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Effect of Bio-organic Manures on Sandy Soils Amelioration and Peanut Productivity under Sprinkler Irrigation System

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THE PRESENT work was carried out on peanut plants growmg in sandy soils under sprinkler irrigation system to study the comparative effect of organic manure additions in the presence of the symbiotic bacterium (*Rhizobium*) under different mineral nitrogen fertilizer levels, as a natural soil improving material, on soil properties and peanut productivity.

Two field experiments were designed in the two summer seasons of 1998 and 1999 at Ahmed Ramy Village, El-Bustan region, Western Desert of Egypt. The experiment was designed in a split-split-plots with three replications. Three levels of mineral nitrogen fertilizer, *i.e.*, zero (control), 71.43 kg ha^{-1} (recommended dose) and 35.71 kg N ha^{-1} (half dose) were used as main plots. Inoculation or uninoculation with *Rhizobium* and the four rates of organic manure (zero, 23.81, 47.62 and 71.43 m^3 ha^{-1}) were used as sub-plots and sub-sub-plots, respectively. All treatments received the recommended doses of mineral phosphorus and potassium fertilizers.

The results clearly show that soil hydrophysical properties (bulk density, hydraulic conductivity, infiltration rate, available water and water use efficiency) were markedly improved. Increasing rates of organic manure application up to 71.43 m^3 ha^{-1} resulted in decrease of soil pH by 6.4% and 4.3% for surface and subsurface layers, respectively and increase of soil salinity to about 2.5 times compared with untreated soil. Moreover, NO_3-N concentration increased by 208, 166 and 57% for surface, subsurface and deep layers, respectively. Application of organic manure up to 71.43 m^3 ha^{-1} in combined with the recommended dose of mineral fertilizers caused a substantial increase in the soil nutrients availability than those obtained when each was applied alone. In general, addition of organic manure with or without inoculation enhanced the macro-and micro~nutrient concentrations in peanut plants. The present study indicates that inoculation with or without organic manure enhanced the nodulation. The number of nodules was increased as a result of rhizobial inoculation when 35.71 kg N ha^{-1} and 47.62 m^3 ha^{-1} of organic manure were added, then it was decreased with increasing the nitrogen mineral fertilier up to 71.43 kg N ha^{-1}. Number of pods/plant, 100 seed weight and dry matter production of organic and mineral fertilized plants under inoculation showed positive and significant differences over inoculated unfertilized plants. Application of organic manure, mineral nitrogen and inoculation did not affect oil seed percentage, while seed protein content was quite affected. The results demonstrate that the highest significant increase in kernel yield was obtained with or without inoculation and addition of 71.43 or 47.62 m^3 ha^{-1} of organic manure under nitrogen fertlizer rates of 71.43 or 35.71 kg N ha^{-1}. On the other hand, the highest net income resulted with addition of the third rate of organic manure (47.62 m^3 OM. ha^{-1}) and 71.43 kg N ha^{-1}, for inoculated plants followed by addition of 71.43 m^3 OM. ha^{-1} and 71.43 kg N ha^{-1} for inoculated plants or with addition of 47.62 m^3 O.M. ha^{-1} and 71.43 kg N ha^{-1} for uninoculated plants.

From the aforementioned discussion, it could be said that the addition of organic manure to sandy soils leads to improvement of their hydrophysical characteristics and, consequently, crop yield. The importance of using biofertilizers with adequate rate of the mineral nitrogen fertilirzer is not only recognized as an economical factor, but it is an important factor in reducing the nitrate pollution of the groundwater as well as the other induced N losses.

Keywords: Bio-organic manure, Rhizobium, Sandy soil, Peanut, Economic aspects analyses.

The increase in population in Egypt requires putting new desert land, that occupies about 96% of the total area, under cultivation such as sandy and calcareous soils. El-Bustan region is classified as sandy soils which contain low total and available essential plant nutrients as well as organic matter. They have inadequate water retention. Under such severe conditions, the productivity of different crops tends to decrease markedly. The resultant widespread chemical fertilizers demand and their high prices make their use uneconomic for certain crops in sandy soils. It is widely recognized that organic substances play a direct role in sustaining soil fertility, as they are sources of plant nutrients. Im (1982) mentioned that the beneficial effects of organic matter addition on soil physical conditions included: 1) better aeration and increased infiltration for silty and clayey soils, 2) increased water holding capacity and moisture availability for sandy soils, 3) decreased soil erodibility and 4) increased resistance to compaction. The addition of organic manure, particularly to newly reclaimed sandy soils, is of vital importance.

Amendment of the soils with organic manure improves their physical, chemical and biological properties which in turn, influence the growth and development of plants (Khadr *et al.*, 1988; Antoun *et al.*, 1989 and Hussein and Abd El-Aziz 1992). When organic solid composts are incorporated into the soil, a gradual assimilation occurs through chemical and biological reactions. Abdel-Sabour *et al.* (1997) evaluated the effect of organic waste composts on the hydro-physical properties of a desert sandy soil. They found that all treatments resulted in reduced bulk density and greater water holding capacity. Abdel-Aziz *et al* . (1996) found that the application of farmyard manure did not show any change in soil texture, while soil bulk density was decreased as well as infiltration rate and hydraulic conductivity were increased. The combination of organic and inorganic nitrogen resulted in greater values of apparent net nitrogen release than those obtained when each applied singly (Metwally and Khamis, 1998)

The use of a symbiotic bacterium, *Rhizobium*, produces enough nitrogen to support the building up of the whole protein requirements of the legumes (Bedrous *et al.*, 1990). Rhizobium nodulation may be fail due to antibiotics formed in the soil by fungi and/or of some growth regulators and pesticides, especially those mixed with legume seeds before sowing (Gray and Williams, 1979). Hence, an external source of nitrogen should be required under nodulation failure conditions to supply legume plants with nitrogen. El-Sersawy *et al.* (1997) studied the role of organic manure mixtures supported by nitrogen fertlizer and biofertilization technique for improving new desertic soil properties. The obtained results indicated improvement for several soil physical parameters. Biofertilization on both seeds and soil under 40 or 60 kg N/fed. was the best supplement of with organic manuring. These treatments showed corresponding improvements in microbial counts, and NPK uptake as well, which were reflected in high grain yield.

Peanut (*Arachis hypogaea L.*) is one of the most important and widely distributed crops in sandy soils at El-Bustan region. Peanut can be grown as a supplementary crop to decrease the gap between the import and the local production of oil in Egypt. Moreover, peanut is one of the most important crops as a cash crop for the farmers and as a crop for export. Joshi *et al.* (1989) and Thorve *et al.* (1989) concluded that increasing nitrogen fertilizer rates from 0 to 40 kg ha^{-1} increased groundnut yield. Massoud *et al.* (1999) reported that the increase of nitrogen fertilizer from 30 to 45 kg N $fed.^{-1}$ caused a clear reduction in seed yield fed^{-1} by 14. 6%.

The present work was carried out on peanut grown in sandy soil under sprinkler irrigation system to study the comparative effect of organic manure (farmyard) in presence or absence of the symbiotic bacterium, ***Rhizobium***, in combined with different mineral nitrogen fertilizer levels on soil hydrophysical and chemical properties, nutrients availability and peanut productivtty.

Material and Methods

Two field experiments were designed in sandy soils during the two summer seasons of 1998 and 1999 at Ahmed Ramy Village, El-Bustan region under sprinkler irrigation system. Surface (0-30 cm) and subsurface (30- 60 cm) soil layers in each season were sampled and analyzed for the main physical, chemical and fertility charactenstics according to Black (1965), (Tables 1 and 2). The applied farmyard manure analysis of the two seasons was done and recorded in Table 3. Results indicated that the soil layers up to 60 cm depth are

TABLE 1. Soil physical and chemical analysis of the investigated soil sites at El-Bustan area (Ahmed Ramy Village) for the experimental years of 1998 and 1999.

