Menoufia J. Soil Sci., Vol. 2 February (2017): 1 - 17

EFFECT OF BIO AND ORGANIC N FERTILIZER AS A PARTIAL SUBSTITUTE FOR MINERAL-N FERTILIZER ON YIELD OF PEANUT (*Arachis hypogaea* L.)

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Received: Oct. 31 , 2016 **Accepted: Nov. 21 , 2016**

ABSTRACT: *Two field experiments were carried out at Ismailia Agricultural Research Station, Agricultural Research Center (ARC), Egypt, located at lat. 30° 35' 30" N, long. 32° 14' 50" E. during two successive summer seasons of 2013 and 2014, to study the effect of partial replacement of mineral N fertilizer by organic or bio-fertilizers on soil microbial activities, some seed macro nutrients content , growth characters, yield and yield components of peanut. Results of this study showed that inoculation with cyanobacteria enhances the soil biological activity in terms of increasing the total bacterial, total cyanobacterial counts, CO_2 evolution, dehydrogenase and nitrogenase activities. Combined inoculation of cyanobacteria at 20 or 30L/fed with 50% of the recommended mineral N + 50% as organic N gave the highest nitrogenase and dehydrogenase activities and CO_2 evolution in rhizosphere as well as the macro nutrient content in seeds of peanut plants. The highest significant increases for all growth characters, yield and yield components of peanut were also recorded by the same treatment.*

Key words: *Cyanobacteria, Organic N, Mineral N, Yield Parameters, Quality of seeds, peanut*

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is considered one of the most important edible oil crops in Egypt, due to its seeds' high nutritive value for humans, as well as the produced cake and the green leafy hay for feeding livestock, in addition to the importance of the seed oil for industrial purposes. The main growing areas are located in the north of the country; they include reclaimed desert to the east and west of the Nile Delta. Peanut seeds are characterized by their high oil content 50%, which is utilized in different industries, besides they contain 26–28% protein, 20% carbohydrates and 5% fiber (Fageria *et al.* 1997).

Fertilization is one of the most important factors that increase plant production. Nitrogen is an integral component of many compounds, including chlorophyll and enzymes, as well as amino acids and related proteins. It is also known that nitrogen is an essential element for achieving high and stable yields and increased grain proteins. Peanut has one of the highest nitrogen requirements among the most agronomic crops (Boroomandan *et al.* 2009).

Cyanobacteria can be a useful potential bio fertilizer whether in solid or liquid forms. Cyanobacteria can both photosynthesize and fix N with great adaptability to various soil types (Mishra and Pabbi, 2004). They have the unique ability to fix N from the atmosphere through coupling photosynthesis to N fixation. Bio fertilizers are typically environmentally safe, cheaper and could satisfy the nutrient demands of crops (Badawy et *al*. 1996). El Gaml (2006) explained that bio fertilization using cyanobacteria led to increases in the soil microbial community such as soil fungi, actinomycetes, and soil bacteria. Increasing soil microbial activity led to increased organic matter content, dehydrogenase and nitrogenase activities and subsequently improved soil fertility and plant growth performance (Hassan *et al.* 2008).In addition to contributing nitrogen, cyanobacteria benefit crop plants also by producing various growth promoting substances, like gibberellins, auxins like indole-3-acetic acid, indole-3-propionic acid, etc., vitamin B_{12}, free amino acids like serine, arginine, glycine ,aspartic acid, threonine, glutamic acid, etc., extra- and intra-cellular polysaccharides like xylose, galactose, fructose, etc. Such substances have several beneficial effects like improved soil structure, stimulation of growth of crop plants as well as useful bacteria, chelation of heavy metals (El-Kholy *et al*. 2005). Certain cyanobacteria have been found not only to grow in such inhospitable ecosystems, but also improve the physico-chemical properties of the soil by enriching them with carbon, nitrogen, available phosphorus, etc. Considerable reduction of exchangeable sodium, soil pH (towards neutrality) and conductivity, by these cyanobacteria has been reported. Cyanobacteria also reduce sodium ion content of the soil by making calcium ions available through solubilisation of calcium carbonate nodules, possibly by releasing various organic acids like, oxalic-, oxaloacetic-, lactic-, succinic acids, etc. (Aref and El-Kassas 2006).

The aim of this study was to replace part of chemical N fertilizers by bio or organic fertilizer firstly for clean agricultural product and increasing yield and yield components and secondly for improving biological properties of these sandy soils.

