ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 44(3): 1307-1322, (2006).

RESPONSE OF PEANUT TO FOLIAR SPRAY WITH BORON AND/OR RHIZOBIUM INOCULATION

BY

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ABSTRACT

A field experiment was carried out on peanut plants grown on sandy soil at Ismailia Agriculture Station, Egypt during two successive summer seasons of 2005 and 2006 to evaluate the influence of boron foliar spray with boron at three rates 100, 200 and 300 mg L^{-1} with a total volume of 600 L/fed for each B-concentration and/ or without microbial inoculation (*Rhizobium japonicum*) on crop yield, yield components, oil and protein contents as well as nutritive status.

The obtained data indicate that seeds inoculated with Rhizobium strains alone or combined with different boron levels showed significant increases in all studied parameters of peanut as compared with the corresponding treatments without biofertilizers. Foliar spray with 200 mg L^{-1} of boron/fed and inoculation with Rhizobium strains gave the highest values of peanut seed and straw yields as well as some yield components, i.e. weight of 100 seeds, pods yield (kg / fed), and shilling % as compared with the control treatment..

Also, inoculation with Rhizobium strains alone or combined with different levels of B increased significantly the uptake of N, P, K, Fe, Mn, Zn and B by straw and seeds of peanut as compared with the corresponding treatments without biofertilizer. The highest values of N, P, K, Fe and Mn uptake by straw and seeds of peanut plants were obtained by using (200 mg L^{-1} of B + inoculation with Rhizobium spp.), while the highest values of Zn and B uptake by straw and seeds were obtained by using (300 mg L^{-1} of B + inoculation with Rhizobium spp.).

The highest oil and protein percentages of peanut seeds were attained when the highest level of B (300 mg L^{-1}) was used followed by 200 and 100 mg L^{-1} in a descending order. Also, inoculation of the seeds before sowing with Rhizobium spp. alone or combined with boron foliar spray increased significantly oil and protein percentages as compared with their corresponding treatments without Rhizobium inoculation. The highest values of oil and protein percentages were obtained by using boron foliar spraying at level of 300 mg boron L^{-1} in combination with Rhizobium inoculation.

It was concluded that boron foliar spray at 200 mg boron L^{-1} in combination with seed inoculation with Rhizobium enhanced plant growth and improved peanut yield and its components.

Key words: Peanut, foliar spray, boron, Rhizobium.

INTRODUCTION

Peanut (*Arachis hypogaea L.*) is considered one of the most important legume and oil seed crops, which are cultivated and thrive in the newly reclaimed sandy soils in Egypt. Rashid and Ryan (2004) stated that Mediterranean type soils generally have high pH, and low organic matter. Consequently, nutrients disorders in these soils are the most important limiting factor to crop production, second only to moisture stress. Major problems are deficiencies in nitrogen and phosphorus; however, recent researches have revealed that micronutrient problems are also hampering crop production.

Boron is an important element in plants metabolism, and it is believed to play the most significant role in the translocation of sugar molecules (Matoh, 1997). In addition, Noor *et al.* (1997) proved the importance of application of boron for increasing peanut yield. Rashid and Ryan (2004) stated that boron is a non metal micronutrient and its deficiency has not been observed widely. However, research in the recent past has revealed this is to be a wide spread problem in crops like cotton, rape seed, wheat, peanut, sorghum, and rice. The boron deficiency can be corrected by its soil application or by foliar application. As the concentration range between B deficiency and toxicity is exceptionally narrow, both are field scale problem in the Mediterranean soils type.

Biofertilizers are microbial preparations containing primary sufficient number of active strains of microorganisms having an explicit role in furnishing better rizosphere for plant growth. Pal (1986) stated that inoculation with Rhizobium strains Jcg 1 and Nc 92 increased nodulation and pod yield of field – grown groundnuts by 53.9 and 37.9 %, respectively. The same author added that application of boron increased yields by 34.3% in groundnuts grown from seeds inoculated with Rhizobium strain Jcg 1. Moreover, Negm *et al.* (1998) found that peas seed inoculated with Rhizobium gave a significant positive effect on green pods, dry seed yields, oven dried seed weight and uptake of N and P.

Therefore, the current research was designed to evaluate the impacts of spraying B at different levels and inoculating peanut seeds with microbial biofertilizer *(Rhizobium jabonicum)* on crop yield, yield components, seed oil and protein contents as well as nutritive status of peanut plants grown on a sandy soil.

