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RESPONSE OF BROAD BEAN PLANTS TO NEW LIQUID FERTILIZER AND SOIL APPLICATION OF NITROGEN AND PHOSPHORUS FERTILIZERS

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ABSTRACT

Two field experiments were carried out during the two growing seasons of 1998/99 and 1999/2000 under the environmental conditions of Nobaria district, north Egypt to study the effect of new liquid fertilizer (S_1), nitrogen levels (20, 40 and 60 kg N/fed) and phosphorus levels ((0, 20, 40 and 60 kg P_2O_5/fed) , as well as their interaction effects on growth, yield and yield components of broad bean cv. Giza blanka.

The main results could b summarized as follows:

Broad bean plants sprayed with S_1 solution gave superiority of all studied parameters, such as plant height, number of branches / plant, number of pods / plant, seed yield/fed, and seed protein content. While, number of leaves/plant did not significantly affect. Moreover, N at 60 kg/fed was the most effective treatment as for all vegetative growth characters, seed yield or yield components. Likewise, P level up to 40 kg/fed had positive effect on in that respect. Further increase in phosphorus levels up to 60 kg P_2O_5/fed showed better effect in all studied characters, but the differences were not significant. Almost interaction treatments gave a significant effect on seed yield in both years of study. However there were different responses to interaction treatments as for vegetative growth and yield components.

In general, it could be concluded that treated broad bean plants with soil application of suitable and economical level of nitrogen and phosphorus (60 and 40 kg/fed, respectively) besides spraying S_1 solution three times is very useful for increasing total yield and improving its quality.

INTRODUCTION

Broad bean (*Vicia faba*, L.) is considered one of the most important food legume crop in Egypt. So, it is of great importance to improve its production throughout increasing the productive area or increasing the productivity per feddan. This could be achieved by planting high yielding varieties and modifying nutrition programs, such as spraying the plants with nutrient solution containing some micro-, macro-elements, amino acids and some medicinal plant extraction in various growth stages. Nitrogen and phosphorus fertilizers are recognized among the effective factors in that respect.

Several investigators reported the importance of nutritional elements (Cu, S, Zn and K) for improving broad bean and its quality (Petrov, 1990, Hamman, 1995 and Marschner, 1995).

Legumes require a comparatively small amount of N compared with other vegetable crops. These legumes are associated with symbiotic bacteria that convert atmospheric nitrogen into forms possible to use by plant. The amount of nitrogen converted into a useable form depends upon the vegetable involved and the estimated pounds fixed per acre were as follows: Peas 72 kg, beans 40 kg, soybean 58 kg and pea nut 42 kg (Delwiche, 1970).

Nitrogen has many functions in plant life, being a part of protein (an important constituent of protoplasm), and enzymes (the biological catalytic agents, which speed up life processes). Therefore, sufficient supply of various nitrogenous compounds is required in each plant cell for its proper functioning (Mengel and Kirkby, 1987).

Under Egyptian conditions, several investigations had been achieved. For instance, Salem and Caesar (1982), and El-Khawaga and Zeiton (1986) found that seed yield / feddan significantly increased with increasing nitrogen application up to 45 Kg/N feddan. Also, Shafik and Kether (1989) found surpass of 40 kg N/ha compared with other does. Also, Abo-Shetaia (1990) found a positive effect of N application which increased 100-seed weight and yield/feddan specially at 70 kg N/fed. In the contrary, Salem and Caesar (1982) reported that N application had insignificant effect on dry matter yield of broad bean plants, but increased the number of days to maturity.

Phosphorus is a constituent of all tissues and is found especially concentrated in younger parts, flowers and seeds. This element is particularly important in germination of seeds and fruits. Phosphorus is essential for cell division and development of meristematic tissue (Mengel and kirkby, 1987).

Studies on phosphorus fertilization of broad bean have demonstrated the demand of broad bean plants for phosphorus. Abdel-Aziz and Kether (1989), Tallaric and Orsi (1988), Shafik and Kether (1984), Abdel-Reheem *et al.* (1992) and Farrag *et al.* (1992) found that nodule number, pod number and seed and straw yield increased with increasing P rate up to 40 kg P_2O_5/feddan.

