yield and chemical constituents of many plants. Increasing of photosynthetic pigments as a result of Zn and B application was reported by several investigators i.e., Shehata (1980) found that spraying wheat plants with either Zn or B increased all of chlorophyll a, b and carotene. Abed *et al*., (1984) noticed that foliar application of Zn or B increased photosynthetic pigments of tomato plant leaves. Eissa *et al.* (1992), and Nassar (1997) observed that spraying wheat plants with zinc sulphate increased leaf chlorophyll and carotene content.

An increase in faba bean growth and yield due to application of micro-nutrients Zn and B was reported by Ziolek(1984) Mazur and Mazur (1984) and Fawzi *et al.* (1986). The effect of Zn and B on the nutrients content was also reported by Paja and Reddy (1987). EL-Naggar *et.al*. (1994) and Nassar (1997).

The objective of the present investigation was to study the effect of foliar application of zinc and boron on photsynthetic pigments, growth, yield and chemical composition of faba bean plants.

MATERIALS AND METHODS

Two field experiments were conducted at the experimental farm of Gemmeiza Agricultural Research station during two successive growing seasons, 1997/98 and 1998/99 to study the effect of the micronutrients zinc and boron on faba bean plants , cultivar Giza-2.

The experimental soil was clay loam with pH values 8 and 7.8 (in 1:2.5 suspention) in the two seasons, respectively. Available N, P, K, Zn and B were 36, 10, 380, 0.82 and 0.52 ppm, respectively in the first season and 38, 9, 430, 0.82 and 0.56 ppm in the second one followed the same order. The complete randomized blocks design with four replicates was followed, plot area was 21 m^2 includes 7 rows.

Basal addition of nitrogen, phosphorus and potassium were added to the experimental plots before sowing at the rates of 15 kg N, 15.5 kg P_2O_5 and 24 kg k_2O/fed. as urea 46%N, calcium superphosphate 15.5% P_2O_5 and potassium sulphate 48% K_2O, respectively .Micronutrients Zn and B were applied as foliar spray in forms of zinc sulphate ($Zn\ SO_4.\ 7H_2O$) and boric acid (H_3BO_3) at concentrations of O, 250, 500 and 750 ppm. Micro-nutrient solutions were sprayed twice, one after 30 days from sowing and repeated after 15 days the sprayed solution was used at rate of 250 L/fed .

Two frish samples of faba bean plants were taken from each treatment after 60 and 90 days from sowing, photosynthetic pigments i.e chlorophyll a, b and carotene were determined in the fourth fresh leaf of each sample according to the method described by Wettstein (1957). The remained of plant samples were dried at 70 c° , crushed and stored for chemical analysis. After harvesting, plant height, number of branches per plant, seeds and straw yields were recorded. Samples of seeds and straw were taken, dried and ground to powder then stored for chemical analysis.

Nitrogen was determined using micro-kjeldahl method as described by Hesse (1971). Phosphorus was determined colorimetrically using the chlorostannous reduced molybdophosphoric blue colour method as described by Jackson (1967). Potassium was determined using a flame photometer. Protein was calculated by multiplying nitrogen content by 6.25 according to Osborne and Voogt (1978).

All collected data were statistically analysed according to the method described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Photosynthetic pigments:

Data concerning the effect of Zn and B on the leaf content of chlorophylls and caroteniods are recorded in Table (1). It is clear from data that leaf of plants sprayed with Zn or B contains more amounts of chlorophyll and carotene than those of untreated plants. Chlorophyll a and total chlorophyll, at the two stages of growth, increased significantly with application of either zinc or boron. In general, the differences in chlorophyll a and total chlorophyll among Zn and B levels were not significant at the first stage of growth and significant at the second stage. The maximum increase in the total chlorophyll obtained with application of 500 PPm Zn or 750 ppm B.

Chlorophyll b content especially at the late stage of growth (90 days after sowing), responded significantly to spraying faba bean plants with zinc or boron. The most effective levels of Zn and B in increasing chlorophyll b were 500 and 750 ppm respectively.

Carotene showed insignificant increase with application of Zn or B at any applied level, these results were generally true in the two studied seasons. From the above mentioned results it can be concluded that application of Zn or B up to 500 and 750 ppm, respectively resulted in faba bean plants contain high amounts of photosynthetic pigments.

