ROLE OF NICKEL IN THE MINERAL NUTRITION OF FABA BEAN PLANTS (*V. FABA*)

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Abstract

Two successive field experiments were carried out in 1988/89 and 1989/90 seasons in Mallawi Research Station, using seed soaking treatments of faba bean in different concentrations of nickel as $NiSO_4$ for 24 hours to obtain the optimum concentration for the growth of faba bean plants. Another field experiment and pot experiment were carried out during 1990/91 season to study the effect of this concentration under three levels of nitrogen (0, 7.5 and 15 kg N/fed. in the field experiment or 0, 0.3 and 0.6 g urea/pot in the pot experiment).

Concentration of 50 ppm Ni was the most suitable level since it gave the highest number of pods/plant and the highest seed yield/fed. in both seasons. Under N application, it was found that seeds soaking in 50 ppm Ni without N application gave significant increase in seed yield/fed. or pot and 100- seed weight and increased number of nodules/plant, dry weight of nodules, dry weight of roots and N content of roots over the control. These parameters were gradually decreased by increasing N rate under soaking treatment.

INTRODUCTION

The nitrogen nutrition of legumes had a marked effect on nitrogen fixation. The presence of a high level of available nitrogen in the soil increases the growth of legumes, but reduces, often considerably, the amount of N- fixed (Hamdi *et al.* 1965).

Nickel has traditionally been considered of no major biologically significance

In both experiments, a complete randomized block design was followed in which each treatment included four replicate plots (each 1/200 fed. in the 1st experiment and 1/400 fed. in the 2nd experiments).

II. Pot experiment:

This experiment was carried out at Giza Research Station to study the effect of seed soaking in nickel sulfate (0 and 50 ppm Ni) for 24 hours under three levels of nitrogen fertilization (0, 0.3 and 0.6 g urea/pot) on seed yield, roots and number of nodules of faba beans (Giza 2). The seeds were sown in pots containing 8 kg soil in four replicates. Each pot received 15 g superphosphate and 2 g potassium sulfate preplanting. After 7 weeks from sowing, number and dry weight of nodules were calculated. Root dry weight was recorded and root - N content was determined using the standard method. Chemical and mechanical analysis of soil experiments are shown in Table 1.

Table 1. Mechanical and chemical analysis of soil samples.

a. Mechanical analysis:	Giza	Minia
Clay %	30.50	40.50
Texture	Loamy	Clay loam
CaCO3%	30.60	3.50
Total soluble salts %	0.25	1.20
Organic matter %	1.78	1.65
b. Chemical analysis:		
pH (1 : 2.5)	8.00	7.90
Total -N (%)	0.13	0.09
Total -Ni (ppm)	55.50	61.50
Available -N (ppm)	52.00	39.50
Available -Ni (ppm)	0.56	0.50
Available -P (ppm)	18.00	17.80
Available -K (ppm)	500.00	408.00

RESULTS AND DISCUSSION

I. Effect of seed soaking in nickel sulfate:

1. Number of pods / plant:

Results shown in Table 2 indicated clearly that soaking faba bean seeds in different concentrations of nickel sulfate increased number of pods / plant in both seasons. Number of pods / plant increased by increasing Ni rate up to 100 ppm Ni with a decline in pod number by increasing Ni rate more than 100 ppm. All soaking treatments in Ni solution gave significant increases in number of pods if compared with control (soaking in water); and 50 and 100 ppm rate recorded the highest pod number / plant in 1988/89 season. However, in 1989/90 season, only 100 ppm treatment caused significant increases compared with control. It can be concluded that the concentration of 50 or 100 ppm Ni as nickel sulfate was suitable for faba been seed

Table 2. Effect of seed soaking in different concentrations of Ni on yield of faba beans during two successive seasons.