MATERIALS AND METHODS

A field experiment was carried out on peanut plants grown on a sandy soil at Ismailia Agriculture Station, Egypt during two successive summer seasons of 2005 and 2006, to study the influence of foliar spray with born at three rates of

100, 200 and 300 g L^{-1} a total volume of 600 L/fed for each B-concentration, with alone or with microbial biofertilizer *(Rhizobium japonicum)* on crops yield, yield components, seed oil and protein contents as well as nutritive status. Representative soil samples (0 – 30 cm) were collected for mechanical and some chemical analysis, as described by Page *et a.l* (1982) and Black (1982), the obtained data are presented in Table (1). Among the experimental plots with an area of 10.5 m^2 (1/400 fed.)

Eight treatments were replicated three times and distributed in a complete randomized blocks design. The experimental treatments were as follows:

1. Control treatment (non-treated soil).
2. Foliar spray with 100 mg L^{-1} boron.
3. Foliar spray with 200 mg L^{-1} boron.
4. Foliar spray with 300 mg L^{-1} boron.
5. Seed inoculation with *Rhizobium japonicum*
6. Seed inoculation with *Rhizobium japonicum* + treatment 2.
7. Seed inoculation with *Rhizobium japonicum* + treatment 3.
8. Seed inoculation with *Rhizobium japonicum* + treatment 4.

Treatments 2, 3, 4, 6, 7 and 8 were sprayed with boron solution (as boric acid) at the concentrations of 100, 200 and 300 mg L-1 with a volume of 600 L /fed., which was divided into three equal amounts added after 30, 45 and 60 days from sowing.

The seeds of treatments 5,6, 7 and 8 were pre-inoculated with a strain of *Rhizobium japonicum*, using Arabic gum (40%) as an adhesive agent.

The seeds of all the 8 treatments were sown on the 15th and 20th of April 2005 and 2006, respectively in hills spaced 10 cm apart.

All the experimental plots were fertilized with 40 kg N/fed as ammonium sulphate and 50 kg K_2O/fed as potassium sulphate in two equal doses added at planting and after one month. The phosphorus fertilizer was applied before planting at a rate of 30 kg P_2O_5/fed as calcium superphosphate (15 % P_2O_5). The mature plants were harvested after 130 days from sowing. The yield of straw and seeds (kg/fed), and peanut pod yield (kg/fed) were calculated and recorded. Shilling percentage was estimated from a random pod sample (100 g), the seeds were hand separated, then shilling percentage was calculated as follows:

$$\text{Shilling \%} = \frac{\text{Seeds weight}}{\text{Pods weight}} \times 100$$

Samples of seeds and straw were ground and wet digested with a mixture of H_2SO_4 and $HClO_2$ acids to determine N, P, K, B, Fe, Zn and Mn in straw and seeds according to the methods given by Chapman and Pratt (1978).

Table (1): Some physical and chemical properties of the experimental soil before cultivation in the two successive seasons of 2005 and 2006.

Particle size distribution%	2005	2006
Coarse sand	78.15	77.48
Fine sand	15.23	16.63
Silt	2.77	1.56
Clay	3.85	4.33
Textural class	Sand	Sand
pH (1:2.5 soil : water suspension)	8.30	8.10
EC in dS/m (soil paste extract)	1.62	1.59
$CaCO_3$%	1.70	1.65
Organic matter %	0.30	0.35
Soluble cations and anions (m molc L^{-1})		
Ca^{++}	3.77	3.87
Mg^{++}	1.20	1.36
Na^{+}	10.85	10.50
K^{+}	0.25	0.32
CO_3^{--}	0.00	0.00
HCO_3^{-}	2.83	3.05
Cl^{-}	9.85	10.17
SO_4^{--}	3.39	2.83
Available macro and micro- nutrients (mg/kg soil)		
N	14.00	16.00
P	4.00	4.30
K	56.00	68.50
Fe	4.10	4.80
Mn	1.30	1.40
Zn	0.80	0.88
B	0.09	0.13
Cu	0.40	0.48

Oil % was determined by using Soxhelt apparatus and petroleum ether as solvent according to A.O.A.C. (1980). Seed protein content was calculated by multiplying N % by 6.25.

Statistical analysis of the data for the two seasons was carried out according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Crop yield and yield components:

a-Effect of foliar spray with B:

Foliar spray is considered as one of the most effective and fast method of correcting nutrients deficiency as remedy for disorders resulting from unfavorable soil factors.