The encouragement effect of Zn and B on chlorophyll and carotene may be attributed to its effects either directly by affecting the activity of enzymes responsible for the biosynthesis of photosynthitic pigments (Aizupiete 1968) or indirectly through the influence of these micronutrients on nitrogen metabolism (Ashour and Thalooth 1974). The effect of zinc and boron on photosynthetic pigments was also reported by Shehata (1980), Abed *et al.* (1984) and Eissa *et al*, (1992).

Growth and yield

Data in Table (2) show that plants sprayed with Zn or B were taller and had more branches than untreated plants. It is clear from such data that all levels of Zn and B caused a significant increase in plant height compared to untreated plants. The differences were not significant when Zn concentration increased from 250 to 500 or 750 ppm. This trend observed in the two studied seasons. Increasing B concentration in the spraying solution reflected in a gradual increase in plant height but the increments among the three applied levels were not significant.

Table (1) : Effect of Zn and B on leaf content of photosynthetic pigments at 60 and 90 days after sowing (mg / g dry weight)

Days after sowing Treatments	60				90			
	Chl.a	**Chl.b**	**(a+b)**	**Carot**	**Chl. a**	**Chl .b**	**(a+b)**	**Carot**
	First season (1997-1998)							
Control	9.20	2.97	12.17	4.43	8.82	2.63	11.45	3.80
Zn 250 ppm	10.56	3.68	14.24	4.63	10.38	3.58	13.96	4.18
500 ppm	11.78	4.37	16.15	4.98	11.29	4.07	1536	4.28
7500ppm	11.14	3.92	15.06	4.96	8.77	2.91	11.68	3.82
B 250 ppm	9.93	3.43	13.36	4.56	9.36	3.19	12.55	3.97
500 ppm	10.94	3.68	14.62	4.61	9.92	3.70	13.62	4.06
750 ppm	10.93	4.02	14.95	4.91	10.84	3.98	14.82	4.09
L.S.D 0.05	1.31	N.S	2.03	N.S	0.85	0.46	0.92	N.S
	Second season (1998 / 1999)							
Control	8.84	2.71	11.55	4.29	8.17	2.25	10.42	3.80
Zn 250 ppm,	10.46	3.53	13.99	4.40	9.31	3.16	12.47	4.10
500 ppm	11.13	4.02	15.15	4.79	10.59	3.70	14.29	4.22
750 ppm	10.14	3.29	13.43	4.75	8.46	2.59	11.05	3.87
B 250 ppm	9.33	3.03	12.36	4.36	8.57	2.79	11.36	3.89
500 ppm	10.33	3.27	13.60	4.39	9.19	3.32	12.51	3. 91
750 ppm	10.27	3.66	13.93	4.71	10.13	3.63	13.76	3.96
L.S.D 0.05	1.72	N.S	1.64	N.S	0.84	0.48	1.19	N.S

All levels of Zn or B showed significant positive effect in number of branches / plant compared to control. The highest values can be observed in plants sprayed by 500 ppm Zn or 750 ppm B. Number of branches / plant did not respond significantly to increasing level of Zn or B from 500 ppm to the two higher applied levels of both elements.

The stimulating effect of Zn and B on plant height and number of branches / plant may be due to the role of these elements in cell development and the production of IAA which is essential for the elongation of plants (Nicholas , 1961 and Follet *et al*. 1981). These results are in agreement with those obtained by Kumar *et al.* (1988) and Nassar (1997)

Seed and straw yields increased significantly with application of Zn or B at any studied concentrations compared to control. The mid rate of Zn and the high one of B were the most effective treatments in this respect. The weight of 100 seeds and protein yield followed the same trend.

The favourite effect of Zn and B on seeds and straw yield may be due to their effects on increasing activity of carboxylating enzymes, carbonic anhydrase and the rate of photochemical reduction, which reflected in maximizing dry matter accumulation (Kumar *et, al*. 1988). The increase in protein yield could be attributed to the enhancing effect of Zn and B on the utilization of N for true protein synthesis, (Mazur and Mazur 1984). The results are in agreement with those obtained by Reisenauer *et al.* (1973), Ziolek (1984), Fawzi *et al.* (1986), EL- Naggar *et al.* (1994) and Nassar (1997).