MATERIALS AND METHODS

Field Experiments

Two field experiments were carried out at Ismailia Agricultural Research Station, Agricultural Research Center (ARC), Egypt, during two successive summer seasons of 2013 and 2014, to study the effect of partial replacement of chemical N fertilizers with organic fertilizers and to identify the best concentration of biological agent to serve as bio fertilizer on peanut plant growth, yield and yield attributes, under sandy soil conditions. Chemical analyses of the experimental soil are shown in Table (1). Chemical analyses of compost are also illustrated in Table (2). Compost was added and mixed thoroughly with soil surface two weeks before seeding.

Table (1): Mechanical and chemical properties of the studied soil.

Mechanical and chemical properties								
Coarse sand %	Fine sand %	Silt %	Clay %	Textural class	Ca CO_3 %	Organic matter %	pH (1:2.5)	EC (dSm^{-1}) in soil paste extract
45.20	39.5	9.34	5.96	Sandy	2.4	0.12	7.68	3.8
Soluble ions in soil paste extract (meq l^{-1})								
Ca^{++}	Mg^{++}		Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
9.7	8.7		15.1	4.5	-	14.2	10.2	13.6
Available macronutrients (mg Kg^{-1})								
N			P			K		
25			7.0			250		

Table (2). Physical and chemical properties of the used compost (averaged in 2013 and2014 seasons)

Properties	Value
EC value (1:10) (dSm^{-1})	7.90
pH value (1:10)	6.70
Moisture content (%)	28.00
Organic matter (%)	44.48
Organic carbon (%)	25.80
Total nitrogen (%)	1.42
C/N ratio	18.20
Soluble ammonium-N mg/kg	615.00
Soluble nitrate-N mg/kg	362.00
Total P (%)	0.57
Total K (%)	0.82

Algal strain sources, growth conditions and culture characterizations

N_2-fixing (*Nostoc muscorum*, *Nostoc humifusum*, *Anabaena oryzae* and *Wollea* sp) and non N_2-fixing (*Phormedium* sp. and *Spirulina platensis*) cyanobacteria strains were obtained from the Microbiology Department, Soils, Water and Environment Res. Inst., Agric. Res., Center. The cyanobacterial strains were grown separately on BG11 medium (Rippka *et al*., 1979) except the *Spirulina platensis*, which was grown on Zarrouk medium (Zarrouk, 1966). The cultures were incubated in growth chamber under continuous illumination (2000 lux) and the temperature of 25°C± 2°C for all strains except the mesophilic alga Spirulina platensis, which was grown on 35°C± 2°C.

Culture growth parameters were shown in Table (3). The pH values and algal dry weight (DW) were estimated according to Vonshak (1986). Culture concentration was determined as optical density (OD) by spectrophotometer at 560 nm (Leduy and Therien, 1977). Chlorophyll-a (Ch-a) was determined spectrophotometrically after extraction by absolute methanol as reported by Vonshak and Richmond (1988).

The studied treatments may be listed as follows:

T_1-100% of the recommended mineral N (30kgN/fed) ***control:***

T_2-75% of the recommended mineral N (22.5kgNfed^{-1}) + cyanobacteria (15 l/fed) as soil drench

T_3-75% of the recommended mineral N + cyanobacteria (20 l/fed) as soil drench

T_4-75% of the recommended mineral N + cyanobacteria (30 l/fed) as soil drench

T_5-100 % organic N (30kg Nfed^{-1}) (2.12 t compost fed^{-1}).

T_6-75% organic N (22.5kgNfed^{-1}) (1.59 t compost fed^{-1}) + cyanobacteria (15 l/fed) as soil drench

T_7-75% organic N (compost) + cyanobacteria (20 l/fed) as soil drench

T_8-75% organic N (compost) + cyanobacteria (30 l/fed) as soil drench

T_9-50% N- mineral (15kgNfed^{-1}) +50% organic N (15kg Nfed^{-1}) (1.06 t compost fed^{-1}).