MATERIALS AND METHODS

Two field experiments were carried out in sandy loam soil, Nobaria district, north Egypt during two successive winter seasons of 1998/99 and 199/2000 to determine the effect of spraying (S_1) solution, nitrogen and phosphorus fertilizers as well as their interaction on the productivity of broad bean (*Vicia faba,* L.) cv. Giza blanka. Soil samples were taken before broad bean sowing for estimating the important chemical and physical soil properties. Soil analysis data are presented in Table 1. The proceeding summer crop was maize in both seasons.

Each experiment include 2 spraying treatments with (S_1)solution (0.5 and 1 L/fed.), 3 N levels (20, 40 and 60 kg/fed.) in form of urea (46% N) and 4 P levels (0, 20, 40 and 60 kg P_2O_5 / fed.) as calcum superphosphate (15.5% P_2O_5). S_1 solution was sprayed 3 times in equal doses at 20, 45 and 60 days after sowing date. Nitrogen fertilizer was applied in two equal does at 20 and 45 days from sowing. While calcium superphosphate was applied after ridging and before sowing irrigation. Broad bran seeds were treated with okaden.

S_1 solution consists of K, Mg, Cu and S, in addition, amino acids and 3 extracted oils (Thymol, carvon and henna).

The experiment design was a split-split plot design with 4 replicates, whereas the spraying treatments were arranged within the main plots, N levels were distributed in the sub-plots and P levels were in the sub-sub-plots. Seeds of broad bean cv. Giza blanka were sown using the dry method (Afir) on first November in the two seasons of study. The experimental basic unit area included five ridges, and 60 cm with and 3.5 m length, occupying an area of 10.5 m^2 (1/400 fed.). Normal and regular cultural practices were applied properly during the growing seasons of the experimentation as recommended by broad bean growers in this region.

Table 1: Some physical and chemical properties of the experimental soil before planting during the two seasons.

Soil properties	1999	2000
Mechanical analysis:	20.79	22.11
Coarse sand %	41.20	39.11
Fine sand %	21.90	39.76
Silt %	16.10	22.98
Clay %	8.00	16.00
$CaCO_3$ %	sandy loam	9.44
Texture		sandy loam
Chemical analysis:		
Organic matter %	0.51	0.49
Total nitrogen %	0.04	0.05
Available phosphorus (ppm)	11.08	11.07
Available potassium (ppm)	149.01	156.0
EC (mmhose/cm)	1.10	0.91
PH	7.88	8.02

At harvest, a random sample of five plants were taken from each replicate to estimate the following characters:

1. Plant height (cm).
2. Number of leaves / plant.
3. Number of branches / plant.
4. Number of pods / plant.
5. Number of seeds / pod.
6. Weight of 100 seeds (g).

In addition the two inner ridges of each plot were collected and the following characters were estimated after seed drying:

1. Seed yield (ardab /fed.).
2. Straw yield (ton/fed.)
3. Seed protein (%) was determined after the method described by Ranganna (1979)

All recorded data were subjected to analysis of variance and treatment means were compared using LSD test according to the method described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Vegetative growth:

Data presented in Table 2 show the effect of spraying (S_1) solution, N and P fertilizers and their interaction on vegetative growth as expressed on plant height and number of branches / plant. The results revealed that plant height and number of branches of broad bean were significantly affected by all studied factors.

Table 2: Effect of spraying S_1 solution, N and P fertilizer levels as well as their interaction on plant height and number of branches and leaves / plant in two seasons of 1999 and 2000.