Table (2) : Effect of Zn and B on some growth characters, seed, straw and protein yield.

Treatments	Plant height (cm)	No. of branches / plant	Straw yield (ton/fed)	Seed yield (kg/fed)	100seed weight (g)	Protein yield (kg/fed.)
	First season (1997 /1998)					
Control	104.2	3.31	2.33	1274	61.56	296.8
Zn250 pm	116.4	3.96	2.64	1462	65.74	358.8
500ppm	121.4	4.42	2.77	1556	69.99	401.6
750 ppm	119.4	4.38	2.66	1519	68.60	382.6
B250 ppm	115.5	4..20	2.67	1505	68.41	377.8
500 ppm	116.7	4.48	2.79	1569	71.08	416.1
750 ppm	119.8	4.61	2.89	1601	72.83	427.2
L.S.D .05	6.2	0.59	0.29	112	3.77	34.2
	Second season (1998 /1999)					
Control	110.1	3.75	2.50	1440	63.74	342.4
Zn250 pm	122.2	4.34	2.77	1628	67.86	400.2
500 ppm	126.7	4.71	2.89	1713	72.08	436.6
750 ppm	122.6	4.70	2.79	1654	70.68	416.6
B250 ppm	119.7	4.49	2.81	1645	70.42	413.1
500 ppm	124.0	4.79	2. 91	1711	73.09	444.3
750 ppm	127.6	4.91	2.99	1747	74.86	455.9
L.S.D 0.05	9.5	0.58	0.20	88	3.55	29.2

Nutrients N,P and K content during vegetative growth

Data concerning the effect of Zn and B on N,P and K percentage of faba bean plants during its vegetative growth (at 60 and 90 days after sowing) are shown in Table (3). It is quite clear from such data that the percentage of N,P and K responded significantly to foliar spray with Zn or B. This effect was true in the two seasons at the two stages of growth. In this concern there were no significant differences in nitrogen percentage, at the first stage of growth, among the three levels of Zn, while increasing B applied level from 250 to 500 or 750 ppm resulted in a gradual significant increase in N percentage. At the second stage of growth, N percentage increased significantly with increasing Zn level up to 500 ppm. On the other hand no significant differences were detected among the three rates of B at this age. This trend was true in both two seasons.

As for P content, data show that the concentration of P at the first stage of growth increased significantly with application of mid and high level of Zn or any B level compared to control. The low level of Zn also increased P concentration but the increments did not reach to significant levels. These results were insistently observed in the two studied seasons. At the second stage of growth, P concentration in plants sprayed with 500 ppm Zn or any B level increased significantly compared to untreated plants. The differences in P concentrations among the levels of either Zn or B showed no significant values at the second stage of growth.

Table (3) : Effect of Zn and B on NPK percentage of faba bean plants after 60 and 90 days from sowing.

Days after sowing	60			90		
	N	P	K	N	P	K
Treatments	First season (1997 /1998)					
Control	3.398	0.446	2.424	3.302	0.400	2.208
Zn 250 ppm	3.789	0.468	2.536	3.448	0.416	2.312
500 ppm	3.912	0.488	2.718	3.693	0.436	2.506
750 ppm	3.820	0.488	2.680	3.865	0.422	2.641
B 250 ppm	3.704	0.482	2.745	3.642	0.456	2.536
500 ppm	3.942	0.492	2.822	3.800	0.460	2.681
750 ppm	4.008	0.526	2.798	3.822	0.453	2. 668
L.S.D 0.05	0.229	0.033	0.106	0.233	0.036	0.104
	Second season (1998 / 1999)					
Control	3.643	0.467	2.341	3.515	0.415	2.106
Zn 250 ppm	3.966	0.488	0.425	3.653	0.432	2.211
500 ppm	4.107	0.510	2.613	3.895	0.447	2.411
750 ppm	4.011	0.508	2.585	4.063	0.439	2.543
B 250 ppm	3.899	0.504	2.634	3.815	0.467	2.443
500 ppm	4.131	0.509	2.714	3.958	0.472	2.581
750 ppm	4.195	0.543	2.696	3.973	0.470	2.562
L.S.D 0.05	0.216	0.025	0.110	0.231	0.030	0.097

Concerning K content, the results illustrated that K concentration at the two growth stages increased significantly with application of Zn or B at any used level in both seasons. The maximum concentrations of K at the first stage of growth were obtained in plants sprayed with 500 ppm of either Zn or B. At the second stage, K concentrations reached to its maximum values with application of Zn or B at 750 ppm.