The crop yield and some yield components of peanut, i.e. weight of 100 seeds, pods yield, shilling percentage, yields of straw and seeds are presented in Table (2). It is clear from data that spraying with B at the two levels of 100 and 200 mg L^{-1} significantly increased all the previous parameters of peanut plants as compared with the control treatment, with insignificant differences for the highest level of B (300 mg L^{-1}).

The positive effects of B spray are in harmony with the results obtained by Jiang *et al.* (1994), Noor *et al.* (1997), Qiong *et al.* (1999) and Khalifa (2005).

The response to B spray may be due to the low available content of B in the studied soil (Table 1) and its essential role in plant, where it plays a role in plant metabolism and in the synthesis of nucleic acid (Humdt *et al.*, 1970). Also, application of B significantly or highly significantly enhanced chlorophyll content and photosynthetic intensity of the leaves, increased dry matter accumulation of the plants, advanced their flowering and promoted the transport of the photosynthates from the vegetative organs to the reproductive organs, which resulted in significant improvement in the crop yield and its components (Qiong *et al* 2002).

Data in Table (2) also show that the highest values of the studied parameters, i.e. weight of 100 seeds, pods yield, shilling percentage, yields of straw and seeds were achieved under treatment 3 (200 mg B L^{-1}), followed by treatment 2 (100 mg B L^{-1}), treatment 4 (300 mg B L^{-1}) and treatment 1 (control) in a descending order for both studied seasons. Khalifa (2005) came to the same results and found that the highest level of B (300 mg L^{-1}) led to non-significant increases in No. of pods /plant, wt. of pods/plant, wt. of seeds/plant and pods yield as compared with the control treatment during the two successive summer seasons, although their values were slightly higher in the second season. This may be due to the residual effect of the native and added fertilizer.

b-Effect of biofertilizer alone or in combination with foliar spray with boron:

Results in Table (2) show that seeds inoculated with Rhizobium strains (treatment 5) significantly increased all the studied parameters of peanut yield as compared with the control treatment. Also, the treatments of foliar spray with boron levels in combined with plants inoculation with Rhizobium had the same significantly positive effect on weight of 100 seeds, pods yield, yields of straw and seeds as well as shilling percentage as compared with the corresponding treatment 2(sprayed with boron alone). The corresponding increases were 5.95 & 5.17 % for seed index; 17.45&17.66 % for pods yield; 20.42 & 11.40 % for straw yield; 13.65&11.37 for seed yield and 6.03& 5.96 % for shelling percentage for both seasons, respectively. This means that the combination of foliar spray with B and inoculation with Rhizobium spp., may enhance plant utilization of nutrients and water which was reflected on growth and high biological yield. Also, these increases may be due to the promoting effect of the microorganisms of the inoculants on the native and/or applied nutrients. In addition the inhibition effect of the pathogenic microorganisms as reported by Gomaa *et al.* (1995). The obtained results are in harmony with those obtained by Pal (1986); Negm *et al.*

(1998); Srivastava *et al.* (1999)and Baktash *et al.* (2003) who reported that inoculation of peanut seeds with Rhizobium strains spp. in combination with B as foliar spray significantly increased the yield and yield components of peanut plants.

Data in Table (2) also show that the sole application of biofertilizer significantly increased the yield and yield components under study as compared with foliar spray with B alone.

The interaction between foliar spray with B and inoculation with Rhizobium spp. showed a significant effect on all the studied growth parameters of peanut plants. Data obtained in this respect (Table 2) indicate that the effect of combined bioadditives and foliar spray with B exceeded those of their single effect. The highest values of yield and yield components were obtained from plants receiving foliar spray with 200 mg boron L^{-1} and inoculation with Rhizobium spp. strains, while the lowest ones were obtained under the control treatment.

Generally, the values of yield and yield parameters of the second season were higher than those obtained in the first season, with insignificant differences.

Nutrients concentrations in peanut straw and seeds:

1- Macronutrient concentrations:

a- Effect of foliar spray with B:

As shown in Table (3) foliar spray with different levels of B (100, 200 and 300 mg L^{-1}) significantly increased the uptake of N, P and K by straw and seeds of peanut plants grown during the studied two successive seasons as compared with the control treatment. Data also show that spraying the plants with B at 200 mg L^{-1} led to significant increases in the N, P and K uptake by straw of peanut plants as compared with the treatment of 300 mg B L^{-1}, however, there were insignificant differences in their uptake values by seeds.

The highest values of N, P and K uptake by straw of peanut plants were obtained by the treatment of 200 mg L^{-1} B followed by treatment of 100 mg L^{-1} B and treatment of (300 mg B L^{-1}), then the control treatment in a descending order. On the other hand, the highest values of N, P and K uptake by seeds of peanut plants were found at the treatment of 200 mg B L^{-1}, followed 300 mg B L^{-1}, 100 mg B L^{-1} and the control treatment in a descending order.