Year	Soil depth (cm)	Soil pH (1:2.5)	EC (dS/m)	Mechanical analysis			Soil texture	Bulk density (D_b) (g/cm^3)	Hydraulic conductivity (cm/hr)	Available water (%)	$CaCO_3$ (%)
				Sand (%)	Silt (%)	Clay (%)					
1998	0 - 30	8.74	0.63	91.42	4.98	3.60	sandy	1.73	26.18	4.27	2.14
	30 - 60	8.63	0.47	88.57	6.49	4.94	sandy	1.62	22.63	4.95	2.69
1999	0 - 30	8.82	0.77	90.73	5.13	4.14	sandy	1.71	25.73	4.38	1.98
	30 - 60	8.78	0.58	86.94	7.33	5.73	sandy	1.65	23.14	4.79	2.52

TABLE 2. Soil fertility status of the investigated soil sites at El-Bustan area (Ahmed Ramy Village) for the two years of 1998 and 1999.

Year	Soil depth (cm)	O.M (%)	Total N (%)	Total P (ppm)	Available P (ppm)	Available K (ppm)	DTPA-extractable micronutrients (ppm)			
							Zn	Fe	Mn	Cu
1998	0 - 30	0.13	0.026	32.16	1.73	87.43	0.15	0.97	0.36	0.09
	30 - 60	0.06	0.017	19.58	1.16	39.26	0.03	0.41	0.14	0.02
1999	0 - 30	0.21	0.031	44.26	1.92	95.69	0.22	1.21	0.45	0.12
	30 - 60	0.08	0.025	23.78	1.23	42.58	0.08	0.48	0.19	0.05

TABLE 3.Chemical analysis of used farmyard manure samples for the two experimental years of 1998 and 1999.

Year	O.M (%)	Total N (%)	Total K (%)	Available P (ppm)	Available micronutrients (ppm)				C/N ratio	θw (%)
					Zn	Mn	Cu	Fe		
1998	28.3	0.692	0.463	63.72	4.21	10.13	20.12	19.13	15 : 1	16.11
1999	26.97	0.788	0.526	74.32	3.97	9.74	18.89	17.95	17 : 1	13.95

characterized by sand texture with low content of $CaCO_3$ (1.98-2.69%), slightly alkaline soil pH and EC values varied between 0.47 and 0.77 dS/m. The hydraulic conductivity is very high (22.63-26.18 cm/h), while the available water is very low (4.27-4.95%). In view of soil fertility, soil samples were deficient in nitrogen, phosphorus, potassium, organic matter and micronutrients.

In a split-split-plots design with three replications, three levels of nitrogen mineral fertilizer, *i.e.,* zero (control), 71.43 (recommended rate) and 35.71 kg N ha^{-1} (half dose), in the form of ammonium nitrate (33.5%N) were used as main plots. Sub-plots were used for inoculation and uninoculation with ***Rhizobium.*** Four rates of organic manure (0,23.81, 47.62 and 71.43 m^3 ha^{-1}) were used as sub-sub-plots. The experimental plot consisted of 6 rows (6 m long and 0.60 m between rows), giving a plot area of 21.6 m^2. Giza 5 peanut cultivar was sown on first week of May and harvested on second week of September for two growing seasons. A total of 360 plants per plot were kept after thinning to one plant per hill. All treatments received the recommended doses of mineral phosphporus and potassium fertilizers [phosphorus fertilizer in the form of mono-superphopsphate (15.5%) at the rate of 71.43 kg P_2O_5 ha^{-1} and potassium fertilizer in the form of potassium sulphate (48% K_2O)at the rate of 114.3 kg K_2O ha^{-1}]. Surface soil samples up to 30 cm were taken form each plot for particle size distribution analysis. Infiltration rate, hydraulic conductivity and bulk density for surface layers (0.30cm) were determined according to Black (1965). Soil porosity was calculated for the different treatments. Available soil moisture was determined on mass basis by pressure extractor apparatus. Soil samples were taken just before and two hours after each irrigation and at harvesting time from each treatment at 0-20, 20-40 and 40-60 cm depths for soil pH , soil salinity, soil NO_3-N and soil moisture determinations. Water consumption and water use efficiency were calculated for the different treatments using the following formulae :

$$\text{Water consumption (cm)} = \frac{(\theta_a - \theta_b)}{(100)} D_b \times D$$ (Israelsen *et al.,* 1962)

where ; θ_a : Soil moisture percentage on weight basis after irrigation.

θ_b : Soil moisture percentage on weight basis before irrigation .

D_b: Bulk density (g cm^{-3}) .

D : Soil depth (cm).

$$\text{Water use efficiency (kg ha}^{-1}\text{ cm}^{-1}) = \frac{\text{Kernel yield (ka ha}^{-1})}{\text{Water consumption (cm)}} \quad \text{(Jensen, 1983)}$$

After 40 days of planting, three random plants per plot were picked to count number of nodules per plant. At harvesting time, five random plants per plot were picked from all the treatments, thoroughly washed with tap water, followed by distilled water, dried in an oven at 65°C for 48 hr and ground in a stainless steel mill, then stored for chemical analysis. The number of pods/plant, pods weight/plant, 100 kernel weight, protein content and oil percentage were determined for each treatment. Total pod yield and kernel yield for each plot were weighed and related to kg ha^{-1}. Soil NO_3-N (Keeny and Nelson, 1982), available phosphorus (Olsen and Sommers, 1982), available potassium (Soltanpour and Schwab, 1977) and available heavy metals (Lindsay and Novell, 1978) were determined. Seeds and plant leaves were wet digested with concentrated sulphuric acid and H_2O_2 (FAO, 1980) and total N, P, K and the concentrations of heavy metals were measured.

The collected data were statistically analyzed according to procedures outlined by Snedecor and Cochran (1981).

Results and Discussion

1.Effect of organic manure application under different nifrogen levels and inoculation on some soil physical properties

The characterization of a soil structure can be carried out either in terms of particle size distribution, degree of aggregation and bulk density or in terms of porosity and pore size distribution, which affect many of the more important phenomena directly related to crop yield, such as ease of root penetration, storage and movement of water and gases (Greenland, 1981). The significant changes in both structural (decrease in bulk density, increase in porosity and aggregate stability) and hydraulic properties (increase in water holding capacity and conductivity) have important implications to agriculture on both heavy and light textured soils in improving the ease of cultivation and moisture retention characteristics.

Particle size distribution

Table 4 shows the effect of the different applied rates of organic manure under different nitrogen levels and inoculation on the particle size distribution of the surface layer (0-30 cm). Data obtained indicated that, when different rates of organic manure were applied to the soil, the percentage of different fractions was slightly affected, but did not show any change in soil texture. From Table 4, it can be noticed that there was a decrease in the fine sand, silt and clay particles by 8.70, 9.15 and 8.74% by increasing organic manure levels from zero up to 71.43 43 m^3 ha^{-1}, respectively. While coarse sand particles percentage was increased by 5.33% (average two years). The slightly increase of coarse formation and decrease of fine particles as a result of manure application may be attributed to the cement effect of these organic products which cause a great stability of coarse formation (Awad *et al.*, 1986). El-Khames (1982) found that continuous application of raw and treated sewage in sandy soil did not significantly change the particle size distribution.

TABLE 4. Effect of organic manure application under different nitrogen levels and inoculation on soil particle size distribution of the investigated soil (0-30 cm) in the two summer seasons of 1998 and 1999.

Organic manure level (m^3 ha^{-1})	Particle size distribution (%)				
	Sand		Silt	Clay	Soil texture
	Fine	Coarse			
			1998		
Zero	30.93	60.53	4.96	3.58	sandy
23.81	29.44	62.31	4.77	3.48	sandy
47.62	28.26	63.86	4.53	3.35	sandy
71.43	27.94	64.38	4.41	3.27	sandy
			1999		
Zero	29.86	61.32	4.85	3.97	sandy
23.81	28.39	63.16	4.64	3.81	sandy
47.62	27.86	63.87	4.58	3.69	sandy
71.43	27.55	64.33	4.50	3.62	sandy

Soil bulk density

Data presented in Table 5 show that the values of soil bulk density significantly decreased with increasing the applied rates of organic manure especially in the surface (0-30 cm) layer. It was decreased by 5.26% with increasing the organic manure application up to 71.43 m^3 ha^{-1} . This finding can be attributed to the low specific gravity of organic materials and the role of these organic products in enhncing soil aggregation which increase the apparent soil volume and consequently, decrease bulk density (Gouda, 1984). Gupta *et al.* (1977) found a significant linear correlation between the increasing content of soil organic matter and the variations of bulk density in a sandy and a loamy soil. Statistical analysis of the individual effect of the different factors studied and the interaction effects among them on soil bulk density. Table 5 indicated that organic manure had a higher contribution as the individual factor, while the interaction effect among different factors studied indicated that the higher significant effect was found between organic manure and nitrogen mineral fertilizer or inoculation and among the three studied factors.