Characters / Treatments	Plant height (cm)		No. of branches / plant		No. of leaves / plant	
	1999	2000	1999	2000	1999	2000
A. S_1 spraying:						
Without	160.0	162.3	4.99	5.22	96.49	97.4
With	162.0	166.9	6.63	6.96	99.01	98.3
F test	**	**	**	**	NS	NS
(B): Nitrogen fert. (kg N/fed.)						
20						
40	158.9	162.9	6.01	6.06	94.2	95.2
60	162.1	166.0	6.25	6.37	98.0	98.8
LSD at 5%	163.1	167.5	6.43	6.53	100.2	101.5
	1.4	1.1	0.07	0.05	1.30	1.50
C: Phosphorus fert. (kg P_2O_5/fed):						
0						
20	158.8	162.0	5.96	6.02	95.5	85.7
40	161.3	165.5	6.22	6.30	95.9	97.8
60	162.8	166.6	6.35	6.41	98.4	94.7
LSD at 5%	162.9	168.0	6.38	6.52	99.1	100.7
	1.9	1.9	0.11	0.09	2.0	2.4
Interaction Treat.:						
A x B	NS	NS	NS	**	NS	NS
A x C	NS	NS	NS	NS	NS	NS
B x C	NS	NS	NS	**	NS	NS
A x B x C	NS	NS	NS	*	NS	NS

Spraying with (S_1) solution caused a pronounced increase in plant height and number of branches / plant in both seasons of study, while number of leaves per plant was not significantly affected. The obvious superiority of (S_1) solution may be due to its effect on photosynthesis promotion, which induce an increment in tissues carbohydrates content and it causes a positive marked influences on nodules formation. Consequently, N-fixation tend to the gradual magnitude and herein increasing growth characters. Such results are in agreement with those reported by Abdel-Haleem (1994), El-Dsoky (1995), Hammam (1995) and Marschner (1995).

In addition, each increase in N or P resulted in an obvious increase in plant height, number of leaves / plant and number of branches / plant in both seasons with some exception. However, raising P rate from 40 to 60 kg P_2O_5/fed did not marked increase in plant height in both seasons and number of branches in the first season only.

Marschner (1995) reported that N and P increase CYT production and export. CYT modulates the synthesis and polar IAA transport (Li and Bangerth, 1992) and this, in turn, increase plant height of broad plants.

On the other hand, the interaction treatments did not affect previous parameters in the first season. This indicates that each factor acts independently. However, this result is in accordance with that obtained by Shafik and Kether (1989), who found that N up to 40 kg/acre increased broad bean plant height.

2. Seed yield components:

Number of pods / plant, number of seeds / pod and 100-seed weight as affected by spraying S_1 solution, N, P fertilization and their interaction are shown in Table 3.

Table 3: Effect of spraying S_1 solution, N and P fertilizer levels as well as their interaction on number of pods / plant, number of seeds/pod and 100-seed weight in two seasons of 1999 and 2000.

Characters / Treatments	No. of pods / plant		No. of seeds / pod		100-seed weight (g)	
	1999	2000	1999	2000	1999	2000
A. S_1 spraying:						
Without	22.97	23.78	7.10	7.14	63.59	64.93
With	29.31	29.97	7.32	7.38	66.14	67.13
F test	**	**	**	**	**	*
(B): Nitrogen fert. (kg N/fed.)						
20						
40	24.21	24.65	7.12	7.16	63.49	65.02
60	26.56	27.17	7.19	7.25	65.47	66.18
LSD at 5%	28.25	28.77	8.77	7.34	66.02	66.79
	0.38	0.19	0.19	0.02	0.38	0.39
C: Phosphorus fert. (kg P_2O_5/fed):						
0						
20	24.83	25.41	7.08	7.14	64.49	64.63
40	26.02	26.62	7.20	7.23	65.16	65.89
60	26.87	27.30	7.20	7.30	65.66	66.54
LSD at 5%	27.65	28.13	7.28	7.32	66.06	66.91
	0.40	0.45	0.07	0.06	0.61	0.60
Interaction Treat.:						
A x B	**	NS	NS	*	*	*
A x C	**	NS	NS	NS	**	NS
B x C	NS	NS	NS	NS	NS	NS
A x B x C	NS	NS	NS	*	NS	NS

In the two years, all parameters mentioned above significantly responded to all studied factors. Spraying S_1 solution caused a significant increase in number of pods / plant, number of seeds / pod and 100-seed weight as compared with unsprayed plants.