The above mentioned results agreed with the findings of Hopman and Clerehan (1991); Jiang *et al.* (1994) and Rizk *et al.* (1995) who stated that increasing B application significantly increased N, P and K uptake by pinus radiate, sugar beat and groundnut plants.

b- Effect of biofertilizer alone or in combination with foliar spray with boron:

Uptake values of macronutrients by straw and seeds of peanut plants grown during the two successive seasons as affected with biofertilization (Rhizobium spp.) alone or in combination with foliar spray with boron are

presented in Table (3). Results show that inoculation with Rhizobium spp. alone significantly increased N, P and K uptake by straw and seeds of peanut plants as compared with the control treatment. These results are true for the two growing seasons and this could be explained as the microorganisms of the used biofertilizer may have improved the rhizosphere conditions and enhanced the availability of soil nutrients and increased N, P and K uptake by the different organs of peanut plants (straw and seeds). These results are in good agreement with those obtained by EL-Habbasha *et al.* (2004) who stated that the microbian inoculated showed the highest values of NPK contents in the seeds as well as in the straw.

Data in Table (3) show that the treatments of foliar spray with 100, 200, and 300 mg L^{-1} of boron in combination with Rhizobium inoculants significantly increased the uptake of N, P and K by straw and seeds of peanut plants grown during the two successive seasons as compared with the corresponding treatments of foliar spray with B only at the rates of 100, 200 and 300 mg L^{-1}. The relative increases in straw of peanut plants were 13.04 & 18.10 % for N; 22.50 & 21.56 %for P and 13.26& 13.48 % for K in both studied seasons, respectively. The corresponding increases in N, P and K uptake by seeds of peanut were 33.14 & 33.42 % for N, 4.38 & 5.20 % for P and 9.66 & 8.22 % for K in both seasons, respectively. In this connection, Saber (1997) stated that soil microorganisms have the ability to change the unavailable forms of nutrient elements to available forms and have successfully been used in biofertilizers farming systems. The obtained results are in good agreement with those obtained by El-Kholi (1998) and Negm *et al.* (1998).

N, P and K uptake by seeds of peanut plants, under all the foliar spray treatments alone or in combination with Rhizobium inoculation in both seasons (Table 3), were higher than those obtained by the straw of peanut plants. This may be attributed to enhancing these elements assimilation and translocation from the leaves to seeds, especially N. Data in Table (3) show also that values of N, P and K uptake by straw and seeds of peanut plants were higher in the second season under all the used treatments as compared with those obtained in the first season. This may be due to the positive impact of residual effect of native and added fertilizers.

The interaction between foliar spray with B and inoculation with Rhizobium spp. showed a significant effect on N, P and K uptake by straw and seeds of peanut plants. The highest values of N, P and K uptake by straw and seeds in both seasons were obtained by applying the treatment of 200 mg B L^{-1} as well as treatment of 200 mg B L^{-1} + inoculation with Rhizobium spp., while the lowest values were attained under the control treatment.

2- Micronutrients concentrations:

a- Effect of foliar spray with B.

Data presented in Table (4) show that foliar spray with boron levels i.e. 100, 200 and 300 mg L^{-1} significantly increased the uptake of Fe, Mn, Zn and B by straw and seeds of peanut plants grown during the two successive seasons as

compared with the control treatment. This result may be due to B, is involved in the physiological processes controlling the uptake and transport of Fe, Mn and Zn and also in the mobilization of reserve proteins (Dave and Kannan, 1981). In this concern, Khalifa (2005) found that foliar spray with B improved the nutritive status of peanut plant, where leaf contents of Mn, Zn and B were increased as compared with nontreated plants in both seasons.