TABLE 5. Effect of organic manure applications and nitrogen fertilizer rates under inoculation or uninoculation with *Rhizobium* on some soil physical properties in the surface layer (combined analysis for the two summer seasons of 1998 and 1999).

Factors		D_b (g/cm^3)	E (%)	K_h (cm/hr)	I.R (cm/hr)	Available water (%)
Organic manure levels (O)	O_0	1.71 a	35.47 d	24.38 d	46.97 a	4.39 d
	O_1	1.69 b	36.23 c	22.93 c	42.85 b	6.13 c
	O_2	1.65 c	37.75 b	20.14 b	41.17 c	7.95 b
	O_3	1.62 d	38.87 a	17.56 a	36.73 d	10.12 a
Mineral nitrogen fertilizer levels (N)	N_0	1.68 a	36.60 a	21.79 a	42.01 a	7.08 a
	N_1	1.67 a	36.98 a	21.57 a	41.96 a	7.11 a
	N_2	1.66 a	37.36 a	21.29 a	41.81 a	7.30 a
Inoculation (I)	I^-	1.68 a	36.36 a	21.20 a	42.17 a	7.20 a
	I^+	1.66 a	37.61 a	20.67 a	41.68 a	7.08 a
N x O		*	*	*	*	*
I x O		*	*	*	*	*
I x N		NS	NS	NS	NS	NS
I x N x O		*	*	*	*	*

I^- : Uninoculated. I^+: Inoculated E: Calculated soil porosity.

Mean values having the same letter are not significantly different based on L.S.D $_{0.05}$.

Soil total porosity

With respect to the values of total porosity, data presented in Table 5 revealed that the total soil porosity significantly increased as a result of organic manure application. It was increased by 8.75% at the highest organic manure rate in the surface layer. In general, this increase may be related to the increase of storage pores in sandy the studied soil, which can be regarded as an index of an improved soil structure. Moreover, in some cases, a thin coat of translocated organic matter partially covered the walls interconnected vughs (Brewer, 1964), which are usually the most common pores in these soils. The increase of total soil porosity observed in all treated plots is mainly caused by these types of pores. These results correspond with those of Pagliai *et al* . (1981) .

Regarding the effect of nitrogen level treatments and biofertilization on bulk density and total porosity, Table 5 reveals that their effects did not exceed more than 1% reduction in bulk density or 2% increase in total porosity values. Thus, organic manure is the major effective factor as compared with the complementary ones of such factors in improving a soil media . The interaction effect between (organic manure x nitrogen level x inoculation) gave great variations in bulk density or total porosity. This behaviour agrees with those reported by Pagliai *et al.* (1981) and El-Sersawy *et al.* (1997).

Soil hydraulic conductivity (K_h) and infiltration rate (I.R)

The hydraulic conductivity and infiltration rate are the most important hydrological properties. Their values are highly affected by different soil physical properties, especially pore size distribution, total porosity, particle size distribution and bulk density. Data in Table 5 reveal that the values of K_h and I.R in the surface soil layer (0-3 cm) were highly and significantly decreased with increasing organic manure. These decreases were equivalent to 27.9 and 21.8%, respectively below the untreated plots. These findings may be due to that organic manure, in general, leads to a raise of water holding capacity of soil and increases soil matrix potential as a result of increasing soil surface area (Hillel, 1982). These results are in agreement with those of Aziz *et al.* (1999) and Hamouda *et al.* (1999). Pore space has a direct effect on soil productivity due to its influence on water-holding capacity and upon the movement of air, water and roots through the soil. It is clear that the effect of nitrogen levels and biofertilization on K_h and I.R does not exceed more than 2.5 and 1% reduction, respectively. The interaction effect between (organic manure x nitrogen level x biofertitzation) gave significant variations in K_h and I.R. These results support the conclusion of El-Sersawy *et al.* (1997).

Water holding capacity

The water holding capacity of a soil is related to the number and size distribution of soil pores and, consequently, may be expected to increase with increasing soil organic matter levels (Table 5). This increase was equivalent to 56.6% (as average) above the untreated plots. This finding can be attributed to the increment in water holding forces of soil by adding the hydrophobic substances, *i.e.*, organic manure(El- Toukhy, 1982). With regard to the values of available water (%), data presented in Table 5 show that they were slightly affected by using nitrogen mineral fertilizer and biofertilittation, while they significantly increased by applying organic manure. This suggests that the organic manure may increase the ability of these soils to store water for plant use.

In general, soil conditioning, *i.e.*, organic manure leads to a decrease of the space of macro-pores and, on the contrary, soil micro-pores increased. This action raises the retaining capacity of soil and consequently, reduces the velocity of water movement within the soil, which means a reduction in soil hydraulic conductivity. The reduction in soil hydraulic conductivity is more pronounced in conditioned mixture treatment, which is obviously considered as the best treatment concerning the improvement of soil hydrological properbes (Nimah *et al.*, 1983). Regarding the effect of nitrogen mineral fertilizer levels and biofertilition on soil hydrophysical properties, the results indicate that the major effect should be made favorable to the bacterial activity, which is essential to the formation and availability of nutrients for plants.

2. Effect of the tested variables on some soil chemical properties

Soil reaction (pH)

Data presented in Table 6 indicate that the application of organic manure had an favourable effect on soil reaction. Increasing rates of organic manure up to 71.43 m^3 ha^{-1} significantly decreased soil pH in surface and subsurface soil layers, , while the deep soil layer (40-60 cm) was unaffected. Mineral nitrogen fertilizer and biofertilization did not exhibit any significant effect on soil pH for all soil layers. In general, application of organic manure up to 71.43 m^3 ha^{-1} decreased soil pH by 6.4% and 4.3% for surface and subsurace soil layers, respectively. This finding is expected to be due to the organic acids that produced during organic matter decomposition. Similar results were obtained by Abdel-Aziz *et al.* (1996) and Mohamed *et al* . (1998)

TABLE 6. Effect of organic manure applications and nitrogen fertilizer rates under inoculation and uninoculation with *Rhizbium* on soil pH, EC and NO_3-N concentration in the different soil layers (combined analysis for two summer seasons of 1998 and 1999).

Factors		Soil pH (1 : 2.5)			EC (dS/m)			NO_3-N (ppm)		
		0-20cm	20-40cm	40-60cm	0-20cm	20-40cm	40-60cm	0-20cm	20-40cm	40-60cm
Organic manure levels (O)	O_0	8.79 a	8.80 a	8.74 a	0.72 d	0.64 d	0.41 b	7.19 d	10.31 d	12.65 a
	O_1	8.51 b	8.75 a	8.74 a	0.97 c	0.98 c	0.69 b	13.21 c	14.38 c	8.53 b
	O_2	8.35 c	8.57 b	8.72 a	1.22 b	1.45 b	1.07 a	19.82 b	22.13 b	13.51 c
	O_3	8.26 d	8.44 c	8.68 a	1.85 a	2.03 a	1.31 a	22.16 a	27.43 a	19.92 c
Nitrogen levels (N)	N0	8.45 a	8.63 a	8.71 a	1.09 b	1.16 b	0.83 b	8.93 c	11.34 c	8.89 c
	N_1	8.46 a	8.64 a	8.72 a	1.18 b	1.28 a	0.85 b	16.51 b	19.28 b	13.98 b
	N_2	8.48 a	8.66 a	8.73 a	1.31 a	1.37 a	0.93 a	21.34 a	25.13 a	18.21 a
Inoculation (I)	I^-	8.48 a	8.65 a	8.72 a	1.18 a	1.26 a	0.86 a	15.62 a	18.29 a	13.79 a
	I^+	8.45 a	8.63 a	8.72 a	1.20 a	1.29 a	0.87 a	15.58 a	18.81 a	13.92 a
N x O		*	*	N.S	**	**	*	**	**	*
I x O		N.S	N.S	N.S	*	*	*	*	*	*
I x N		N.S	N.S	N.S	N.S	N.S	N.S	*	*	*
I x N x O		N.S	N.S	N.S	*	*	*	**	**	*

I^-: Uninoculated. 1^+ : Inoculated

EC (dS/m) = electrical conductivity of saturated soil paste.