T_{10}-50% of the recommended mineral N +50% organic N (compost) + cyanobacteria (15 l/fed) as soil drench

T_{11}-50% of the recommended mineral N +50% organic N (compost) + cyanobacteria (20 l/fed) as soil drench

T_{12}-50% of the recommended mineral N +50% organic N (compost) + cyanobacteria (30 l/fed) as soil drench

The experimental design:

The experiment was laid out in a complete randomized block design with three replicates with a plot area of 10.5 m^2 (1/400 feddan).Superphosphate (15% P_2O_5) at a rate of 200 kg /fed. and potassium sulfate (48% K_2O) at a rate of 50 kg/fed were incorporated into the soil for all studied treatments before sowing. Ammonium sulphate (20.5% N) as mineral N-fertilizer treatments were added in three equal doses, i.e., at 30, 45 and 60 days after sowing.The mixture of algal culture suspension was used for soil drench application at a rate of 15, 20 or 30 l fed^{-1} which were divided into two equal portions for two doses. The first was with the first irrigation after 21 days from sowing and the second was at the flowering stage.Peanut seeds (variety Giza 6) were provided by the Oil Crops Research Department, Field Crops Research Institute, ARC, Giza, Egypt.

At harvest, ten guarded plants were randomly taken from the second inner two rows of each experimental unit to determine plant height (cm) and yield components, namely, pod number/plant, seed number/plant, weight of pods and seeds/plant, 100- pod and seed weight, total pod and seed yield (kg/fed) as well as crude protein and shelling percentages.

Soil Biological Analysis:

Soil biological activities were measured after the second soil drench addition. The CO_2 evolution was determined according to Gaur *et al.* (1971), total bacterial count was performed on nutrient agar using the spread plate method (APHA, 1992) and total cyanobacterial counts were conducted by plating ten-fold serial soil suspension-dilutions in triplicate onto agarized BG11 medium (Stanier *et al.* 1971). Soil enzymes, i.e., dehydrogenase activity (DHA), was estimated according to Casida *et al*. (1964), while nitrogenase activity was measured by acetylene reduction assay as described by Dart *et al.* (1972).

Table (3): The algal growth parameters (Mean values of 2013 & 2014 seasons).

Properties	*Nostoc muscorum*	*Spirulina platensis*	*Anabaena oryzae*	*Wollea sp.*	*Nostoc humifusum*	*Phormedium sp.*
pH	8.11	10.16	7.14	6.82	8.05	8.67
OD	1.19	2.77	0.87	2.40	1.67	2.09
T-Ch(mgl^{-1})	5.26	11.63	4.03	9.82	7.56	3.00
DW (mgl^{-1})	760.96	1772.80	557.76	1532.80	1065.60	1334.40

Methods of analysis

– Soil properties and compost traits were determined according to Piper (1950) and Page *et al.* (1982).

- The seeds of harvested plants were air-dried, oven –dried at 70 º c weighted ,ground and kept for chemical analysis , the oven dried plant materials were wet digested using a mixture of pure $HClO_4$ and H_2SO_4 at a ratio of 1:1, according to Chapman and Pratt (1961). Total nitrogen, phosphorous and potassium was determined in the seed, according to Chapman and Pratt (1961).

– Seed crude protein percentage was calculated by multiplying N% by 6.25 (A.O.A.C., 1990).

- Oil (%)in seeds was determined by using Soxhlet apparatus and petroleum ether as an organic solvent as described by A.O.A.C. (1990).

- Oil yield (kg/fed) was estimated by multiplying seed yield (kg/fed.) by seed oil percentage.

The experimental data obtained were subjected to analysis of variance (ANOVA), according to the procedures outlined by Snedecor and Cochran (1980).

