Effect of Residual Organic N, Applied Mineral N Rates and Inoculation with Rhizobium on Yield and N Uptake of Bean

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ABSTRACT

This experiment aimed to examine the effect of residual organic N from the previous crop fertilization, inorganic N fertilization rates and inoculation with *Rhizobium phaseoli* on the N uptake and bean yield. The experiment was conducted during the season 2006-2007 in Al-Salam village on soil received different doses of organic N (manure compost) as the following 0.0, 15, 30, 45, 60 kg N / faddan for the previous crop. All studied factors showed positive effect on the seed yield of common bean and N uptake significantly. The applied mineral N contribution was 43.7 % of the seed yield and 39.3 % of the N uptake. Residual organic N contribution was 41.4 % of the seed yield and 47.6 % of the N uptake. The contribution of inoculation was 6.5 % of the seed yield and 5.7 % of the N uptake. Also, the interactions between any two factors were significant. The highest effect of interaction was between the applied mineral N and residual organic N where both were affected strongly by each other. The interaction between the inoculation and mineral N or residual organic N showed that the effect of inoculation on seed yield was almost the same. The effect of applied mineral N in interaction with inoculation was almost the same with or without inoculation. The effect of residual organic N in interaction with inoculation increased slightly with the inoculation from 480 to 533 kg seeds / faddan.

INTRODUCTION

Applying organic matter (OM) as soil amendment to cropland reduces requirements for synthetic fertilizer and may eliminate yield differences between mineral and organic fertilization and the compost application for soil OM enhancement must be balanced with P input to minimize the potential for excessive soil P accumulation (Singer et al., 2004). Soil surface (0–15 cm) pH significantly increased with N-based manure (MN) or compost application (CN), but decreased with NH_4–N fertilizer application as compared with the check (Bahman Eghball 2002). Bahman Eghball (2000) reported that the amount of compost N mineralized under field conditions needs to be determined in order to apply these resources to provide adequate N for the crop without adverse environmental effects. The amount of N mineralized from organic sources during the growing season provides a major portion of the plant N needs. Nitrogen mineralization was

significantly, but not closely, related to thermal unit. Nitrogen mineralization needs to be considered when applying manure or compost for crop production to effectively utilize these resources and protect the environment. Rafael J. et al (2002) studied the soil residual nitrogen on common been in a continuous rotation with wheat (fertilizer rates were 0, 50, 100, and 150 kg N ha^{-1}) under the Mediterranean conditions when no application of N fertilizer was added to faba been, they found that seed yield ranged from 587 to 2964 kg ha^{-1}. Attallah et al. (2002) showed that the ECe and pH of the untreated soils 5.40 dS/m and 7.6 were decreased to 4.31 and 7.2 for compost treatment, respectively. Weiser G.C et al (1985)reported that Inoculation with the commercial strains, compared with uninoculated controls, did not increase seed yield; however, nodule number and nodule fresh weight were influenced.

The objective of this study is to evaluate the effect of the contribution of organic soil N from the previous crop on the nutrition of the following crop and how much this contribution help in reducing the applied mineral N either with or without inoculation with *Rhizobium phaseoli*.

MATERIALS AND METHODES

The experiment was a complete randomized design with three replications and conducted in El-Salam village (Bohira governorate) during the season 2006-2007**.** Eighteen soil unit (2m X 3m) cultivated with corn plant (*zea mayz*) received 0.0, 15, 30, 45, 60 kg organic N / faddan to raise the total received N up to 60kg N and the control (3 units for each treatment) in the last season were used to conduct this experiment. Ammonium sulfate was applied in the rate of 25, 50, 75 kg N / faddan. Only one half of each treatments inoculated by *Rhizobium phaseoli*.

Soil was chemically analyzed for, pH, EC, in the soil paste (table 1), organic matter, available N and total N were also analyzed (Table2) , and the plant N content were determined according to standard methods edited by Black (1965). The expected soil N was calculated as the following

Expected soil N = (Previous N fertilization +soil N) - N uptake by previous crop

The grain yield (kg / faddan) and N uptake were determined. The obtained data were computed and statistically analyzed for testing the

significance of the studied factors and the possible interaction between them.