Mean values having the same letter are not significantly different based on $L.S.D_{0.05}$.

Soil salinity

Concerning the effect of the tested variables on soil salinity, data presented in Table 6 reveal that the values of soil salinity were significantly increased by increasing organic manure up to 71.43 m^3 ha^{-1} and they are regularly distributed with soil depth. Regarding the values of soil salinity, as affected by organic manure application rates, the obtained data show that the highest values were obtained at the higher rate of organic manure (71.43 m^3 ha^{-1}). The magnitude of this increase reached about 2.5 times as compared to the untreated soil. The highest values of soil salinity, as affected by soil depth, were obtained in subsurface layers (20-40 cm). The increase in soil salinity for surface and subsurface layers in treated soil may be related to the salts associated with the used organic materials. Concerning the effect of mineral nitrogen fertilizer levels or biofertilization on soil salinity and salt distribution, the obtained data (Table 6) indicate that the values of soil salinity were slightly affected. It was increased by 20, 18 and 12% with increasing nitrogen fertilizer level up to 71.43 kg N ha^{-1} in surface, subsurface and deep layers, respectively, also it was increased by about 2% with inoculation for the same soil layers. These results are in full agreement with those reported by El-Shanawany *et al.* (1994) Abdel -Aziz *et al.* (1996) and Aziz *et al* . (1998).

NO_3-N leaching and accumulation

Data presented in Table 6 show that all studied factors and their interactions, except biofertilization, had a highly significant effect on soil nitrate concentration. The higher contribution effect of individual factors was found for organic manure levels, followed by nitrogen fertilizer rates. Regarding the effect of organic manure levels on soil NO_3-N concentration, data clearly indicate that increasing the organic manure level up to 71.43 m^3 ha^{-1} increased the NO_3-N concentration by 208, 166 and 57% for the surface, subsurface and deep soil layers, respectively. Data also revealed that the high concentration of NO_3-N in the deepest layer of untreated soil (zero organic manure) could be attributed to the high volume of macro-pores in sandy soil, which enhance the leaching process. Concerning the effect of nitrogen fertilizer rates, data revealed that the same trend was observed. The increment rate of NO_3-N concentration was 139, 122 and 105% for the same soil layers, respectively.

3. Effect of the tested variables on soil nutrients

Results indicated that soil nitrogen availability was not affected by inoculation, while it was slightly affected by nitrogen fertilizer levels and significantly affected by organic manure application levels (Fig. 1).

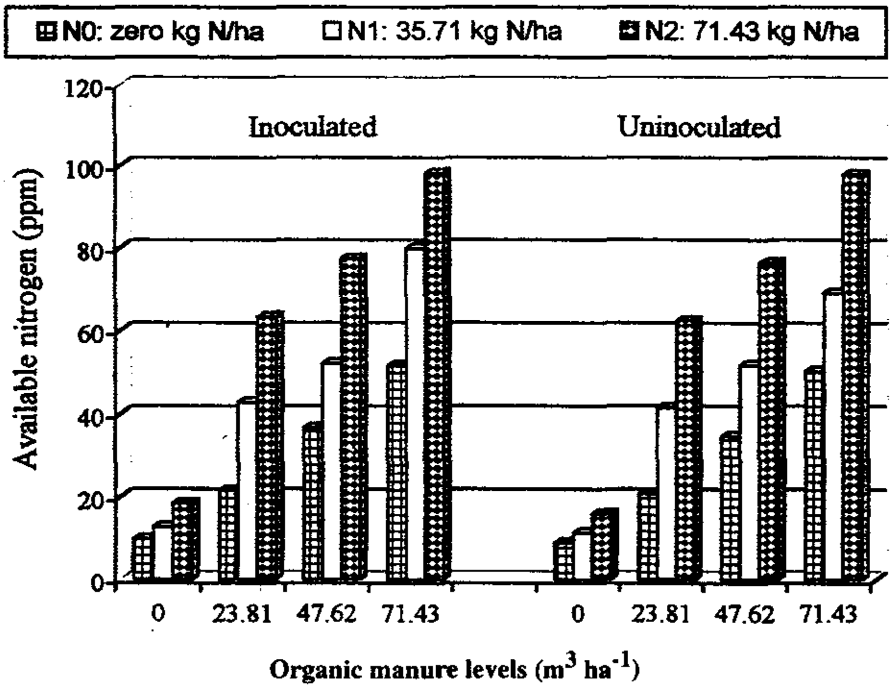

Fig. 1. Effect of organic manure application under different nitrogen levels and biofertilization on soil nitrogen availability (ppm) in surface layer (average two years 1998 and 1999).

As expected, the increase of available soil N was not noticed in the control treatments (without organic manure or nitrogen addition), while among the other treatments it seemed obvious that there was a significant effect between organic manure and mineral nitrogen levels on the availability of soil N. Both application of organic manure and mineral nitrogen fertilizer at the rate of 71.43 m^3 ha^{-1} and the recommended dose, respectively, caused a more substantial increase in the soil nitrogen availability than those obtained when each was applied alone.

The maximum increment rates of soil-N percentage were 110.9 and 90.3% over the control at the rates of 47.62 and 71.43 m^3 ha^{-1} of organic manure and 71.43 kg N ha^{-1} with inoculation, respectively.

Data illustrated in Fig. 2 show that the amounts of extractable-P and available K were increased as the rate of organic manure increased up to 71.43 m^3 ha^{-1} under the different nitrogen levels and inoculation. The maximum values of available P and K (18.2 and 286 ppm, respectively) were obtained when the same organic manure level was added. Results also revealed that the availability of P and K was not affected by inoculation or addition of nitrogen fertilizer levels.

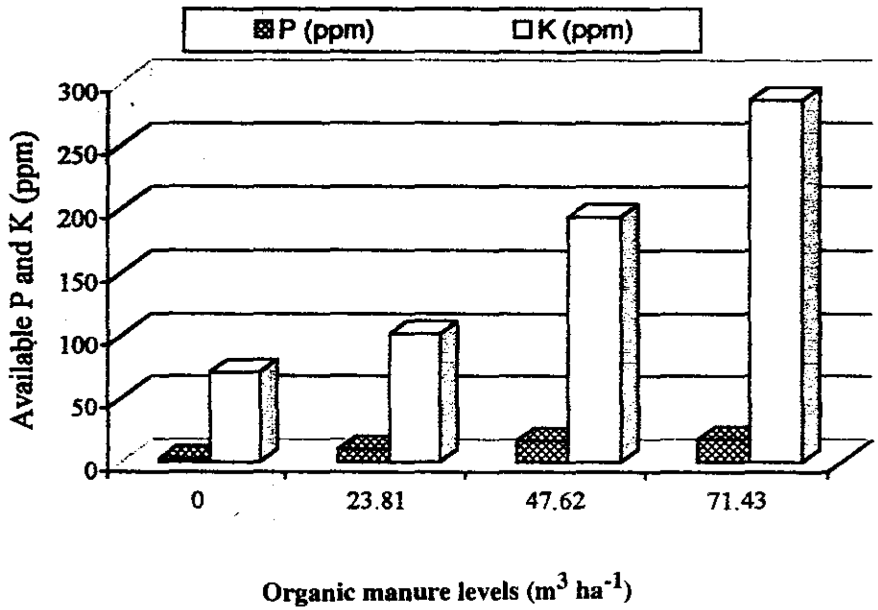

Fig. 2. Effect of organic manure application under the different nitrogen levels and biofertilization on soil phosphorus and potassium availability (ppm) in the surface layer (average two years 1998 and 1999).

As shown in Fig. 3, the application of organic manure under different levels of nitrogen application and inoculation increased the availability of Fe, Zn, Mn and Cu in the surface soil layers as compared with the control treatment. It could be noticed that the micronutrients availability was not affected by inoculation or addition of nitrogen fertilizer levels. Treatment of 71.41 m^3 ha^{-1} was superior in that respect to all other treatments for the soil micronutrients availability. The increment rates were 155, 82, 105.6 and 91.7% over the control treatment for Fe, Mn and Cu, respectively.