The increase in N, P and K content of plants during its vegetative growth could be interpreted to the enhancing effect of Zn and B on plant growth and subsequently increased N, P and K uptake. The results are in harmony with those found by Paja and Reddy (1987) and Nassar (1997).

Nutrients N , p and K content in seeds and straw

Data presented in Table (4) show that seeds and straw of plants sprayed with either Zn or B contained high concentrations of N , P and K compared to untreated plants. The increments were significant for N, P and K concentrations in seeds and only for N concentration in straw, while the increments in P and K concentration in straw did not reach to significant values. The highest relative increase in N and P concentrations in seeds were obtained with application of mid level of Zn and high level of B. The highest values of K concentration in seeds resulted with the high level of either Zn or B. This trend was observed in the two studied seasons.

As for the effect of Zn and B on N, P and K uptake, data recorded in Table (5) reveal that N,P and K uptake in seeds and straw responded positively to foliar spray with Zn or B. It is quite clear from such data that N uptake in seeds increased significantly with increasing applied levels of Zn or

B up to 500 ppm. The increment was not significant when Zn or B increased from 500 to 750 ppm. This trend was true in straw only with B treatments whereas the differences among the three levels of Zn were not significant. So spraying faba bean plants with 500 ppm of either Zn or B is accepted for increasing N uptake in seeds and subsequently protein production.

Table (4) : Effect of Zn and B on NPK percentage of faba been seeds and straw.

Treatments	Seeds			Straw		
	N	P	K	N	P	K
	First season (1997 /1998)					
Control	3.727	0.385	0.814	0.447	0.153	0.930
Zn 250 ppm	3.928	0.400	0.850	0.465	0.158	0.952
500 ppm	4.129	0.437	0.909	0.488	0.186	1.000
750 ppm	4.030	0.402	0.914	0.467	0.187	0.988
B 250 ppm	4.016	0.432	0.870	0.467	0.166	0.967
500 ppm	4.244	0.477	0.898	0.508	0.181	1.014
750 ppm	4.269	0.490	0.913	0.483	0.174	1.019
L.S.D 0.05	0.190	0.025	0.056	0.033	N.S	N.S
	Second season (1998 /1999)					
Control	3.805	0.396	0.752	0.453	0.160	0.844
Zn 250 ppm	3.934	0.410	0.760	0.468	0.166	0.859
500 ppm	4.079	0.446	0.822	0.489	0.193	0.918
750 ppm	0.030	0.416	0.858	0.467	0.190	0.900
B 250 ppm	4.019	0.442	0.814	0.467	0.177	0.875
500 ppm	4.154	0.483	0.819	0.504	0.189	0.923
750 ppm	4.176	0.495	0.864	0.486	0.184	0.933
L.S.D 0.05	0.141	0.025	0.068	0.030	N.S	N.S

Table (5): Effect of Zn and B on NPK uptake of faba been seeds and straw. (kg/fed.)

Treatments	Seeds			Straw		
	N	P	K	N	P	K
	First season (1997 /1998)					
Control	47.49	4.91	10.37	10.42	3.52	21.67
Zn 250 ppm	57.41	5.85	12.42	12.28	4.17	25.13
500 ppm	64.26	6.80	14.15	13.52	5.15	27.70
750 ppm	61.22	6.11	13.88	12.42	4.97	26.28
B 250 ppm	60.44	6.50	13.09	12.47	4.43	25.82
500 ppm	66.57	7.48	14.09	14.17	5.05	28.29
750 ppm	68.35	7.84	14.62	13.96	5.03	29.45
L.S.D 0.05	5.47	0.58	1.30	1.25	0.73	3.40
	Second season (1998 /1999)					
Control	54.79	5.70	10.83	11.33	4.00	21.10
Zn 250 ppm	64.03	6.67	12.37	12.96	4.60	23.79
500 ppm	69.86	7.64	14.08	14.13	5.58	26.53
750 ppm	66.65	6.88	14.19	13.03	5.30	25.11
B 250 ppm	66.09	7.27	13.39	13.12	4.97	24.59
500 ppm	71.08	8.27	14.01	14.67	5.50	26.86
750 ppm	72.95	8.65	15.09	14.53	5.50	27.90
L.S.D 0.05	4.67	0.63	1.33	1.25	0.68	1.91

