EFFECTS OF SOME MICRONUTRIENTS AND METHODS OF APPLICATION AND RHIZOBIUM INOCULATION ON FABA BEAN

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Abstract

A factorial field experiment on faba bean crop was conducted in 1989 / 1990 season to evaluate the effect of some micronutrients (Fe, Mn, Zn, Mo and a mixture of them) and methods of their application (spraying , coating and spraying + coating) in the presence of inoclation of Rhizobium on faba bean charcteristics . The soil of the experimental site was clayey in texture and has a pH of 8. 56.

The important results could be summarized as follows:

1) Most faba bean characteristics increased in their values as a result of a single addition of Fe or Mn or Zn or Mo or mixture of them (in the presence of Rhizobium inculation) relative to the control treatment (uninoculated and non - fertilized). Highest seed yields were obtained by Mo and micronutrients mixture.
2) Seed coating method gave better yields relative to foliar fertilization , but treatments using foliar fertilization beside seed coating gave the best yields.
3) The siginificant interactions revealed that micronutrients effecincy is depentent on the method of its addition, where the highest faba bean seed yields were obtained by adding the mixture of these micronutrients (using seed coating , and seed coating + spraying).
4. Using inoculation with rhizobia, besides micronutrients addition, gave better faba bean seed yield and nodulation compared with the check treatment (uninoculated and non - fertilized). Such result is attributed to the positive effect on rhizobium nodulation and subsequently increased N_2 - fixation and seed yield.

INTRODUCTION

In the alluvial soils of the Nothern Delta Region in Egypt there are many problems which lead to micronutrient deficiencies and subsequent low production of most crops i. e. the high soil pH and ESP, low percentage of soil organic matter, intensivecropping and high addition of NPK fertilizers without considering micronutrients needs and nutrient balance in plant.

Faba bean, as the main leguminous crop, should be investigated for its requirement of micronutrients which lead to higher yield. Abd El - Naim and Awady (1990) found that foiliar fertilization of Mo twice (one month after planting and once before flowering) with rates from 0 to 100 g Mo/fed as molybdic acid ($H_2MoO_4.H_2O$) resulted in higher yields of soybean and faba bean. The rates of 40 and 60 g Mo/ f significantly increased faba beanseed yield. El-Awady *et al.*, (1990) indicated that all faba bean characteristics postitively responded to phosphate and zinc treatemts. The best values were obtainded by using 45 kg p_2O_5 + 200, Zn (F.F.) per feddan . Khadr *et al.*, (1990). in a study lasted for 4 years on faba bean plants indicated that foliar fertilization with Zn in soils low in availble Zn gave higher seed yield increase, while soils that had adequate available Zn gave negative values . Shafshak (1990) found that faba bean plants indicated that were sprayed just prior to flower initiation and full bloom phase with a mixture of Zn , Mn , Fe, Cu and Mo solution gave better yield and mineral concentrations in both plant foliage and greem seeds.

The efficiency of micronutrients fertilization is mainly dependent on the method of application (soil application or foliar fertilization or seed coating at planting) and micronutient fettilizer source (salts or acids or chelates) .Bailie and Elward (1980) defined seed coating as the process designed to create a nutritious environment in the immediate vicinity of the germinating seed. This provides a "boost" for the seedling in its critical early phase of development, which is particularly important under the type of stress conditions found in many land reclamation projects. They also reported the reasons why coating seed was necessary:

a) Pre - inoculation for legume seeds with nodule bacteria (rhizobia).

b) Nutrient benefits, where seed coating creates a nutritious environment around the germinating seeds.

c) Protection from stress conditions such as wind and high temperature , moisture

stress and nutrient deficiencies.

d) Protection from rodents , birds and harmful effect of fertilizers.