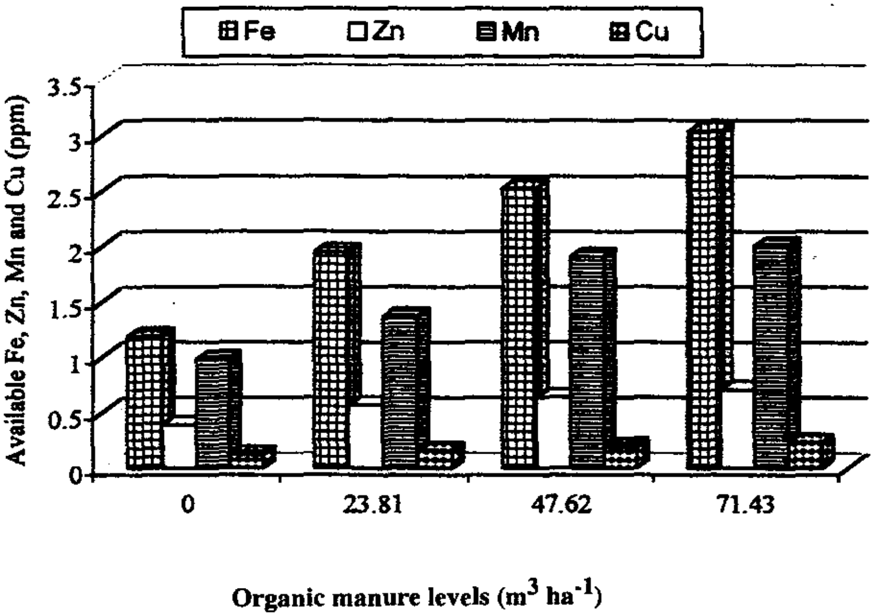

Fig. 3. Effect of organic manure application under the different nitrogen levels and inoculation on soil available micronutrients (ppm) in the surface layer (average two years 1998 and 1999).

In general, the combination of organic manure and mineral nitrogen fertilizer with inoculation resulted in greater values of apparent net nitrogen release than those obtained when each was applied alone, while P, K and micronutrients were not affected. It is widely recognized that organic manure plays a direct role in sustaining sandy soil fertility, this is attributed to enhanced soil macro- and micro-nutrients availability that resulted in a significant increase of soil NPK and soil micronutrients content, compared with the untreated soil. Beheiry *et al.* (1998), Metwally and Khamis 1998 and Nadia *et al.* (2000) confirmed these results.

4.Effect of the tested variables on plant biomass nutrients concentration

Concerning the combined effect of the three tested variables on plant biomass macro-and micro-nutrients concentration, it was found that all variables involved in the current investigation significantly increased plant biomass nitrogen concentration. An inverse relation occurred between P, K and micronutrients concentration and all tested variables, except the organic manure application levels, where P, K and micronutrients concentrations were not affected by inoculation or the increasing of mineral nitrogen fertilizer levels. Fig. 4, 5 and 6 show considerable increases in N, P, K and micronutrient contents with the studied treatments. The nitrogen concentration in the plant biomass was markedly affected by the application of the organic manure under the different levels of nitrogen fertilizer and inoculation up to 47. 62 m^3 ha^{-1}.

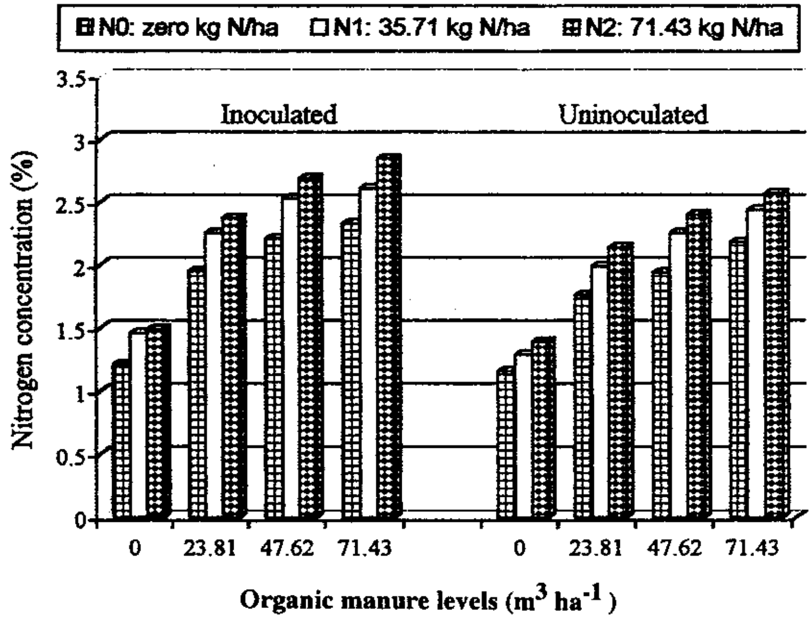

Fig. 4. Effect of organic manure application under the different nitrogen levels and biofertilization on plant biomass nitrogen concentration (%) (average two years 1998 and 1999).

It was slightly inereased as the rate of organic manure increased up to 71.43 m^3 ha^{-1}. The increment rates of N concentration were 59, 80.5 and 91% over the control when 23.81, 47.62 and 71.43 m^3 ha^{-1} of organic manure and 71.43 kg N ha^{-1} were added with inoculation, respectively. While it was declined to 52.8, 71.7 and 83.6% without inoculation treatment. On the other hand, the application of organic manure levels gave an increase of phosphorus and potassium concentrations in the plant biomass. The increment rates of P and K concentrations were 61.9, 80.9 & 90% and 32.7, 59.6 & 73% over the control, when 23.81, 47.62 and 71.43 m^3 ha^{-1} of organic manure were added, respectively, under the different rates of nitrogen and inoculation and uninoculation treatments.

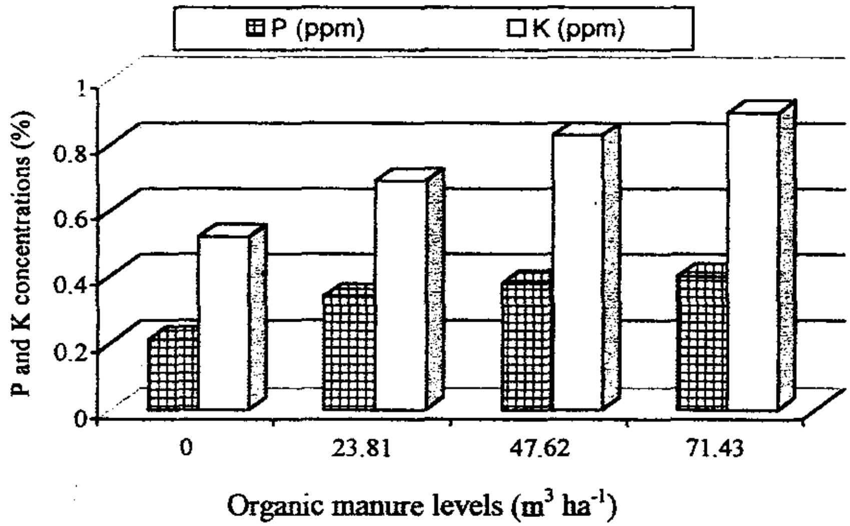

Fig. 5. Effect of organic manure application under the different nitrogen levels and biofertilization on plant biomass phosphorus and potassium concentrations (%) (average two years 1998 and 1999).