Treatments (Ni ppm)	No. of pods/ plant	Seed yield Ardab*/ fed.**	Relative Yield %
		1988 / 1989	
Control	7.4	7.48	100.00
25	9.00	8.58	114.70
50	12.60	9.51	127.10
100	12.50	9.51	127.10
200	11.30	8.26	110.00
400	10.50	7.03	94.00
L.S.D. at 5%	0.80	1.02	
		1989 / 1990	
Control	1.20	4.27	100.00
25	1.27	4.29	100.50
50	13.53	4.42	103.50
100	13.93	4.33	101.50
200	13.07	3.84	90.00
400	11.73	2.61	61.10
L.S.D. at 5%	2.70	1.01	

*Ardab = 155 kg. , **Feddan = 4200 m^2

soaking for 24 hours.

2. Seed yield:

Statistical analysis showed that seed yield significantly increased in the 50 and 100 ppm Ni treatments in the first season (1988/89), while 400 ppm Ni caused a slight decrease (Table 2). In the second season, there was slight increase when Ni concentrations were used up to 100 ppm compared with control. On the other hand, Ni concentration over 100 ppm reduced seed yield, and 400 ppm Ni gave significant decrease (38.9%). It can be concluded that soaking faba bean seeds in 50-100 ppm Ni is the most favorable concentration that would increase yield.

II. Effect of seed soaking in nickel sulfate solution under nitrogen fertilization:

This study was carried out to find out the relationship between the applied nitrogen and seed soaking in 50 ppm Ni and seed yield, seed index, root dry weight, N content of roots and number of nodules of faba bean plants.

1. Seed yield:

Data in Table 3 indicated that in the field experiment, seed soaking in Ni solution (50 ppm) with N- levels applied caused significant increase in seed yield/fed. compared with control treatment. However, seed yield/fed. was insignificantly decreased with increasing N-level under soaking treatment compared with soaking in Ni solution without N. Nickel seems to activate root nodules an, thus, increases N-fixation and addition of N fertilizer becomes useless. It is also noticed, hence, in the pot experiment, that low level of N (0.3 g/pot) without soaking treatment induced significant increase (14.6%) in seed yield/plant over control. The higher level of N (0.6 g/pot), with or without seed soaking in Ni solution had no effect. The high level of nitrogen may have reduced the amount of N-fixed (Hamdi *et al.* 1965). On the other hand, seed soaking in Ni sulfate solution (50 ppm Ni), with or without N application at low level (0.3 g/pot) caused significant increases e.g. 23% and 24.5%, respectively, in seed yield/plant over the control. Ni seems important for microbiological fixation of N in soil (Bertrand 1974).

Generally, it could be concluded that seed soaking in $NiSO_4$ solution (50 ppm,

Table 3. Seed yield of faba bean under field (Ardab/fed.) and pot (g/plant) experimens as affected by N applications and seed soaking in Ni solution (50 ppm Ni).

Symbols of treatments	Seed yield	Relative yield (%)	100-Seed weight/ (g)
	Field exeriment 1990 / 91 (Giza 402)		
Ni0 N0	4.70	100.00	56.9
Ni0 N1	--	--	--
Ni0 N2	--	--	--
Ni1 N0	6.60	140.40	61.8
Ni1 N1	6.50	138.30	61.4
Ni1 N2	5.60	119.10	61.1
L.S.D. at 5%	1.10	--	2.1
		Pot experiment (Giza 2)	
Ni0 N0	14.23	100.00	82.1
Ni0 N1	16.23	114.60	87.0
Ni0 N2	14.44	102.00	83.0
Ni1 N0	17.63	124.50	88.5
Ni1 N1	17.41	123.00	89.1
Ni1 N2	14.48	102.30	83.7
L.S.D. at 5%	1.40	--	2.9

Ni) without N application resulted in the increases seed yield higher than did N treatment only.