Alexander (1986) stated that foliar fertilization (FF) has an increasing role in crop nutrition , but years of research and development work are still needed . Historically, FF is nothing new . In France, already in 1844 FF with Fe sulfate was successful against plant chlorosis . Today certainly , nobody doubts that FF is capable of quickly, cheaply , economically overcoming various dificiency symptoms. Foliar fertilization is of growing interest for both developing and developed countries., Foliar spray with Zn - chelate obviously produced the best effect. Osman *et al.*, (1990) in a field experiment on faba bean (Giza 2 variety) using Fe, Mn and Zn chelates by the method of seed coating , found that this method was efficient for correcting the requirment of the crop planted in alluvial slightly alkaline soils.

Inoculation of faba bean seeds with effective strains of rhizobia has become a fact in increasing nodulation and subsequent N_2 - fixation and seed yield production .Hallworth (1970) stated that the potential response of faba bean to the application of micro nutrient fertilizers is affected by:

a. The level of supply in an available form of the nuritional elements required by the plant and by the nodule system.

b. By the persence or absence of strains of rhizobia capable of forming effective nodules.

c. By the variation in the quality of the trace elements in the used seeds.

d. By the methods by which trace elements or bacterial inoculants are applied.

In the light of the above, the current resarch was conducted to evaluate the single application of Fe, Mn, Zn and Mo and a mixture of them using the methods of seed coating and foliar fertilization in the presence of rhizobia inoclation on faba bean yield in a slightly akaline soil.

MATERIALS AND METHODS

A factorial field exeriment on faba bean (*Vicia faba L.*) Giza 2 variety was carried out during 1989 / 1990 season at Sakha Research Station . The soil was

clayey in texture, with organic matter 1. 57 % and total nitrogen content of 0.098 % . The pH of soil -water suspension (1 : 2.5) was 8.45 and T. S. salts was 0. 18 % . The available forms of N, P, Fe, Mn, Zn and Mo nutrients were found as follows:

Avilable - N	(K. sulfate extract. N)	65	ppm	
Avilable - P	(Olsen extractable-P)	11.51	ppm	
Avilable - Fe	(DTPA-Fe)	13.50	ppm	Lindsay
Avilable - Mn	(DTPA- Mn)	11.61	ppm	and Norvell
Avilable - Zn	(DTPA-Zn)	1.13	ppm	(1978)
Avilable - Mo	(Amm. Acetate extract)	9.17	ppm	

All the soil cfharacteristics were determined according to the standard methods mentioned by Black (1965), Chapman and Pratt (1961) and Jakson (1958).

The factors comprised some micronutrients addition (None, Fe - EDTA, Mn - EDTA, Zn - EDTA and Mo- molybdic acid H_2MoO_4. H_2O)X methods of application (spraying , seed coating and spraying + seed coating) X 4 replicates. The Completely Randomized Block Design was used with plot area of 12 m^2 . Seed coating treatments were done at the rate of 2 g of the micronutrients compounds per one kg seeds. Triton B was used as a spreader in all treatements .

Inoculation with *Rhizobium leguminosarum biovar vicea* was carried out by mixing two cultures of rhizobial strains (F21 an F 50) , kindly supplied from the Unit of Biofertilizers at Sakha Research station.

Inoculation with *Rhizobium* was done for seed treated with micronutrients only, but the control treatment was not inoculated. Faba bean seeds (coated and non-coated, and noninoculated) were sown in rows 60 cm apart and the hills were spaced at 20 cm. The recommended N - and P- rates of 20 kg N /f as urea 46.5 % and 15 kg P_2O_5 /f as single super-phosphate (15 %) were added at sowing. Foliar spraying treatments of micronutrients were applied at 0.1% concentation in 200 L/f twice at the vegetative and productive stages of growth.

Data for nodule number and weight, dry matter of plants at 50 and 80 days

from planting, number of pods per plant, 100-seed weight (seed index), nitrogen content in seeds and straw and the yield (seeds and straw) were recorded. Statistical analysis for all data was carried out according to Snedecor and Cochran (1971). The mean values for the factors studied and significant interactions were compared by using the L. S. D. test at the level of 0.05 probability.