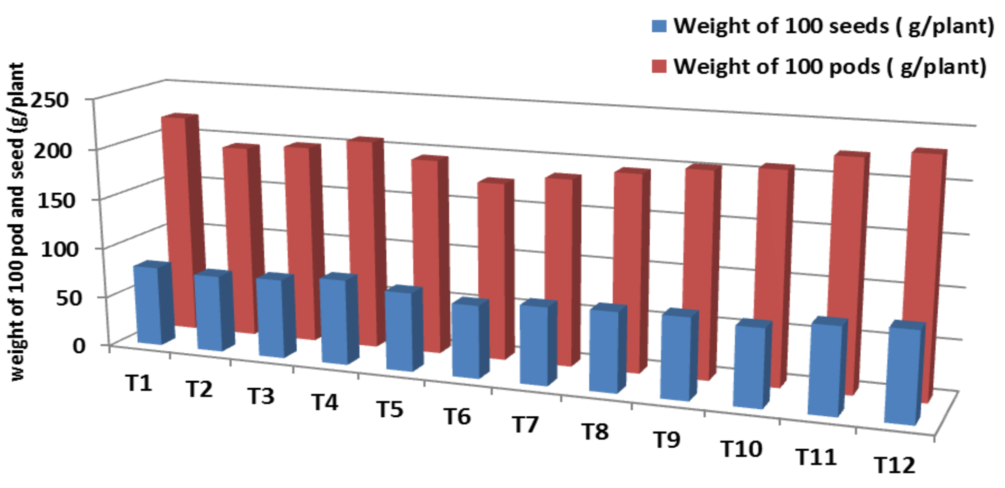
RESULTS AND DISCUSSION

I-Yield and yield components

Plant height, pod and seed number/plant, hundred pod and seed weight as well as pod and seed weight/plant of peanut crop as affected by inoculation with cyanobacteria in combination with inorganic nitrogen and/or compost (organic N) are given in Table (4) and Fig. (1). Results showed that maximum enhancement was observed in plants treated with 50% N- mineral +50% N- Org. and inoculation with cyanobacteria at 30L/fed (T_{12}). Inoculation with cyanobacteria with application of either the N- mineral or organic N increased plant height, pod and seed number/plant, pod and seed weight/plant, as well as 100-seed weight, 100-pod weight and seed weight comparing with those of the inorganic nitrogen or compost when used alone . Similar results were reported by Abd El-Moniem *et al*. (2008) and Zaki *et al.* (2010).These increases may be attributed to the beneficial effects of nitrogen on stimulating the meristmatic activity for producing more tissues and organs, since nitrogen plays major roles in the synthesis of structural proteins and other several macro molecules, in addition to its vital contribution in several biochemical processes in the plant related to growth (Marschner 1995). Moreover, the positive effect on growth traits by using compost manure might be related to the improvement of physical conditions of the soil and supplying plant with mineral nutrients, i.e., N.P.K and micronutrients (Fe, Zn and Mn), organic matter as well as humic acid content (Rechcigl, 1995). Also, (T_{12}) produced the greatest plant height, pod and seed number/plant, pod and seed weight/plant, as well as hundred pod and seed weight. This superior treatment induced increases in these parameters over that of 100 % N- mineral treatment (T_1) reached about (6.15, 8.06, 14.61, 15.22, 14.17, 5and10.13%) respectively.

Regarding the effect of inoculation treatments on peanut yield components, data in Table (4) illustrated also that cyanobacteria inoculation in combination with any of the tested treatments caused increases in all peanut yield components, as compared with the uninoculated treatments. These results may be attributed to that cyanobacteria release promoting substances mainly indole acetic acid, gibbrellines and cytokinines .These promotive effects of cyanobacteria could stimulate plant growth, absorption of nutrients and their efficiency, as well as the metabolism of photosynthesis. These results stand in accordance with those obtained by Maqubela and Menkeni (2009). However, peanut plants exerted high responses to the combined application of cyanobacteria 30L/fed as soil drench with 50% of the recommended mineral N fertilizer + 50%

Table 4



Fig,(1) weight of 100 pod and seed (g/plant) as affected by combinations of chemical, organic and bio-fertilizers

compost being the best treatment for enhancing plant growth followed by the same application with 75% of the recommended mineral N fertilizer. In fact, cyanobacteria have been shown to greatly improve the productivity and quality of many legumes, when they inoculated with rhizobia. This synergistic effect may be elucidated by their ability to enhance the N_2-fixation performance, as well as nutrients availability and uptake from soil, which results in the production of substances like hormones, siderophores, phosphate solubilization and improvement of nutrients and water uptake. The acts of these algae include: (1) Increase in soil pores with having filamentous structure and production of adhesive substances. (2) Excretion of growth-promoting substances such as hormones (auxin, gibberellin), vitamins, amino acids. (3) Increase in water holding capacity through their jelly structure (Roger and Reynaud 1982). (4) Increase in soil biomass after their death and decomposition. (5) Increase in soil phosphate by excretion of organic acids. Also Data in Table (5) and Fig. (2) exhibited that yield was significantly influenced by inoculation with cyanobacteria in combination with inorganic nitrogen and/or compost. It was found that there were significant differences in the pod and seed yields among different treatments. High yields of pod and seed (2151and 1467 kg/fed. respectively) were obtained from T_{12} (50% mineral N + 50% as organic N + cyanobacteria 30L/fed) followed by T11 (50% mineral N + 50% as organic N + cyanobacteria 20L/fed) (2048 and 1373kg/fed respectively) and lowest yield was produced by T6 (75% as organic N + cyanobacteria 15L/fed) (1279 and 807.94). It was also observed that there were no significant differences between T_1 and T_4 as well as T_5 and T_8 in seed yield. Also there were no significant differences between T_4, T_9 andT_{10} as well as $T_2$and T_7 in pod yield. The present results suggest that using the treatmentsT_{12}, T_{11} or T_{10} gave higher values of seed yield (1467, 1373 and 1293.97 kg/fed respectively) than using 100% mineral N fertilizer T_1 (1245.75 kg/fed). This might be due to the positive