Table (1): Effect of previous N fertilization on the soil pH and soil salinity

Previous N fertilization	Soil EC dS/m	Soil pH
60 kg O+0.0 M	2.5	7.65
45 kg O+15 M	2.8	7.70
30 kg O+30 M	2.9	7.70
15 kg O+45 N	3.0	7.75
0.0 kg O+60 M	3.1	7.80
0.0 kg O+0.0 M	3.1	7.80

Table (2): Nitrogen concentrations and organic matter percent in soil as affected by previous treatments

(Soil N=33kg) Previous N fertilization kg/faddan	N uptake by previous crop kg/faddan	Expected soil N kg/faddan	Determined soil N kg/faddan	Available soil N kg/faddan	Organic matter %
0.0 kg O*+0.0 M*	21.0	12.0	11.86	0.675	0.31
0.0 kg O*+60 M*	51.53	41.47	40.73	2.037	1.23
15 kg O*+45 M*	48.95	44.05	42.96	2.058	1.32
30 kg O*+30 M*	43.88	49.12	48.36	2.388	1.46
45 kg O*+15 M*	39.66	53.34	51.92	2.515	1.55
60 kg O*+0.0 M*	37.72	55.28	54.48	2.688	1.66

O* **= Organic N** M* **= Mineral N**

RESULTS AND DISSCUSION

Effect of applied mineral nitrogen:

Seed yield and N uptake increased significantly with the increase of applied mineral N (table3). The increases of seed yield were 29.1 and 42.1 % of the minimum yield (at 25 kg N) for 50 and 75 kg N addition respectively. The increases of N uptake were 29.0 and 42.05 % of the minimum yield (at 25 kg N) for 50 and 75 kg N addition respectively. According to the statistical analysis the contributions of the mineral N fertilization were 43.7 and 39.3 % of the variation occurred in seed yield and N uptake respectively. The standard partial regression coefficient showed that the effect of mineral N was greater three times of inoculation effect or organic N on the seed yield and it was greater three times of inoculation effect and one time and half of the organic N on the N uptake which means that the mineral N fertilization was the most effective studied factor may due to the more availability of mineral N which dissolve in irrigation water to be easy for absorption by plants comparing with organic N which needs more time to be converted biologically to the absorbed form.

Effect of residual organic nitrogen:

The soil samples from all treated soil with different rates of organic and mineral nitrogen for the previous crop (60 kg M*), (45 kg M*+15 kg O*), (30 kg M*+30 kg O*), (15 kg M*+45 kg O*), (60kg O*) and (control = 33kg N) were analyzed for total nitrogen. The expected total nitrogen in soil of those treatments was calculated from the data of the nitrogen balance of the previous crop. Also, organic matter percent and available nitrogen were determined. The data of nitrogen balance of the previous crop, the expected soil N, the determined soil N, available soil N and percentage of organic matter were listed in table 2. The results of the total soil N showed that the determined total N was close to (% 98.1 ± 0.7) of that calculated from the data of nitrogen balance for the previous crop. Available N of the treated soils was relatively high comparing with the soil did not receive any fertilizers (control). Available N and organic matter percent were increased with the increase of applied organic N to the previous crop.

According to the statistical analysis the contributions of the residual organic N were 41.4 and 47.6 % of the variation occurred in seed yield and N

uptake respectively. The standard partial regression coefficient showed

that the effect of residual organic N was one third and one half of the effect of mineral N for the seed yield and N uptake respectively, which means that the residual organic N fertilization was less effective than the applied mineral nitrogen. Seed yield increased significantly with the increase of soil N (soil N = total N in soil after the previous crop) as shown in fig. 1, which means that the residual organic nitrogen from the previous crop contributes in the fertilization of nitrogen in the following season. The increases of seed yield were 10.0, 16.2, 22.7 and 25.1 % of the seed yield of no applied organic N during the last season while it were 10.2, 15.2, 26.21, 29.9 and 31 % of the control (table 3). The nitrogen uptake by common bean plants followed the same behavior of seed yield as affected by the residual organic nitrogen (fig. 2). The complete agreement between the seed yield and the nitrogen uptake refer to the almost fixed yield of seeds for one kg of N uptake by plants, where it was 18.25 ± 0.65 kg seeds / kg N uptake. Finally, the soil organic N level at 54.5 kg N/faddan showed the highest seed yield with the highest addition of mineral N(75 kg / faddan)

Effect of inoculation:

Seed yield and N uptake increased significantly by the inoculation with *Rhizobium phaseoli.* Inoculation increased seed yield by 12.3 % of none inoculated and increased the N uptake by 12.1 % of none inoculated (table 3). According to the statistical analysis the inoculation contributed by 7.5 and 6.5 % of variation of seed yield and N uptake respectively.