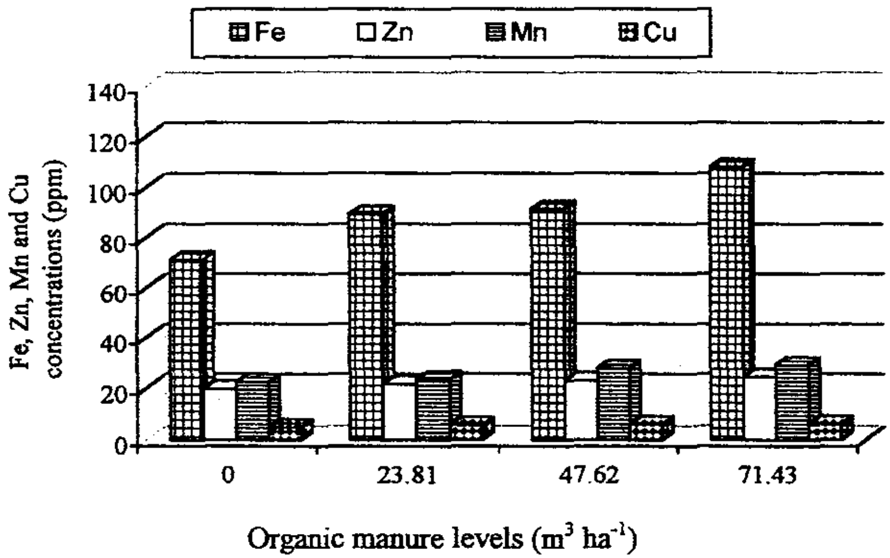

Fig. 6. Effect of organic manure application under the different nitrogen levels and inoculation on biomass micronutrients concentrations (ppm) (average two years 1998 and 1999).

Regarding micronutrient concentrations in the plant biomass, data revealed that the application of organic manure resulted in an increase of micronutrient concentrations. It was noted that the conditioned treatments gave higher increase of Fe concentration over the control treatment (51.47%), while it gave a lower increase of Zn, Mn and Cu concentrations over the control (24.9, 30.4 and 24.5%, respectively).

Generally, for a sandy soil, data showed a positive response to the applied treatnents for macro- and micro-nutrients. The highest positive response was associated with the organic manure application for NPK and micro-nutrient concentrations, while the inoculation, nitrogen fertilizer and organic manure treatments were superior to other treatments for nitrogen concentration. Those findings are in agreement with results reported by several investigators (El-Sersawy *et al.*, 1997 ; Beheiry *et al.*, 1998; Metwaly and Khamis, 1998 and Negm *et al.*, 1998).

5. Nodulation as a response to biofertilization

The response of peanut to inoculation under the three tested variables (Fig. 7) revealed that the inoculation with or without organic manure enhanced the nodulation. The number of effective nodules was increased by increasing organic manure application up to 47.62 m^3 ha^{-1} with inoculation. Then it was depressed at 71.43 m^3 ha^{-1} level. The effect of mineral nitrogen fertizer level was more severe on the number of effective nodules per plant tlan the organic manure application levels. Nodulation was reduced to about 21, 35, 57 and 61% at nitrogen level of 71.43 kg N ha^{-1} as compared to 35.71 kg N ha^{-1} with inoculation and under organic manure levels zero, 23.81, 47.62 and 71.43 m^3 ha^{-1}, respectively. On the other hand, nodulation was increased to 212, 193 and 157% at nitrogen levels of zero, 35.71 and 71.43 kg N ha^{-1}, respectively with uninoculation and at organic manure level of 71.43 m^3 ha^{-1} as compared to zero level. It is also clear that nodulation was decreased to 57,44, 39 and 37% at organic manure levels of zero, 23.81, 47.62 and 71.43 m^3 ha^{-1}, respectively without inoculation and at nitrogen level of 71.43 kg N ha^{-1} as compared to zero level.

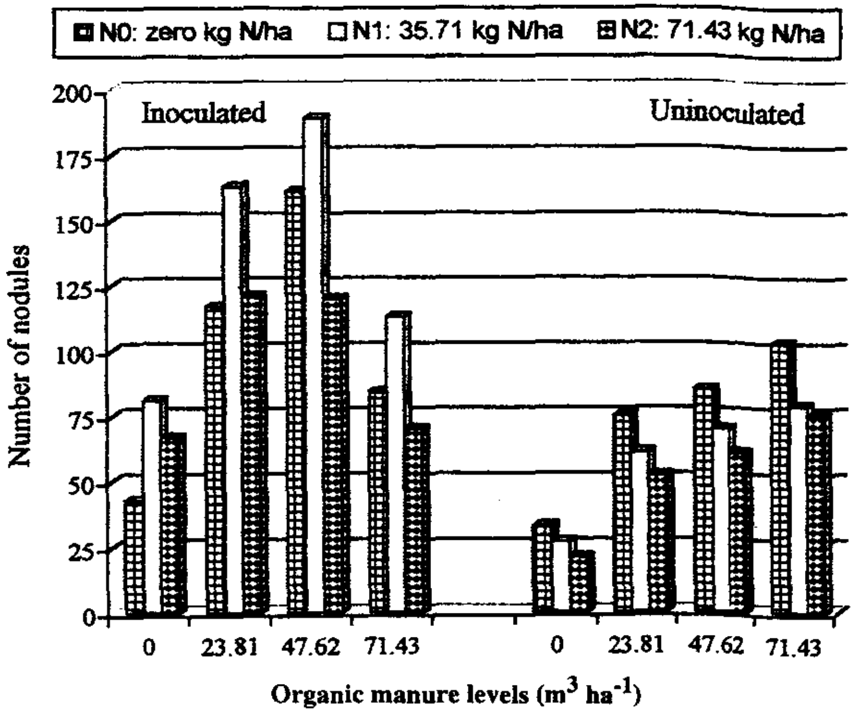

Fig. 7. Effect of organic manure application under the different nitrogen levels and biofertilization on number of nodules per plant (average two years 1998 and 1999) .

6. Plant growth and biomass parameters

The statistical analysis (Table 7) showed that there was a highly significant effect of organic manure and nitrogen fertilizer levels under the two inoculation treatments on total biomass yield. Data also showed that total biomass increased from 6815.3 to 8031.9, 8374.2 and 9891.4 kg ha^{-1} as organic manure levels increased from zero to 23.81, 47.62 and 71.43 m^3 ha^{-1}, respectively. In addition, it was increased from 7630.4 to 8401.8 and 8710.5 kg ha^{-1} as nitrogen fertilizer increased from zero to 35.71 and 71.43 kg N ha^{-1}', respectively. Moreover, the values significantly increased from 7991.5 to 8519.7 kg ha^{-1} as affected by inoculation. At harvesting time, data (Table 7) showed that all variables involved in the current investigation significantly negative affected peanut pod weight and the number per plant and 100 kernel weight.

TABLE 7. Effect of organic manure applications and nitrogen fertilizer rates under inoculation and uninoculation with *Rhizobium* on peanut yield and yield components (combined analysis for two summer seasons 1998 and 1999).

Factors		Biomass yield (kg ha^{-1})	Pod weight /plant (g)	No. of pods /plant	100 kernel weight (g)	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Oil content (%)	Protein content (%)	K.R.I.Y (%)
Organic manure levels (O)	O_0	6815.3 d	39.75 d	28.11 d	61.82 d	2178.5 d	1189.1 d	47.93 a	18.51 c	-
	O_1	8031.9 c	48.13 c	31.59 c	66.31 c	2986.3 c	1405.3 c	48.15 a	19.16 b	18.18
	O_2	8374.2 b	55.92 b	37.51 b	71.02 b	3161.9 b	1699.5 b	48.52 a	19.43 a	42.92
	O_3	9891.4 a	63.71 a	41.62 a	75.62 a	3350.7 a	2030.8 a	48.62 a	19.62 a	70.78
Nitrogen levels (N)	N_0	7630.4 c	43.62 c	35.42 c	65.94 b	2391.5 c	1362.3 c	48.35 a	18.89 b	-
	N_1	8401.8 b	49.20 b	37.49 b	69.13 a	2961.9 b	1559.8 b	48.46 a	19.22 a	14.49
	N_2	8710.5 a	52.11 a	38.61 a	70.92 a	3215.7 a	1834.1 a	48.50 a	19.39 a	34.63
Inoculation (I)	I^-	7991.5 b	46.91 b	34.96 b	67.89 b	2753.4 b	1573.8 b	48.51 a	18.89 b	-
	I^+	8519.7 a	49.73 a	39.14 a	69.94 a	2981.7 a	1597.1 a	48.59 a	19.36 a	1.48
N x O		**	**	**	**	**	**	*	N.S	
I x O		**	**	*	**	**	*	*	N.S	
I x N		**	**	*	**	**	*	*	N.S	
I x N x O		**	**	**	**	**	**	*	N.S	

I^-: Uninoculated. I^+ : Inoculated

K.R.I.Y : Kernel relative increasing yield.