The highest values of Fe, Mn and Zn uptake by straw and seeds in both seasons were obtained by using foliar spray with 200 mg B L^{-1}, followed by 100; 300 mg B L^{-1} and the control treatment in a descending order. Foliar spray with B levels i.e. 100, 200 and 300 mg B L^{-1} gradually increased B uptake by straw and seeds in both seasons. The highest values were found at treatment 300 mg B L^{-1}. This finding is confirmed by that of Jiang *et al.* (1994) who stated that the concentration of B in groundnut plants increased with increasing B fertilizer rates.

b- Effect of biofertilizer alone or in combination with boron foliar spray:

Data presented in Table (4) show that applying Rhizobium spp. alone led to significant increase in all the micronutrients uptake by straw and seeds of peanut in both seasons as compared with the control treatment. Also, data show that foliar spray with the different B levels in combination with biofertilizers inoculation increased significantly the uptake of Fe, Mn, Zn and B by straw and seeds of peanut plants in both seasons as compared with those obtained by using B foliar spray only at different levels. The increments of micronutrients uptake as affected by inoculation with biofertilizer (Rhizobium spp.)in straw were 7.03 & 4.54%; 8.02 & 7.69%; 10.43 &11.16%; and 19.67 & 21.66% for Fe, Mn, Zn and B uptake in the studied two successive seasons, respectively. Moreover, the increases in seeds uptake were, 5.54 & 6.94%; 12.56 & 15.04%; 20.47 & 21.03% and 10.08 &10.24 % for Fe, Mn, Zn and B in the two successive seasons, respectively.

Generally, data in Table (4) reveal that uptake of Fe, Mn, Zn and B by straw and seeds in both studied seasons increased significantly as a result of applying foliar spray with B and biofertilizer inoculation, however, the highest values of Fe and Mn uptake by straw and seeds in both seasons were obtained by using the treatment of Rhizobium inoculation + 200 mg B L^{-1}, followed by seed inoculation +100 mg B L^{-1}, and seed inoculation + 300 mg B L^{-1} in a descending order. On the other hand, the highest values of Zn and B uptake by straw and seeds in both seasons were obtained at treatment 8, followed by treatment 7 and treatment 6 in a decreasing order. In this concern, El-Shazly *et al.* (2003) stated that using the bioregulator, of Snow Grow Ace (SGA-1), which was prepared from the metabolite of basidiomycetes mycelium, significantly increased leaf N, B, Fe, Mn and Zn contents of cotton plants.

The interaction between seed inoculation with Rhizobium and foliar spray with B, significantly affected the uptake of Fe, Mn, Zn and B by straw and seeds of peanut plants in both seasons. The highest values of all the studied micronutrients were attained due to treatment of seed inoculation with Rhizobium + 200 mg B L-1, while the lowest ones were associated with the control treatment (Table 4).

Table (2): Effect of foliar spray with different Boron levels of alone or in combination with microbial biofertilizer inoculation on yield and yield components of peanut plants grown on a sandy soil for two successive seasons 2005 and 2006.

Treatments			Wt. of 100 seeds (g)		Pods yield (Kg/fed)		Yield (kg/fed)				Shilling %	
Inoculation with Rhizobium spp.		Foliar spray with B (mg L^{-1})					Straw		Seeds			
			2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
1	Control		71.74	77.49	996.65	1041.87	1321.32	1497.81	670.90	795.61	61.41	68.00
2	-	100 mg L^{-1}	78.79	82.20	1057.05	1153.63	1460.39	1587.54	753.01	831.25	66.02	70.11
3	-	200 mg L^{-1}	81.04	87.55	1081.15	1187.45	1583.11	1667.08	790.53	874.12	69.25	72.15
4	-	300 mg L^{-1}	74.54	79.15	1040.57	1085.30	1382.79	1568.52	692.67	817.07	64.00	69.10
	Mean		76.53	81.60	1043.86	1117.06	1436.90	1580.24	726.78	829.51	65.17	69.84
5	Inoculation with rhizobium spp.		78.56	81.98	1138.80	1205.47	1541.18	1600.16	795.53	852.36	64.53	70.83
6	IWR	100 mg L^{-1}	82.94	85.78	1233.19	1311.71	1760.29	1711.88	834.34	925.41	70.99	75.77
7	IWR	200 mg L^{-1}	83.50	90.52	1376.55	1456.01	1950.46	2052.05	867.95	1005.01	72.17	77.36
8	IWR	300 mg L^{-1}	79.30	84.99	1155.84	1284.29	1669.51	1678.67	805.77	912.43	68.69	72.02
	Mean		81.08	85.82	1226.10	1314.37	1730.36	1760.69	826.02	923.80	69.10	74.00
LSD 5% Boron			4.16	3.31	45.81	52.75	88.83	76.25	23.16	26.85	2.94	2.10
Inoculation			4.50	3.81	72.56	73.46	125.63	100.61	32.75	37.93	3.56	2.69
Interaction			2.11	1.10	17.21	20.21	101.89	91.30	26.56	28.48	1.24	1.93

IWR: Inoculation with Rhizobium spp

Table (3): Effect of foliar spray with different level of Boron alone or in combination with microbial biofertilizer inoculation on yield and yield components of peanut plant grown on sandy soil for two successive seasons 2005 and 2006.