2. 100 - seed weight:

In the field experiment, it is noticed that soaking faba bean seeds in Ni solution gave significant increases in 100 - seed weight under N application compared with control (Table 3). However, there were no significant differences between N levels used. On the other hand, in pot experiment, soaking with 0 and 0.3 g N/pot increased seed index parameter significantly if compared with control, while the higher level of N (0.6 g/pot), with or without soaking in Ni solution, had only a slight effect. It is interesting to notice that soaking faba bean seeds in Ni solution in both experiments,

without N application, gave the highest increase in seed yield per fed. or /pot and 100-seed weight. The rate of 7.5 kg N/fed. can be recommended for faba bean fertilization as an activation doe to encourage seedling growth.

III. Effect of seed soaking in Ni-sulfate on nodulation and roots:

1. Nodulation:

Data in Table 4 illustrated that both levels of N without soaking treatment induced a slight increase in nodule number and dry weight of nodules compared with control. Soaking in Ni solution without N application recorded the highest increase in

Table 4. Roots and nodulation of faba beans plants (7 weeks old) as affected by N applications and seed soaking in Ni solution.

Symbols of treatments	Number of nodules/ plant	Dry weight of nodules (g)	Roots			
			Dry weight (g/ plant)	N-content %	N-uptake mg/ plant	N-uptake % increase over control
Ni0 N0	115	0.129	0.93	2.10	19.5	--
Ni0 N1	120	0.200	0.88	2.40	21.1	8.2
Ni0 N2	120	0.200	0.90	2.45	22.1	13.3
Ni1 N0	178	0.297	1.07	2.50	26.7	36.9
Ni1 N1	142	0.237	0.90	2.45	22.1	13.3
Ni1 N2	140	0.233	0.90	2.40	21.6	10.8

nodule numbers (54.8%) and dry weight of nodules (130.2%) over the control treatment. It was also noticed that nodule number and dry weight of nodules decreased gradually by increasing N rate under soaking treatment.

2. Roots:

a. Root dry weight (g/plant):

Dry weight of faba bean roots was not affected with applied N with or without

soaking treatment (50 ppm Ni) while, soaking caused a slight increment (15.05%) in root dry weight (Table 4).

b. Nitrogen content:

The results in Table 4 showed that either N uptake or N- content of faba bean roots was slightly increased over control using N applications with or without soaking treatment. However, soaking seeds in Ni solution without N application gave the highest N uptake by roots (36.9%) over the control. It was also noticed that N uptake or N content under soaking treatment decreased by increasing N rate. It can be concluded that Ni plays an important role in the activation of enzyme-system in nodules responsible for N fixation in rizosphere and increases the supply of N element (Bertrand 1974).

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دور النيكل فى التغذية المعدنية للفول البلدى

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أقيمت تجربتان حقليتان فى موسمين متتاليين (١٩٨٨ / ٨٩ ، ١٩٨٩ / ٩٠) لدراسة تأثير نقع بذور الفول البلدى فى تركيزات من كبريتات النيكل لمدة ٢٤ ساعة لاختيار التركيز الأمثل. ثم دراسة تأثير هذا التركيز فى تجربة حقلية أخرى موسم ١٩٩٠ / ١٩٩١ وأخرى فى اصص تحت معدلات مختلفة من التسميد الأزوتى.

وقد وجد أن النقع فى ٥٠ جزء فى المليون من النيكل (فى صورة كبريتات نيكل) هو افضل التركيزات حيث أعطى أكبر عدد من القرون لكل نبات وأعلى محصول للبذرة خلال الموسمين. وتحت معدلات التسميد الآزوتى المختلفة ووجد ان النقع فى ٥٠ جزء فى المليون بدون تسميد آزوتى ادى الى زيادة معنوية فى المحصول ووزن ١٠٠ بذرة بالاضافة الى زيادة فى عدد العقد البكتيرية / نبات ووزنها الجاف وكذلك الوزن الجاف للجذور ومحتواها من النيتروجين. كما لوحظ ان التسميد الآزوتى مع النقع لم يؤثر على القياسات السابقة والتى كانت تقل بزيادة معدل التسميد الآزوتى تحت معاملة النقع.