Moreover, adding N or P at all levels significantly increased the above mentioned parameters, since each increase in N or P fertilizers gave an obvious increase in those parameters. That was true in both years of study. Such significant effect could be attribute to the helpful influences of various elements in the sprayed solution which caused enhance in nodule formation, and consequently raised N fixing and then increased vegetative growth and yield. Moreover, the extracted essential oils exhibit resistance for plants against fungi. This findings are in agreement with those of Beveridge *et al.* (1983), Hartmans *et al.* (1990), Voughn and Spencer (1991), Oesterhaven *et al.* (1993) and Vokou *et al.* (1993).

Nitrogen and phosphorus increase root primordial in which CYT synthesized and there are close relationship between root primordial and leaf area index and leaf duration and also rapid leaf expansion and thus increased photosynthesis (Marschner, 1995) and this, in turn, increase seed yield. Marschner (1995) reported that additional application of N at the onset of flowering lead to an increase in seed number and yield. In the same time, bacterial nodules provide broad bean with additional N through N-fixing process at flowering, which lead to an increase in seed pods and yield.

These results are in accordance with those obtained by Fayez *et al.* (1988), Petrov (1990) and El-Desouky (1995).

The interaction between spraying S_1 solution and N or P fertilizer had a significant effect on number of pods / plant as well as 100-seed weight. While, number of seeds / pod was affected by the interaction between spraying S_1 solution and N as well as the triple interaction in the second season only.

3. Seed yield:

Data in Table 4 clearly indicated that spraying S_1 solution increased seed and straw yields over the untreated one in both seasons of study. This effect may be attributed to the following reasons:

i. S_3 solution contains many amino acids which play an important role to chelate the nutrient elements inside the plant tissues (Marschner, 1995).
ii. It contains also some elements (K, Cu, mg and S), which help strongly plant growth and development as a result to photosynthesis efficiency (Marschner, 1995).
iii. Essential oils which found in S_1 solution gained plants excess resistance against fungi diseases (Voughn and Spencer, 1991)..

The previous reasons lead to obvious activity in nodule formation and, in turn, increasing the amount of N fixed by Rhizobium bacteria. Several investigators came to the same conclusion (Fayez *et al.*, 1988; Petrov, 1990 and El-Desoky, 1995). The results in the same table also clearly indicate that spraying S_1 solution significantly increased both straw yield and seed protein percentage.

Increasing N rate from 20 up to 60 kg/fed gave an increase in the seed yield as well as straw yield. The highest yield was recorded with 60 kg N level compared with 20 or 40 kg N/fed. It could be concluded that the economic level of N needed to obtain the highest seed yield under the conditions of this study is 60 kg N/fed. The same trend was obtained as for straw yield and seed protein percentage. This result is in agreement with those obtained by Salem and Caeser (1982) and El-Khawaga and Zeiton (1980).

Table 4: Effect of spraying S_1 solution, N and P fertilizer levels as well as their interaction on seed, straw yield and seed protein percentage in two seasons of 1999 and 2000.

Characters / Treatments	Seed yield (Ardab/fed)		Straw yield (ton/fed)		Seed protein (%)	
	1999	2000	1999	2000	1999	2000
A. S_1 spraying:						
Without	8.99	10.08	1.49	1.69	29.93	30.09
With	13.61	13.76	1.69	1.88	32.00	31.92
F test	**	**	**	**	**	**
(B): Nitrogen fert. (kg N/fed.)						
20						
40	10.7	10.69	1.36	1.66	30.45	30.76
60	11.23	11.52	1.61	1.81	30.80	31.33
LSD at 5%	12.44	13.24	1.83	1.98	30.66	31.71
	0.25	0.55	0.06	0.08	0.21	0.17
C: Phosphorus fert. (kg P_2O_5/fed):						
0						
20	10.21	10.82	1.24	1.47	31.48	30.99
40	11.06	11.56	1.56	1.75	31.70	31.24
60	11.67	12.33	1.77	1.90	30.89	31.42
LSD at 5%	11.48	12.57	1.79	1.97	30.22	31.57
	0.45	0.34	0.08	0.09	0.37	0.30
Interaction Treat.:						
A x B	**	**	NS	NS	NS	NS
A x C	**	**	NS	NS	**	NS
B x C	**	**	NS	NS	NS	NS
A x B x C	NS	**	NS	NS	NS	NS