Treatments			Straw uptake (kg/fed)						Seeds uptake (kg/fed)					
Inoculation with Rhizobium spp.		Foliar spray with B (mg L^{-1})	N		P		K		N		P		K	
			2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
1	Control, sprayed with tap water		18.43	19.04	1.67	1.80	22.68	25.76	25.63	29.15	2.66	2.83	13.00	13.00
2	-	100 mg L^{-1}	24.40	25.16	2.20	2.42	28.34	30.34	32.20	33.42	3.02	14.00	14.10	30.34
3	-	200 mg L^{-1}	25.39	25.43	2.24	2.52	32.64	35.18	34.02	36.63	3.65	14.90	15.66	35.18
4	-	300 mg L^{-1}	23.19	22.98	1.89	1.96	29.38	31.32	33.41	34.96	3.47	13.91	13.92	31.32
	Mean		22.85	23.15	2.00	2.18	28.27	30.65	31.32	33.54	3.20	3.46	13.95	14.17
5	Inoculation with Rhizobium spp.		24.51	25.57	2.34	2.54	27.20	30.09	38.72	41.85	2.90	3.12	14.51	15.11
6	IWR	100 mg L^{-1}	.26.20	28.01	2.35	2.65	33.03	35.06	43.02	45.78	3.32	15.91	16.01	35.06
7	IWR	200 mg L^{-1}	26.76	28.47	2.62	2.73	33.82	35.48	43.99	46.57	3.79	17.11	17.70	35.48
8	IWR	300 mg L^{-1}	25.84	27.29	2.50	2.66	29.96	32.05	41.05	44.80	3.35	15.67	16.91	32.05
	Mean		25.83	27.34	2.45	2.65	31.00	33.17	41.70	44.75	3.34	3.64	15.80	16.08
LSD 5% Boron			0.88	1.26	0.15	0.11	1.94	1.14	2.07	2.43	0.19	0.16	1.94	0.80
Inoculation			1.24	1.69	0.22	0.15	2.70	2.21	2.93	2.95	0.12	0.15	2.70	1.40
Interaction			1.00	1.10	0.17	0.13	2.23	2.11	2.38	2.81	0.20	0.17	2.23	1.10

IWR: Inoculation with Rhizobium spp

Table (4): Effect of foliar spray with different boron levels alone or in combination with microbial biofertilizer inoculation on some micronutrients (Fe, Mn, Zn and B)uptake by peanut plants grown on sandy soil for two successive seasons 2005 and 2006.

Treatments			Straw uptake (g/fed)								Seeds uptake (g/fed)							
Inoculation with Rhizobium spp.		Foliar spray with B ($mg\ L^{-1}$)	Fe		Mn		Zn		B		Fe		Mn		Zn		B	
			2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
1	Control		87.90	89.31	36.00	39.17	36.31	37.11	13.05	14.11	80.12	82.37	24.35	26.11	29.40	30.30	14.48	15.35
2	-	100 $mg\ L^{-1}$	127.69	129.40	42.33	43.01	40.60	41.22	21.87	22.80	89.08	90.66	31.41	33.16	32.40	33.11	20.49	21.59
3	-	200 $mg\ L^{-1}$	132.21	135.01	45.76	46.18	47.90	48.01	29.59	30.11	92.90	93.37	34.78	34.60	36.93	37.20	23.77	24.80
4	-	300 $mg\ L^{-1}$	125.77	126.90	41.12	42.69	38.98	39.90	33.27	34.16	84.21	86.23	30.50	31.11	31.40	32.90	28.59	30.11
	Mean		118.39	120.16	41.30	42.76	40.95	41.56	24.45	25.30	86.58	88.16	30.26	31.25	32.53	33.38	21.83	22.96
5	Inoculation with Rhizobium spp.		103.65	110.27	41.22	42.61	42.97	43.11	16.22	18.30	85.49	90.58	29.44	31.24	33.26	35.15	18.41	19.80
6	IWR	100 $mg\ L^{-1}$	135.40	123.76	46.33	47.86	44.80	45.70	32.48	33.11	92.89	94.60	34.16	36.23	37.73	39.12	22.90	23.11
7	IWR	200 $mg\ L^{-1}$	141.40	138.48	48.76	48.80	45.80	47.10	33.11	34.50	97.36	98.57	39.99	40.81	40.33	41.11	24.90	26.20
8	IWR	300 $mg\ L^{-1}$	126.38	129.95	42.11	44.91	47.30	48.88	35.22	37.20	89.76	93.35	33.60	35.51	45.44	46.20	29.69	32.11
	Mean		126.71	125.62	44.61	46.05	45.22	46.20	29.26	30.78	91.38	94.28	34.30	35.95	39.19	40.40	24.03	25.31
LSD 5% Boron			4.20	5.50	4.50	3.12	2.14	2.50	1.91	2.00	3.57	3.80	1.80	1.95	1.90	2.11	1.86	1.90.
Inoculation			5.94	4.99	3.11	3.10	3.80	4.11	3.11	4.11	4.41	5.11	3.00	4.11	3.98	4.11	2.00	2.77
Interaction			4.82	5.33	4.20	4.80	2.46	3.01	3.50	4.20	5.22	5.80	2.50	3.50	2.80	3.20	1.16	1.91