RESULTS AND DISCUSSION

The discussion would deal with the effects of the main variables and interactions on some imoportant faba bean characteristics as found in Tables 1,2,3,4 and 5

A. Effect of micronutrients treatments :

Table 1 indicates that faba bean seed and straw yields were significantly affected by micronutrients addition with rhizobium inoculation compared to the control (without micronutrient addition and uninonculated). For seed yield the obtainable increments were 5, 11, 15 and 19 % over the control as a result of adding Fe , Mo and their mixture, respectively. With regardect to straw yield, the differences due to the addition of Fe the addition Mo and their mixture were only significant and increments were 9,7 and 8 % over the conrtrrol, respectively.

For faba bean nodulation at 50 days (Table 2) , micronutrient fertilization affected the number of nodules and their dry weights. Zinc and iron showed high values compared to the control and the other micronutrient treatments. The effect of the method of application was only signigicant on the number of nodules, where foliar fertilization gave the highest value compared to seed coating or the combinations of the two methods.

Table 3 shows that most micronutrient additions significantly increased the number of nodules and thier weights. The relative increments in nodule number over the conrtol teratement were 62 , 19, 32 , 11 and 27 % for Fe, Mn , Zn , Mo and mixture, respectivelly . The other increments in nodule weight were doubled many times, especially by using Zn-fertilixation.

As shown in Table 4, micronutrients fertilization with *Rhizobium* inoculation significantly increased dry matter weights at 50 and 80 days from planting. The increments due to the addition of Fe, Mn, Mo and their mixture over the control were

Dry matter yield:

Data in Table 2 reveal that DMY of corn plants was significantly affected by soil type, the highest mean value of DMY was found in alluvial soil while the lowest one was obtained in calcareous soil. This may be due to the improvement of soil conditions for plant growth under alluvial soil if compared with calcareous one. Similar results were obtained by Dahdoh (1986) and Abd El-Maksoud (1990). Data also clarified that DMY of corn plants was insignificantly affected by the application methods of zinc while significantly affected by levels of Zn.

Data in Table 2 generally show that the effect of all interactions between different factors had similar trends of individual factor effect. In this respect, the highest DMY value of corn plants was obtained for the combination including foliar

Table 2. Fresh weight and dry matter yield of corn plants as affected by soil types, methods of zinc application and zinc levels.

Soil types	Zn levels	Fresh-weight g/pot			Dry matter yield g/pot		
		Zn application		Mean	Zn application		Mean
		Soil	Foliar		Soil	Foliar	
Alluvial	0	336.9	336.9	336.9	61.33	61.33	61.33
	5	354.9	390.4	372.7	62.90	79.57	71.24
	10	303.1	394.5	348.8	59.70	76.66	68.18
	20	221.5	277.7	249.6	54.77	48.15	51.46
	Mean	316.9	341.9	333.2	59.68	66.43	63.05
Calcareous	0	210.6	210.6	210.6	40.20	40.20	40.20
	5	284.8	236.5	260.7	57.73	46.18	51.96
	10	274.2	260.6	267.4	46.90	47.63	46.91
	20	256.6	235.9	246.3	53.25	52.73	52.99
	Mean	256.5	235.9	246.2	49.54	46.69	48.11

L.S.D.	at 5%	at 1%	at 5%	at 1%
Soils (S)	13.8	18.4	2.77	3.70
Methods of Zn application (M)	N.S.	N.S.	N.S.	N.S.
Zn-level (L)	19.4	26.0	3.92	5.23
S x M	19.4	26.0	3.92	5.23
S x L	27.5	36.7	5.54	7.40
M x L	N.S.	N.S.	5.54	N.S.
S x M x L	38.9	N.S.	7.83	10.46

Table 3. Effect of micronutrients and methods of application on faba bean nodulation at 80 days.