Any used level of Zn or B increased P and K uptake in seeds and straw compared to control in both seasons. No significant differences were detected in P and K uptake between 500 and 750 ppm of B. On the other hand increasing Zn applied level from 500 to 750 ppm slightly decreased the increments in P and K uptake in either seeds and straw.

The increments in N,P and K concentration and uptake in seeds and straw may be due to the stimulating effect of Zn and B on the absorption and translocation of these elements. Similar results were obtained by Paja and Reddy (1987), they found that foliar spray of Zn or B led to significant increase in N,P and K uptake, Ziolek (1984) observed that application of B increased crude protein content. Fawzi *et al*. (1986), EL-Naggar *et al*. (1994) and Nassar (1997) reported that application of Zn enhanced N,P and K concentration and uptake.

It could be concluded from the aforementioned results that spraying faba bean plants with 500 ppm of either Zn or B is accepted for increasing the productivity beside improving seed quality.

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تأثير الرش بالزنك والبورون على المحصول وبعض المكونات الكيماوية فى الفول البلدى

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أقيمت تجربتان حقليتان بالمزرعة البحثية لمحطة البحوث الزراعية بالجميزة خلال موسمى 1998/1997 ، 1998 /1999 لدراسة تأثير رش نباتات الفول البلدى (صنف جيزه —2) بعنصرى الزنك والبورون بتركيزات 250 ، 500 ، 750 جزء فى المليون على محتوى الأوراق من صبغات البناء الضوئى ، المحصول ، كمية البروتين وكذلك المحتوى من عناصر النتروجين والفوسفور والبوتاسيوم. وقد أوضحت النتائج المتحصل عليها ما يأتى:

زيادة كمية الكلوروفيل والكاروتين فى أوراق النباتات المعاملة بالزنك أو البورون مقارنة بالكنترول وذلك عند عمرى 60 ، 90 يوم من الزراعة. وقد كان الاختلاف فى كمية الكلوروفيل الكلى نتيجة اختلاف التركيزات المستخدمة من الزنك والبورون معنويا عند عمر 90 يوم من الزراعة.

جميع المستويات المستخدمة من الزنك أو البورون أدت إلى زيادة فى طول النبات وعدد الفروع كما كان هناك زيادة أيضا فى محصول البذور والقش وكذلك محصول البروتين.

أدى رش النباتات بتركز 500 جزء فى المليون من الزنك أو 750 جزء فى المليون من البورون إلى الحصول على أعلى تركيز من النتروجين والفسفور فى الأنسجة النبائية عند عمر 60 يوم من الزراعة وعندما بلغت النباتات عمر 90 يوم من الزراعة كان أعلى تركيز للنتروجين فى أنسجة النباتات التى عوملت بتركيز 750 جزء فى المليون من أى من العنصرين بينما كانت المعاملة بتركيز500 جزء فى المليون من أى من العنصرين كاف للوصول بالفوسفور فى الأنسجة البنائية إلى أعلى تركيز ، وبالنسبة لمحتوى النباتات من البوتاسيوم عند هذا العمر كانت أفضل المعاملات 750 جزء فى المليون زنك ، 500 جزء فى المليون بورون

تركيز كل من النتروجين والفوسفور والبوتاسيوم وكذلك الكمية الممتصة من هذه العناصر فى البذور والقش إذدادت بالنسبة للنباتات التى عوملت بالزنك أو البورون مقارنة بتلك التى لم تعامل. وبصفة عامة فإن أكبر زيادة فى كمية النتروجين والفوسفور والبوتاسيوم الممتصة فى البذور كانت فى النباتات التى عوملت بـ 500 جزء فى المليون من الزنك أو 750 جزء فى المليون من البورون.