IWR: Inoculation with Rhizobium spp

- Seeds oil and protein content %

a- Effect of foliar spray with B.

Data in Table (5) show that both oil and protein % of peanut plants in both studied seasons significantly increased by increasing the applied rates of foliar spray with B up to 300 mg L^{-1} as compared with the untreated treatment (control). Moreover, the highest oil and protein % in peanut in both studied seasons were attained when the highest level of boron (300 mg L^{-1}) was used, followed by 200 mg B L^{-1}, 100 mg B L^{-1} and the control in a descending order. However, there were insignificant differences for oil and protein % in both seasons at the levels 100 and 200 mg B L^{-1}. However, the level 300 mg B L^{-1} significantly increased oil and protein % in both seasons as compared with the level of 200 mg L^{-1} B. The above results are in good agreement with those obtained by Rifaat *et al.* (2004) and Khalifa (2005) who stated that the highest values of oil and protein contents in peanut plants were obtained with applying the foliar spray B at a highest concentration of 300 mg B L^{-1}. The beneficial effect of foliar spray with B may be attributed to the role of B element on fundamental metabolic reactions and acceleration protein synthesis (Mayer and Anderson, 1972). Also B, is involved in a number of metabolic pathways (sugar transport, respiration, carbohydrate, RNA, IAA and phenol metabolism or a cascade effect, which is known for photo-hormones (Parr and Loughman, 1983).

B – Effect of biofertilizer alone or in combination with B foliar spray:

From the data in Table (5), it could be noticed that seed inoculation before plantation with Rhizobium spp. alone significantly increased oil and protein percentages of peanut in both studied seasons as compared with the control treatment. Also, data show that foliar spray with B together biofertilizer application significantly increased oil and protein % in both seasons as compared with their corresponding treatments without biofertilizer. The oil and protein percentages increased progressively in both seasons with increasing boron applied B rate from 100 to 300 mg L^{-1} in combination with biofertilizer. The increments of oil and protein % in both seasons were 5.78 & 8.07 % for oil and 9.52 & 20.38 % for protein. The obtained results show that the increases in oil and protein percentages were higher in the second season (2006) than in the first one (2005), may be due to the higher seed yield (Table, 2) and nutrient contents (Table, 3) of peanut plants in the second season than those in the first one. Baktash *et al.* (2003) and El-Habasha *et al.* (2005) went almost to similar results and stated that using different inoculum strains of *Rhizobium japonicum* gave clear increases in oil and protein yields.

The interaction between foliar spray with B and inoculation with rhizobium spp. significantly affected the oil and protein percentages in both seasons. The highest values of oil and protein % in both seasons were obtained by using foliar spray at B level of 300 mg L^{-1} in combination with Rhizobium spp inoculation. Moreover, the lowest values of oil and protein % were obtained under the control treatment.

Table (5): Effect of foliar spray with different boron levels alone or in combination with microbial biofertilizer inoculation on oil and protein % of peanut plants grown on sandy soils for the two successive seasons 2005-2006.