Data in Table 4 also indicate that adding P at 20, 40 and 40 kg P_2O_5/fed caused a significant increase in seed yield, straw yield and seed protein percentage as compared with control. Moreover, the economic P level was 40 kg P_2O_5/fed at which seed yield was higher than at 20 kg/fed and did not differ significantly with 60 kg/fed. This result holds true in both seasons of study. This result was expected, since phosphorus increases growth and yield components such as number of branches / plant, number of leaves / plant, number of pods / plant, number of seeds / pod and 100-seed weight, which cause an increase of seed and straw yield. Similar results were obtained by Abdel-Aziz *et al.* (1987), Tallarico and Orsi (1988), Shfik and Kether (1989) and Abdel-Raheem *et al.* (1992).

All interaction treatments had a highly significant effect on seed yield, except in the first seasons as for the triple interaction.

Marschner (1995) reported that sufficient N and P supply is needed for nodulation, they increase nodule dry matter. He added that P and N in nodules were higher than in root or shoots and the storage N in host plant is detrimental to the formation of source leaf area needed to photosynthesis and this, in turn, affect nodule growth and activity and affect pods, seed and yield.

In general. it could be concluded that the suitable and economic level of nitrogen and phosphorus is 60 and 40 kg/fed, respectively. However, spraying S_1 solution is very useful and effective to increase broad bean yield and improve its quality.

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إستجابة نباتات الفول الرومى لسماد سائل جديد والتسميد الأرضى لمستويات مختلفة من التسميد النتروجينى والفوسفاتى

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أجريت تجربتين حقليتين فى موسمى الزراعة لعامى ١٩٩٨/٩٩ ، ١٩٩٩/٢٠٠٠ بمنطقة النوبارية شمال ج٠م٠ع٠ وذلك لدراسة تأثير نوع جديد من الأسمدة السائلة وكذلك مستويات مختلفة من النتروجين والفسفور وكذلك التداخل بينهما على إنتاجية محصول الفول الرومى٠

يتكون السماد السائل الجديد (S_1) من مجموعة من العناصر الغذائية (البوتاسيوم – المغنسيوم – النحاس – الكبريت) بالإضافة إلى أحماض أمينية ومستخلصات نباتات طبية (الحنا – الزعتر – الكراويه)٠ ويضاف رشا على المجموع الخضرى للنباتات ثلاث مرات (جرعات متساوية) بعد ٢٠ ، ٤٥ ، ٦٠ يوما من الزراعة٠ أما بالنسبة للسماد النتروجينى فكان فى صورة يوريا وأضيف بمستويات ٢٠ ، ٤٠ ، ٦٠ كجم/فدان ٠ والسماد الفوسفاتى فكان فى صورة سوبر فوسفات الكالسيوم وأضيف بمستويات صفر ، ٢٠ ، ٤٠ ، ٦٠ كجم/فدان٠

أدت معاملة نباتات الفول بالسماد السائل إلى زيادة معنوية فى كل قياسات النمو الخضرى وكمية المحصول وذلك خلال موسمى الزراعة٠ كذلك وجد أن معدل ٦٠ كجم أزوت/فدان هو الأكثر فعالية فى زيادة إنتاجية الفول وكذا إضافة ٤٠ كجم فوسفور / فدان إدت إلى تحسين النمو الخضرى والمحصول البذرى٠ كما أوضحت معاملات التداخل بين كلا من السماد السائل والتسميد بكل من الأزوت والفوسفور تأثير إيجابى واضح على محصول البذور٠

وبصفة عامة لم يكن هناك تأثير واضح للتداخل بين الرش بالسماد السائل ومستويات التسميد الأرضى على كل من النمو الخضرى ومكونات المحصول٠

ويمكن القول أن معدل التسميد المناسب والإقتصادى هو ٦٠ كجم أزوت/فدان بالإضافة إلى ٤٠ كجم بو٢أ٥/فدان٠ كذلك معاملة نباتات الفول بالسماد السائل الجديد (S_1) رشا ثلاث مرات يسبب زيادة واضحة فى المحصول٠