Effect of interactions:

Residual organic nitrogen and applied mineral nitrogen:

According to the statistical analysis the contribution of the mineral N fertilization was 47.5% and the contribution of the residual organic N was 45.1 % of the variation occurred in seed yield, while with N uptake those contributions were 50.0 and 42.2 % of the variation occurred. These values represent the contributions of the applied mineral N and residual organic N as the only two effective factors (table4). The data of table 4 cleared the highest effectiveness of applied N when no residual organic N and the soil N was the minimum (11.86 kg N/faddan)

The effectiveness of applied N was the maximum (775.2 kg seeds /faddan) when no residual organic N. Addition and more addition of residual organic N reduced the production of seed yield refer to the applied mineral N and

reached the minimum (338.3 kg seeds /faddan) with the highest value of the residual organic N (table 4). On the other side, the effectiveness of residual organic N was the maximum (731.5 kg seeds /faddan) with the lowest addition of mineral N (25 kg N /faddan). More addition of mineral N reduced the production of seed yield refer to the residual organic N and reached the minimum (293.6 kg seeds /faddan) with the highest addition of mineral N (75 kg N /faddan). Spite of the competition between organic and mineral N on seed yield production the decrease of seed yield refer to any of the two sources of N in favor of the other did not affect negatively on the net yield but the net yield increased due to the effect of applied mineral N(47.5%), residual organic N (45.1%)and the interaction between them (6.5 %).

Residual organic nitrogen and inoculation:

The effectiveness of residual organic N on seed yield was higher (533kg seeds /faddan) with the inoculation than without inoculation (480 kg seeds /faddan), while the effectiveness of inoculation inhibited slightly from 157 kg seeds /faddan with the highest value of residual organic N to 153 kg seeds /faddan (table 5) with no applied organic N (not the control). The contributions of the two factors in the absence of the applied mineral effect were relatively closed where the contribution of the residual organic N was 84.3 % and the contribution of the inoculation was 13.8 %.

Applied mineral nitrogen and inoculation:

The contribution of the applied mineral N was 85.6 % and the contribution of the inoculation was 12.5 % when the effect of residual organic N was excluded. Applied mineral N increased the seed yield by 418 and 415 kg seeds / faddan with and without inoculation respectively, and at the same time inoculation increased the seed yield by 164 and 161 kg seeds with the highest and lowest addition of applied mineral N respectively (table 6). That means both factors showed the same effect on the seed yield either with the highest or with the lowest value of the other factor.

CONCLUSION

The determination of soil content N is too important in the fertilization policy where the applied N needed depends on it. The results showed that the soil organic N should be kept more than 50 kg N / faddan

and applied N should raise the total N to over 100 kg N / faddan to reach

the most economical addition of mineral N. The effect of inoculation was noticed but it was independent of the nitrogen form.