Micronutrient treatment	(A) Seed (ardab / fed)				(B) Straw (ton / fed)			
	S	C	S+C	.Mean nutrient	S	C	S+C	.Mean nutrient
None	.22.50	18.50	20.50	20.50	0.08	0.07	0.06	0.06
Fe	52.00	26.00	21.50	33.17	0.39	0.12	0.22	0.24
Mn	22.50	29.50	21.00	24.33	0.08	0.16	0.21	0.15
Zn	29.50	28.75	22.75	27.00	0.37	0.49	0.25	0.37
Mo	23.75	25.00	19.75	22.83	0.15	0.23	0.15	0.18
Mixture	23.00	21.50	24.25	25.92	0.25	0.16	016	0.19
Mean method	30.05	6.22	21.63		0.22	0.20	0.18	

Notes:S = spraying C = coating

		(A)	(B)
L. S. D. (0.05) :	Micronutrient =	3.85	0.12
	Method of application =	3.53	N .S.
	Interaction =	8.72	0.255

Table 4. Effect of micronutrients and methods of application on faba bean dry matter of plants.

Micronutrient treatment	(A) DM weight at (50 days)				(B) Dry weight at (80 days)			
	S	C	S+C	.Mean nutrient	S	C	S+C	.Mean nutrient
None	10.93	10.53	10.73	10.73	53.18	53.14	53.16	53.16
Fe	14.05	14.88	17.41	15.45	58.70	66.05	68.06	64.27
Mn	15.43	15.82	17.74	16.33	63.55	68.14	66.29	65.99
Zn	18.41	27.10	20.97	22.16	65.98	73.19	69.41	69.53
Mc	14.89	16.77	16.99	16.22	73.20	74.57	72.51	73.43
Mixture	15.69	17.45	18.15	17.09	65.35	74.55	77.90	72.60
Mean method	14.88	17.12	16.99		63.33	68.27	67.89	

Notes : S = spraying C = coating

		(A)	(B)
* L. S. D. (0.05) :	Micronutrient =	1.623	2.37
	Method of application =	1.171	2.927
	Interaction =	2.619	N. S.

43 , 52 , 18 , 20, 51, and 59 % at the first sampling and (20 , 24, 30 38 and 36 % at the secound sampling, respectively.

Table 5 demonstrates the number of pods / plant, as well as 100 seed weight which increased as a result of micronutrients addition and inoculation with rhizobia. The highest values were obatained by Mo and mixture additions, with increments of 39 , 35 % and 8, 9 % , respectively.

Nitrogen content in faba bean seeds and straw (Table 6) significantly inceased by micronutrients fertilization and inoculation with rhizobia compared to the control treatment, but there was no significant difference between the different micronutrients on N content in seeds. For N content in straw, the highest values were obtained by adding Zn and mixture fertilization with inoculation.

Similar findings were found by Alexander (1986), Abd-El - Naim *et al* . (1990) , El - Awady *et al.*, (1990) , khader *et al.,* (1990) and Shafshak (1990) concerning faba bean response to the addition of micronutrients and inoculation with rhizobia.

B. Effect of micronutrients method of application :

As shown in Table 1 seed and straw yields were siginficantly affected by the micronutrient method of addition . For seed yield, the seed coating was more effective than foliar fertilization , but using seed coating with foliar fertilizaion gave the highest seed yield . The increments due to seed coating and the two methods were 5 and 8 % over that obtained by using foliar spraying only. With respect of straw yield, foliar spraying was more effective than seed coating, but using the two methods gave also the highest yield with an increment of 5 and 9 % over the two methods, respectively.

Tables 2 and 3 show that faba bean nodulation was significanly affected in muber but was not significantly affected in weight by micronutrient addition. Folair fertilization gave the best values relative to the other two methods.

As seen in Table 4, faba bean dry matter weights at 50 and 80 days from planting were affected by the method of application where seed coating gave the highest values with incements of 15 and 8 % over that obtained by foliar fertilization at the two intervals , respectively . Using the two methods gave nearly the same result as seed coating.