effect of inoculation with cyanobacteria
in

Table 5

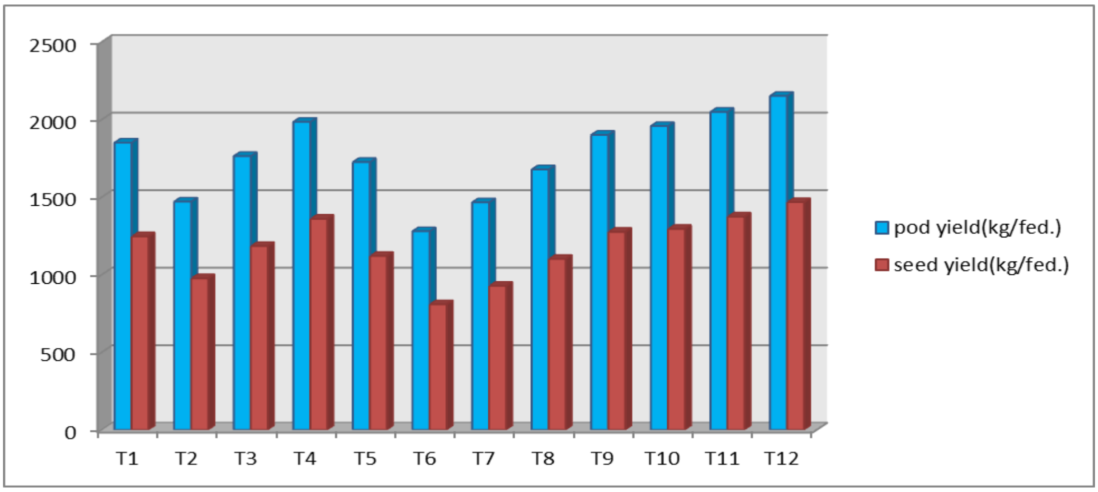


Fig. (2) Effect of treatments on pod and seed yield of peanut

combination with inorganic nitrogen and/or compost on better root development which resulted in more nutrient uptake. These microorganisms also produce vitamins and plant growth promoting substances for the betterment of plant growth. Organic manures not only release nutrients slowly but also prevent the losses of leaching (Anup Das *et al.* 2010). In this connection, De-Mule *et al.* (1999) and De-Caire *et al.* (2000) indicated that blue-green algae excrete many of substances (growth promoting regulators, vitamins, amino acids, polypeptides, antibacterial and polymers, especially exopolysaccharides), which induced a growth promotion of other microorganisms and increased the enzymes activities.

Cyanobacteria also add organic matter, synthesize and liberate amino acids, vitamins and auxins, reduce oxidizable matter content of the soil, provide oxygen to the submerged rhizosphere, ameliorate salinity, buffer the pH, solubilize phosphates and increase the efficiency of fertilizer use in crop plants (Kaushik, 2004).

II -Seed protein content

Protein percentage in peanut seeds was significantly affected by the applied treatments (Table 5 and Fig. 3) and varied from 20.63 to 26.25% according to treatments. The highest protein content was obtained with T_{12} (50% mineral N + 50% as organic N + cyanobacteria 30L/fed) followed by T_{11} (50% mineral N + 50% as organic N + cyanobacteria 20L/fed) and T_{10} (50% mineral N + 50% as organic N + cyanobacteria 15L/fed). From Table (5), it is clear that protein content significantly increased with inorganic fertilizer more than organic fertilizer. Protein yield fed^{-1} was also significantly affected by the applied treatments. The favorable effect of N fertilizer on protein might be explained by assuming an influence of N availability on critical stage of seeds initiation and development of plant metabolism in away leading to the increase in the synthesis of amino-acid and their incorporation into seed protein.