Mean values having the same letter are not significantly different based on $L.S.D_{0.05}$.

Concerning the effect of interaction between the tested variables and peanut yield production, it was found that, although the total peanut pod yield was significantly affected by organic manure application, it was increased from 2178.5 to 2986.3,3161.9 and 3350.7 kg ha^{-1} as organic manure levels increased from zero to 23.81, 47.62 and 71.43 m^3 ha^{-1}, respectively. Moreover, the values significantly increased from 2391.5 to 2961.9 and 3215.7 kg ha^{-1} as nitrogen fertilizer levels increased from zero to 35.71 and 71.43 kg N ha^{-1}, respectively. On the other hand, inoculated plants had a higher total pod yield than uninoculated plants by 8.3%. The relative increase of kernel yield by seed inoculation under different organic manure levels and nitrogen fertilizer treatments was 1.5%. This value was increased by 18,43 and 71% for the three organic manure levels

(23.81, 47.62 and 71.43 m^3 ha^{-1}), respectively. On the other hand, kernel yield was about 35% higher at nitrogen fertilizer level 71.43 kg N ha^{-1} as compared to zero level, while it was depressed to 14.5% at 35.71 kg N ha^{-1} level. This response could be explained on the basis of a strong and persisting effect of the interaction between organic manure application and nitrogen fertilizer treatments under inoculation condition. Also, results (Table 7) clearly show that application of organic manure, mineral nitrogen fertilizer and inoculation did not affect seed oil percentage, while seed protein content was quite affected. Similar results were reported by Joshi *et al.* (1989), El-Sersawy *et al.* (1997) and Massoud *et al.* (1999).

7. Water use efficiency

Water use efficiency values are used to evaluate the effectiveness of the tested variables on maximizing water utilization by peanut crop. Data presented in Table 8 show, in general, that water use efficiency was more influenced by organic manure levels than the other tested variables. The highest water use efficiency values (0.477, 0.469, 0.446, 0.444, 0.440 and 0.436 kg kernel m^{-3} water) were obtained at 71.43 and 47.62 m^3 ha^{-1} organic manure levels for inoculated and uninoculated plants under 35.71 and 71.43 kg N ha^{-1}, respectively. The lower values (0.256 and 0.258 kg kernel m^{-3} water) were recorded at zero level of organic manure and nitrogen fertilizer for inoculated and uninoculated plants, respectively. In general, results revealed that water use efficiency value reached to about twice that of the control treatment when 71.43 m^3 ha^{-1}, of organic manure and 71.43 or 35.71 kg N ha^{-1}, were added for inoculated or uninoculated plants. Also, it was about twice when 47.62 m^3 ha^{-1}, and 71.43 kg N ha^{-1}, were added for inoculated or uninoculated plants. The presented data are in agreement with the results of El-Hady *et al* . (1990) and Aziz *et al.* (1998). El-Hady *et al.* (1990) reported that increasing both water and fertilizers use efficiencies by plants are largely due to the improving effect of the applied conditioner on soil structure, the water holding capacity of the rooting media and consequently, on the availability of the plant nutrients.

8. Economic aspects analysis

Economic estimation procedures supply an important part of the data required for quantitative analysis. Economic analysis should be based on the data related to the availability of resources and their allocation by producers,

TABLE 8. Means of water use efficiency as affected by organic manure (O) application, nitrogen fertilizer (N) rates and inoculation (I) for peanut crop during the two summer seasons of 1998 and 1999.

Factors			Consumptive use (m^3 ha^{-1})	Kernel yield (kg ha^{-1})	Water use Efficiency (kg kernel m^{-3} water)
O_0	N_0	I^-	4257.4	1089.73	0.256
		I^+	4279.7	1105.79	0.258
	N_1	I^-	4521.6	1174.19	0.260
		I^+	4524.7	1198.28	0.265
	N_2	I^-	4526.3	1279.28	0.283
		I^+	4529.1	1288.47	0.285
O_1	N_0	I^-	4594.8	1268.68	0.276
		I^+	4598.7	1280.93	0.279
	N_1	I^-	4604.9	1358.45	0.295
		I^+	4611.6	1373.65	0.298
	N_2	I^-	4621.7	1571.04	0.338
		I^+	4668.3	1582.13	0.339
O_2	N_0	I^-	4793.9	1382.92	0.288
		I^+	4796.8	1397.37	0.291
	N_1	I^-	4802.1	1862.83	0.388
		I^+	4809.8	1881.94	0.391
	N_2	I^-	4811.6	2097.50	0.436
		I^+	4813.8	2118.33	0.440
O_3	N_0	I^-	4817.3	1683.06	0.349
		I^+	4821.6	1692.52	0.351
	N_1	I^-	4888.4	2170.08	0.444
		I^+	4918.5	2195.65	0.446
	N_2	I^-	4985.2	2342.51	0.469
		I^+	5021.7	2396.23	0.477

I^-: Uninoculated. I^+ Inoculated

input-output relationship, sale patterns and prices and costs. Costs of production include such seasonal production costs as those of seeds, labours, fertilizers, pesticides, soil amendments, equipments and transportation,... etc. Data in Table 9 show calculation for the input production items to all studied treatments considering the appraisal of all cultivation process costs. Total input costs, outputs and net income (\$ ha^{-1}) for the three tested variables are illustrated in Table 10. It can be noticed that the highest net income (422.9 and 418.3 \$ ha^{-1} followed by 414.2 and 390.3 \$ ha^{-1}) resulted with organic manure applications at the rates of 47.62 and 71.43 m^3 ha^{-1} under 71.43 kg N ha^{-1} level with and without biofertilization, respectively. The lowest values were always incorporated with high rates of organic manure applications under zero level of nitrogen fertilizer with or without biofertilization. It ranged between 195.3 and 126.6 \$ ha^{-1} under the condition of control (without organic manure) or with application of organic manure at the rate of 23.81 m^3 ha^{-1}. On the other hand, it clearly depressed to 26, 31, 34.9 and 36.6 \$ ha^{-1} with organic manure application at the rates of 47.62 and 71.43 m^3 ha^{-1}, respectively under the same conditions of nitrogen fertilizer (zero level) and biofertilization.

From the above mentioned results, one might safely conclude that the intensive use of organic manure beyond 47.62 m^3 ha^{-1} under zero level of mineral nitrogen fertilizer with or without biofertilization is not advisable to yield economical net income under the experimental conditions. On the other hand, data indicated that this rate or more of organic manure coincided with the point of greatest economic return under other mineral nitrogen fertilizer levels with or without biofertilization. In general, the highest net income values were increased as shown in the descending orders $O_2N_2I^+ > O_3N_2I^+ > O_2N_2I^- > O_3N_2I^-$ combinations. Finally, El-Kholi (1998) concluded that the importance of using biofertilizers is not only recognized as an economical factor, from the view point of reducing the use of chemical fertilizers and in turn saving money, but also it is an important factor in reducing the nitrate pollution in the groundwater, as well as the other induced N losses. The improvement of soil fertility, due to the residual organic nitrogen, as well as sustaining plant production, could also be considered.

TABLE 9. Input production items and output of the experiment (average two seasons 1998 and 1999).

Items	Treatment	Unit	Unit price ($)
Inputs			
Organic fertilizer :			
- Organic manure	23.81 m^3 ha^{-1}	m^3	7.02
	47.62 m^3 ha^{-1}		7.02
	71.43 m^3 ha^{-1}		7.02
Mineral fertilizer			
- Nitrogen fertilizer	35.71 kg N ha^{-1}	kg N	0.42
	71.43 kg N ha^{-1}		0.42
- Phosphorus fertilizer	71.43 kg P_2O_5 ha^{-1}	kg P_2O_5	0.49
- Potassium fertilizer	114.3 kg K_2O ha^{-1}	kg K_2O	0.59
- Biofertilizer	5 bags ha^{-1}	bag	0.73
Seeds	120 kg ha^{-1}	kg	1.45
Land preparation*		per ha	34.60
Labour		per ha	100.20
Pesticides		per ha	40.40
Other costs**		per ha	55.60
Outputs			
Kernel yield		ton	584.80

* Rent of agricultural machines.