Table 5 indicates that the effect of micronutrient addition was significant on faba bean number of pods, but nonsignificant on 100 seed weight. Seed coating with the two methods led to higher values in the number of pods with increments of 7 and 11 % over that obained by spraying method, respectively.

Nitrogen concentration in faba bean seeds and straw (Table 6) was not significantly affected by the method of micronutrient fertilization , where the obtained values were similar.

Alexander (1986) and others in different locations in Egypt found higher faba bean responses using foliar fertializtion (FF) of micronutients. Seed coating which was recently introduced to Egyptian Agriculture had shown to produce high faba bean yield (Osman *et al.*, 1990).

C. Interaction effects :

As shown in Tables 1, 2, 3, 4, 5 and 6 there were significant interactions between micronutrients X methods of their application, where the efficiency of any single micronutrient depended on the method of its application. This interaction was not significant only in case of dry matter weight at 50 days and N content in seed and straw. For seed yield, the highest values were obtained by the mixture of micronutrients with methods of coating and spraying + coating, and Zn and Mo (with methods of coating and spraying + coating), and Zn and Mo with coating, or spraying. The efficiencies of Fe, Mn, Zn, Mo and mixture increased in coating method relative to spraying method, and were increased by using coating + spraying. With respect to straw yield, higher values were obatained by Fe, Zn, Mo and mixture by using coating + spraying compared to the other method. The significant interaction on faba bean nodulation revealed that Fe or mixture by spraying and Mn, Zn, by seed coating gave higher numbers of nodules. With respect to nodule dry weight, Fe and Zn by spraying as well as Zn by seed coating, gave the highest values. For nodulation number and weight, the effeciencies of Fe and Zn fertilization were the highest using foliar spraying relative to the other methods. Higher values in faba bean dry matter were obtained by using Zn (using the three methods), Mn (spraying + coating) and Mixrture (coating, spraying + coating) compared to the other treatments. The number of pods was the highest by using Mo and mixture, by the two methods. Higher values due to micronutrients were obtained by seed coating compared with the spraying method. One hundred seed weight was highest by using Mn (seed coating) and mixtue (two methods) compared to the other treatments. Nitrogen content in

Table 5. Effect of micronutrients and methods of application on faba number of pods and 100 seed weight .

Micronutrient treatment	(A) Seed (ardab / fed)				(B) Straw (ton / fed)			
	S	C	S+C	.Mean nutrient	S	C	S+C	.Mean nutrient
None	.15.95	15.55	15.75	15.75	57.00	57.50	57.60	57.60
Fe	21.00	22.00	19.75	20.29	58.00	60.00	62.25	60.08
Mn	17.75	18.00	19.75	18.50	56.75	64.00	59.25	60.00
Zn	17.50	19.00	21.25	19.25	59.25	61.50	59.25	60.00
Mo	20.00	22.50	23.25	21.92	60.75	62.75	63.25	62.25
Mixture	19.06	21.50	23.25	21.27	62.00	62.15	64.00	62.72
Mean method	18.50	19.78	20.50		58.96	61.32	60.99	

Notes: S = spraying C = coating (A) (B)

* L. S. D. (0.05) : Micronutrient = 1.86 1.728

Method of application = 1.64 N. S.

Interaction = 3.67 2.186

Table 6. Effect of micronutrients and methods of application on faba bean nitrogen content (%) in seed and straw.

Micronutrient treatment	(A) DM weifht at (50 days)				(B) Dry wight at (80 days)			
	S	C	S+C	.Mean nutrient	S	C	S+C	.Mean nutrient
None	4.22	4.20	4.23	4.21	2.72	2.79	2.65	2.73
Fe	4.51	4.51	4.66	4.56	2.83	2.82	2.79	2.81
Mn	4.64	4.58	4.45	4.56	2.93	2.89	2.78	2.87
Zn	4.74	4.53	4.46	4.58	2.92	2.95	2.86	2.91
Mo	4.63	4.42	4.69	4.58	2.84	2.77	2.83	2.81
Mixture	6.68	4.54	4.74	4.65	2.95	2.96	3.15	3.02
Mean method	4.57	4.46	16.99		2.87	2.86	2.84	

Notes S = spraying C = coating (A) (B)

* L. S. D. (0.05) : Micronutrient = 0.33 0.13

Method of application = N. S. N. S.