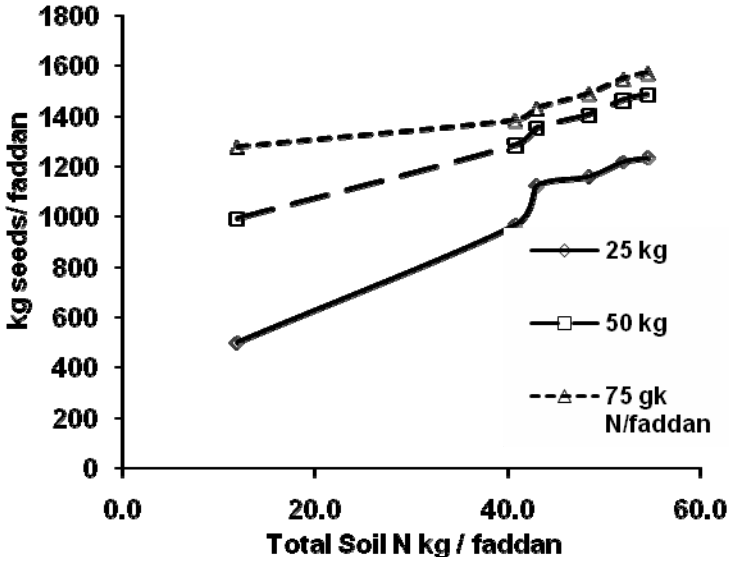

Figure (1): Effect of total soil N and applied mineral N on the seed yield

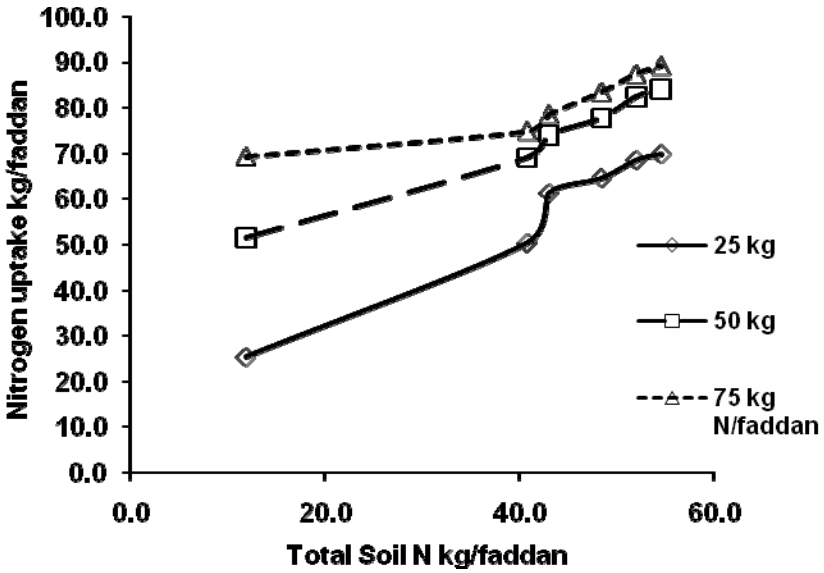

Figure (2): Effect of total soil N and applied mineral N on the N uptake

Table (3) Significance effect of the residual organic N, applied mineral N and inoculation on the seed yield and N uptake

	Determined Soil N kg/faddan	Seed Yield kg/faddan	N Uptake kg/faddan
Prev. ferti.	11.86	925.3f	48.76f
	40.73	1212.5e	64.82e
	42.96	1302.8d	71.31d
	48.36	1346.6c	75.33c
	51.92	1410.3b	79.54b
	54.48	1430.1a	81.11a
Applied N	25	1033.9c	56.69c
	50	1329.4b	73.21b
	75	1450.6a	80.53a
inoculation	yes	1344.0b	74.21b
	No	1198.6 a	66.09a

Table (4): The interaction between applied mineral N and residual organic N on the seed yield of common been

	O1	O2	O3	O4	O5	O6	L.S.D
75	1277.8	1383.5	1431.6	1489.6	1549.5	1571.4	176.2
50	995.5	1285.8	1353.5	1406.5	1464.5	1485.8	
25	502.6	968.2	1123.4	1159.0	1217.0	1233.1	

Table (5): The interaction between residual organic N and inoculation on the seed yield of common been

	O1	O2	O3	O4	O5	O6	L.S.D
Inoculated	978	1289	847	1426	1488	1509	117.5
None	872	1136	748	1268	1332	1352	

Table (6): The interaction between applied mineral N and inoculation on the seed yield of common been

	25	50	75	L.S.D
Inoculated	1116	1385	1531	58.7
None	952	1274	1370	

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الملخص العربى

تأثير النتروجين العضوى المتبقى و النتروجين المعدنى المضاف و التلقيح ببكتيريا العقد الجذرية على محصول و إمتصاص النتروجين للفول

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إستهدف البحث إختبار تأثير التسميد النتروجينى العضوى المتبقى من المحصول السابق و تأثير التسميد المعدنى المضاف وكذلك تأثير التلقيح البكتيرى على محصول الفول و إمتصاص النتروجين . وقد تم تنفيذ التجربة فى الموسم الشتوى 2006-2007 بقرية السلام بمحافظة البحيرة فى ارض سبق زراعتها وتسميدها بسماد عضوى بمعدلات صفر، 15 ، 30 ، 45 ، 60 كجم نتروجين. وقد أظهرت العوامل الثلاثة محل الدراسة تأثيراً معنوياً على محصول البذور وكذا على إمتصاص النتروجين. وقد أسهم النتروجين المعدنى بإنتاج 43.7% من محصول الفول بينما أسهم النتروجين العضوى المتبقى بنسبة 41.4 % أما التلقيح البكتيرى فقد أسهم بنسبة 6.5%. أما بالنسبة للنتروجين الممتص فقد أسهم النتروجين المعدنى بنسبة 39.3% والعضوى المتبقى بنسبة 47.6% والتلقيح البكتيرى بنسبة 5.7%. أما عن التفاعل الثنائى بين أى من العوامل محل الدراسة فقد كانت كل التفاعلات الثنائية المحتمل حدوثها إيجابية و معنوية التأثير. كان التفاعل بين التسميد المعدنى و العضوى المتبقى هو الأعلى تأثيراً بين التفاعلات الثنائية حيث أن التأثير لأى منهما على المحصول تأثر بالآخر بقوه. التفاعل بين التلقيح وأى من النتروجين العضوى أو المعدنى أظهر ثباتاً لتأثير التلقيح على محصول الفول. وأيضا كان تأثير النتروجين المعدنى شبه ثابت فى تفاعله مع التلقيح. أما تأثير النتروجين العضوى المتبقى فقد إزداد زيادة بسيطة مع التلقيح فبلغ 533 كجم بذور لكل فدان بينما كان 480 كجم بذور مع عدم التلقيح.