** Depreciation rate of pumping machine, irrigation system, ... etc., electric consumption, irrigation system, repairing, tax, transportation of seeds, fertilizers, ... etc. 1 $ = 3.42 L.E (average two years 1998 and 1999).

TABLE 10. Economical assessment for the three tested variables [Organic manure (O), nitrogen fertilizer (N) and inoculation (I)] under the present investigation .

Factors			Kernel yield (ton ha^{-1})	Inputs ($ ha^{-1})	Outputs ($ ha^{-1})	Net income ($ ha^{-1})
O_0	N_0	I^-	1.090	447.82	637.43	189.61
		I^+	1.106	451.47	646.79	195.32
	N_1	I^-	1.174	462.82	686.56	223.74
		I^+	1.198	466.47	700.59	234.12
	N_2	I^-	1.279	477.82	747.96	270.14
		I^+	1.288	481.47	753.22	271.75
O_1	N_0	I^-	1.268	614.97	741.53	126.56
		I^+	1.280	618.62	748.54	129.92
	N_1	I^-	1.358	629.97	794.16	164.19
		I^+	1.373	633.62	802.93	169.31
	N_2	I^-	1.571	644.97	918.72	273.75
		I^+	1.582	648.62	925.15	276.53
O_2	N_0	I^-	1.382	782.11	808.19	26.08
		I^+	1.397	785.76	816.97	31.21
	N_1	I^-	1.862	797.11	1088.90	291.79
		I^+	1.881	800.76	1100.01	299.25
	N_2	I^-	2.097	812.11	1226.33	414.22
		I^+	2.118	815.76	1238.61	422.85
O_3	N_0	I^-	1.683	949.26	984.22	34.96
		I^+	1.692	952.91	989.48	36.57
	N_1	I^-	2.170	964.26	1269.02	304.76
		I^+	2.195	967.91	1283.64	315.73
	N_2	I^-	2.342	979.26	1369.60	390.34
		I^+	2.396	982.91	1401.18	418.27

I^-: Uninoculated. I^+ Inoculated

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تأثير الأسمدة العضوية والحيوية على خواص الأراضى الرملية وإنتاج الفول السودانى تحت نظام الرى بالرش

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أجريت تجربتين حقليتين على نبات الفول السودانى (صنف جيزة ٥) بقرية أحمد رامى بمنطقة البستان-غرب النوبارية -خلال الموسم الصيفى لعام ١٩٩٨-١٩٩٩ بغرض دراسة التأثير المتداخل لإضافة معدلات من المادة العضوية والسماد النتروجينى المعدنى تحت تأثير التلقيح وعدم التلقيح بالريزوبيم على الخصائص الهيدروفيزيقية والكيمائية وخصوبة الأراضى الرملية وإنتاجية الفول السودانى بها تحت نظام الرى بالرش . وقد تم إختبار أربعة مستويات من المادة العضوية (صفر ، ٨١ . ٢٣ . ٦٢ . ٤٧ ، ٤٣ . ٧١ متر مكعب /هكتار) مع ثلاثة معدلات من السماد الازوتى (صفر ، ٧١ . ٣٥ ، ٤٣ . ٧١ كيلوجرام نتروجين /هكتار) تحت ظروف التلقيح بالريزوبيم وعدمه فى تصميم القطع المنشقة ذات الثلاثة مستويات فى ثلاث مكررات . وقد أوضحت النتائج المتحصل عليها مايلى :

-التوزيع الحجمى للحبيبات قد تأثر قليلا دون حدوث أى تغيير فى قوام التربة مع إضافات المادة العضوية بينما تحسنت كافة الخصائص الهيدرفيزيقية المدروسة للتربة بايجاب مع هذه الإضافات والتى أدت إلى ارتفاع كفاءة استخدام مياه الرى بواسطة نباتات الفول السودانى .

-زيادة معدلات إضافة المادة العضوية حتى معدل ٤٣ . ٧١ م^{٣} / هكتار أدى إلى إنخفاض رقم pH التربة بمقدار ٤ . ٦٪ للطبقات السطحية وبمقدار ٣ . ٤٪ للطبقات تحت السطحية بينما زادت ملوحة التربة إلى مايقرب من مرتين ونصف مقارنة بالكنترول (عدم إضافة مادة عضوية) بالاضافة إلى ذلك حدث زيادة فى تركيز النترات بمقدار ٢.٨ ،١٦٦، ٥٧٪ لطبقات التربة السطحية وتحت السطحية والعميقة على الترتيب.

-إضافة كل من المادة العضوية والنتروجين المعدنى معا حتى معدل ٤٣ . ٧١ م ٣ / هكتار و ٤٣ . ٧١ كيلو جرام نتروجين /هكتار أدى إلى زيادة معنوية لصلاحية العناصر الكبرى والصغرى بالتربة عنه فى حالة إضافة كل منهما دون الاخر .

-إضافة المادة العضوية مع التلقيح أو عدم التلقيح أدى إلى تحسن فى محتوى النبات من العناصر الكبرى والصغرى .

– جدث زيادة معنوية فى عدد العقد الجذرية النشطة للنباتات الملقحة تحت مستوى ٧١ . ٣٥ كيلو جرام /هكتار من التسميد الأزوتى ومستوى ٦٢ . ٤٧ م ٣/ هكتار مادة عضوية بينما حدث نقص لعدد العقد مع زيادة معدل السماد الأزوتى إلى ٤٣ . ٧١ كيلو جرام نتروجين /هكتار .

– حدث زيادة معنوية لعدد ووزن القرون / نبات ووزن المائة بذرة والمادة الجافة للنباتات مع زيادة معدلات المادةالعضوية والسماد الأزوتى حتى معدل ٧١ . ٣٥ كيلو جرام نتروجين /هتكار وتحت ظروف التلقيح .

– إضافة المادة العضوية والسماد الأزوتى مع التلقيح لم يؤثر معنويا على نسبة الزيت بالبذور بينما تأثرت نسبةالبروتين قليلا ايجابيا .

– أعلى زيادة معنوية للمحصول (طن/هكتار) تم الحصول عليها باضافة معدلات O_2 (٦٢ . ٤٧) ، O_3 (٤٣ . ٧١) م^{٣} هكتار مادة عضوية مع إضافة معدلات N_2 (٧٥ . ٣٥) ، N_3 (٤٣ . ٧١) كيلو جرام نتروجين /هكتار تحت ظروف التلقيح (I^+) أو عدم التلقيح (I^-) . وكان الترتيب التنازلى لكمية المحصول تحت التداخلات السابقة كالاتى :

$$O_3N_2I^+ > O_3N_2I^- > O_2N_2I^+ > O_2N_2I^-$$

أعلى عائدة اقتصادى لصافى الدخل المزرعى (دولار/ هتكار) أمكن الحصول علية بإضافة المادة العضوية بمعدل ٦٢ . ٤٧م^{٣} /هتكار) (O_2) مع السماد الأزوتى بمعدل ٤٣ . ٧١ كليو جرام /هتكار(N_2) تحت ظروف التلقيح(I^+) · وبصفة عامة كان الترتيب التنازلى لصافى الدخل المزرعى هو

$$O_2N_2I^+ > O_3N_2I^+ > O_2N_2I^- > O_3N_2I^-$$

ومما سبق يتبين أن إضافة المادة العضوية كمحسنات تربة طبيعية إلى الأراضي الرملية حديثة الاستصلاح بصفة عامة يؤدى إلى رفع خصوبتها وتحسين السلوك المائى بها و رفع كفاءة إستخدام مياه الرى بواسطة النباتات النامية مما يكون له مردود جيد على إنتاجية مثل هذه النوعية من التربة كما أوضحت النتائج أن استخدام الملقحات الحيوية مع معدلات التسميد الآزوتى الملائم فى وجود المادة العضوية يعتبر من العوامل المهمة التى تؤدى إلى خفض معدلات السماد الآزوتى المستخدم والذى بدوره يؤدى إلى المردود الجيد على خفض تلوث التربة والماء الأرضى بالنترات وخفض تكلفة التسميد الأزوتى المعدنى مما يؤدى إلى زيادة العائد الاقتصادى بزيادة صافى الدخل المزرعى.