Interaction = N. S. N. S.

eeds and straw was not affected by the interaction of each micronutrient with the other using any method of addition.

B. Conclusion :

1) Most of faba bean characteristics incresased in their values as a result of a single addition of either Fe, Mn, Zn , Mo or a mixtrue of them in the presence of inoculation with rhizobia. Highest seed yield was obtained by Mo and mixture of most of the micronutrients. This explain the unavailability of these micronutrients under the slight alkaline conditions or the hidden hunger resulting from nutrient imbalance.

2) The method of micronutrient addition has an important role in increaesing faba bean growth and yield Seed coating gave better values compared to foliar fertilization, but treatments using seed coating in addition to foliar application gave the best resutls

3) The interaction effects revelaled that micronutrient efficiency depends on the method of its addition. The highest faba bean seed yields were obtained by spraying mixture of micronutrients (using seed coating , seed coating + spraying) and Zn , Mo (using seed coating or spraying). As for Zn and Mo, either seed coating or spraying gave satisfactory results.

4) Using inoculation with rhizobia plus micronutrients additon have produced better faba bean seed yield and nodulation than in the control treatment especially with seed coating.

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تأثير بعض المغذيات الدقيقة وطرق اضافتها مع التلقيح ببكتريا العقد الجذرية على محصول الفول البلدى

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تم تنفيذ تجربة حقلية خلال موسم ١٩٨٩ / ١٩٩٠ لتقييم تأثير اضافة بعض المغذيات الدقيقة (حديد ، منجنيز ، زنك ، موليبدنم ، مخلوط من هذه العناصر) مع طرق اضافتها (تغليف البذرة او الرش الورقى مع تغليف البذرة) وذلك فى وجود التلقيح البكتيرى على محصول الفول البلدى المنزرع بمحطه البحوث الزراعية بسخا (ممثلة لبعض الأراضى المتأثرة بالقلوية).

ويمكن تلخيص اهم النتائج فى الآتى :

١) تأثرت معظم خصائص الفول البلدى ايجابياً نتيجة استخدام الإضافة الفردية لأى من المغذيات المستخدمة أو المخلوط منها وذلك فى حالة استخدام التلقيح البكتيرى مقارنة بمعاملة المقارنة . أدى استخدام عنصر الموليبدنم وكذلك مخلوط المغذيات الى قيم مرتفعة من محصول البذور .

٢) أدى استخدام طريقة تغليف البذرة الى محصول أعلى مقارنة بطريقة الرش الورقى ، ولكن استخدام الطريقتين معا حقق المحصول الأعلى .

٣) أوضح التفاعل المعنوى أن كفاءة استخدام العنصر المغذى تتوقف على طريقة إضافته ، حيث تحقق أعلى محصول للبذور بإستخدام مخلوط العناصر بإستخدام طريقة تغليف البذور او بإستخدام طريقة الرش او بإستخدام طريقة الرش مع طريقة تغليف البذور . كذلك تم الحصول على محصول عالى بإستخدام اى من عنصرى الزنك او الموليبدنم بإستخدام الرش الورقى او طريقة تغليف البذور.

٤) ادى استخدام التلقيح البكتيرى مع التسميد بالعناصر الدقيقة الى زيادة محصول البذور مقارنة بمعاملة المقارنة ، ويرجع ذلك الى التأثير ايجابياً على بكتيريا العقد الجذرية وزيادة التثبيت النتروجينى مما ينعكس أثره على زيادة المحصول .