Treatments		Oil %		Protein %	
Inoculation with Rhizobium spp	Sprayed with boron (mg L^{-1})	2005	2006	2005	2006
Control, sprayed with tap water		38.03	44.33	22.20	23.41
	100 mg L^{-1} B	41.80	46.63	26.80	27.80
	200mg L^{-1} B	43.23	48.23	27.90	28.90
	300 mg L^{-1} B	45.50	50.13	30.22	32.11
Mean		42.14	47.33	26.78	28.06
Inoculation with Rhizobium spp.		41.40	46.11	25.00	29.11
Inoculation with Rhizobium spp	100 mg L^{-1} B	43.91	48.90	28.11	33.20
Inoculation with Rhizobium spp	200mg L^{-1} B	45.11	53.67	30.80	35.80
Inoculation with Rhizobium spp	300 mg L^{-1} B	47.89	55.91	33.40	36.99
Mean		44.58	51.15	29.33	33.78
LSD 5% Boron		2.10	1.87	2.05	1.98
Inoculation		2.30	2.64	2.36	2.41
Interaction		1.82	2.11	1.72	1.63

From the above results, it could be concluded that biofertilizer in combination with foliar spray with 200 mg B L^{-1} led to enhancing plant growth and improving yield of peanut under the conditions of the current experiment and similar conditions through the indirect effects on improving soil fertility status, besides its popular effect on reducing environmental pollution.

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استجابة الفول السوداني للرش بالبورون والتلقيح بالريزوبيوم

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أجريت تجربة حقلية خلال موسمي صيف ٢٠٠٥ ، ٢٠٠٦ على نباتات الفول السوداني النامي بارض رملية بمحطة التجارب بالإسماعيلية وذلك لدراسة تأثير ثلاث مستويات من البورون (١٠٠ ، ٢٠٠ ، ٣٠٠ ملليجرام/لتر)بمعدل ٦٠٠ لتر/فدان بصورة منفردة أو مشتركة مع التسميد الحيوي (تلقيح البذور بالريزوبيم) على المحصول ومكوناته وكذلك محتوى البذور من الزيت والبروتين والحالة الغذائية.

توضح النتائج أن الرش بالبورون بتركيز ٢٠٠ ملليجرام/لترقد أعطى أعلى القيم للمحصول ومكوناته ممثل في وزن ١٠٠ بذرة ومحصول القرون (كجم/فدان) ومحصول القش والبذور وكذلك النسبة المئوية للامتلاء مقارنة بمعاملة الكنترول.

أدى تلقيح البذور بسلالات من الريزوبيم منفردا أو مشتركا مع البورون بمستوياته المستخدمة (١٠٠ ، ٢٠٠ ، ٣٠٠ ملليجرام/لتر) الى زيادة معنوية فى محصول الفول السودانى ومكوناته السابق ذكرها مقارنة بمثيلاتها من المعاملات التى

لم يتم تلقيحها بالريزوبيم . وقد أعطت معاملة الـرش ٢٠٠ ملليجـرام/لتـر بـورون بالاشتراك مع التسميد الحيوي (التلقيح باليزوبيم) أعلى قيم للمحصول ومكوناته .

أدى استخدام التسميد الحيوي منفردا او مع مستويات البورون المختلفة الـى زيادة امتصاص القش والبذور لنباتات الفول السودانى لعناصر النتروجين والفوسـفور والبوتاسيوم والحديد والمنجنيز والزنك والبورون زيادة معنوية مقارنة بمثيلاتهـا مـن المعاملات الغير معاملة بالسماد الحيوى.وكانت اعلـى قـيم لامتصـاص النتـروجين والفوسفور والبوتاسيوم والحديد والمنجنيز بالقش والبذور في حالة معاملة الـرش ٢٠٠ ملليجرام/لتر بورون بالاضافة الى التسميد الحيوى (الريزوبيم) بينمـا الـرش ب ٣٠٠ ملليجرام/لتر بورون مع التسميد الحيوى اعطى اعلى القيم لامتصاص الزنك والبورون بكل من القش والبذور.

أدى رش نباتات الفول السودانى ب ٣٠٠ ملليجرام/لتر بورون منفـردا إلـى أعلى القيم للنسب المئوية للزيت والبروتين مقارنة بمعاملة الكنترول ، كما أدى تلقـيح البذور بالريزوبيم منفردا أو مضافا مع مستويات البورون السابق ذكرها رشا الى زيادة معنوية فى النسبة المئوية للزيت والبروتين مقارنة بمثيلاتها من معاملات النباتات الغير ملقحة بالريزوبيم والتى تم رشها بالبورون فقط وكانت أعلى القيم للنسب المئوية للزيت والبروتين في حالة النباتات التي تم رشها ب ٣٠٠ ملليجرام/لتر بورون بالاضافة الـى التسميد الحيوى (تلقيح البذور بالريزوبيا).

ومما سبق يتضح أن التسميد الحيوى بالإضافة الى الـرش الـورقى ب ٢٠٠ ملليجرام/لترمن البورون يشجع من حالة النمو الخضري ويحسن من محصول الفـول السوداني ومكوناته تحت ظروف التجربة تحت الدراسة.