These results suggest that the high N increases the amino acids synthesis in the leaves and this stimulate the accumulation of protein in the seed. The significant effect of compost may be due to the fact that this manure consists of different nutritive elements, so, it is considered a balanced fertilizer that encourages the photosynthetic process and other physiological factors that increase protein synthesis. El kramany *et al.* (2007) reported that protein content increases with improved plant nutrition and that the application of manure results in a high exchangeable capacity, hence a considerable quantity of nitrogen is diverted to available form and thus increased protein. Nitrogen is one of the essential nutrients involved as a constituent of bio-molecules such as nucleic acids, coenzymes and proteins and any deviation in these constituents would inhibit the growth and yield of plants. Protein concentrations in plants tend to increase with fertility level of the growth medium. Dixit and Gupta (2000) reported that farmyard manure or bio - fertilizer either alone or in combination showed an increasing tendency of protein content in rice grain.Cyanobacteria fertilizer also helps the stabilization of soil, add organic matter, release growth promoting substances, improve the physico-chemical properties of soil and solubilize the insoluble phosphates.

III -Seed oil content

The applied different treatment combinations caused increases in seeds oil content and oil yield (Table 5) and Fig. (3). T_1 (100% N-mineral) recorded the highest oil content (49.8%), however, a maximum oil yield was recorded by the treatment T_{12} (715.68 kg fed^{-1}) followed by T_{11} (668.84 kg fed^{-1}). This may be due to the improvement in the soil's physical, chemical and biological properties as well as nutritional status due to the addition of cyanobacteria in combination with inorganic nitrogen and/or compost which have contributed to the higher yield. Similar results were also reported by Abd El Rasoul *et al.* (2002). Increases in seed oil yield (kg fed^{-1}) by cyanobacteria might be due to their positive effect on nutrients absorption, higher photosynthetic rate, higher dry matter accumulation and higher vegetative growth. Nitrogen is an essential nutrient in creating the plant dry matter, as well as many energy-rich compounds which regulate photosynthesis and plant production, thus influencing pod development, increasing the number of pods/plant and pod weight and consequently increases oil yield.

IV- Nutrient concentration and contents of peanut seeds

Nutrients concentration and contents in seeds of peanut plant (Table 6) and Fig. (4) differs significantly amongst all the treatments. Plants inoculated with cyanobacteria 30L/fed in combination with 50% mineral N + 50% as organic N (T_{12}) followed by T_{11}, (50% mineral N + 50% as organic N + cyanobacteria 20L/fed) and T10 (50% mineral N + 50% as organic N + cyanobacteria 15L/fed) increased nutrient content (NPK) compared to (100% mineral N).The N content varied from 36.94 to 61.60kg/fed in favor of T_{12} which was significantly different from other treatments (Table 6). The maximum P content was obtained from T_{12} (50% mineral N + 50% as organic N + cyanobacteria 30L/fed) followed by T_{11} (50% mineral N + 50% as organic N + cyanobacteria 20L/fed) and T_{10} (50% mineral N + 50% as organic N + cyanobacteria 15L/fed). The highest K content (14.08kg/fed.) was observed in T_{12} followed by T_{11} (12.91kg/fed). The beneficial effects of using organic fertilizers along with mineral -N fertilizer on increasing nutrient concentration and contents of peanut seeds could be due to their effect on providing plants with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the plants. Combined application of organic N with bio fertilizers as a partial substitute for chemical fertilizers was very effective in stimulating nutrient concentration and contents of peanut plant. These results may be due to the ability of bio fertilizer to transport major nutrients like N and P besides secreting plant growth promoting substances such as IAA, gibberellins and abscisic acid. Organic acids resulting from organic manure have led to increase in soil acidity and consequently convert insoluble forms of phosphorus into soluble ones (Wani *et al.* 2007).

Data in (Table 6) exerted that cyanobacteria inoculation with 50% of the recommended mineral N + 50% as organic N significantly increased concentration and contents of N, P and K in peanut seeds as compared with the recommended N dose only. The activity of soil organisms is very important for ensuring sufficient nutrient supply to the plant. If the microorganisms find suitable conditions for their growth, they can be very efficient in dissolving nutrients and making them available to plants. Increases in N, P and K concentration were 7.2, 20.9 and 4.35% and those in contents were 31.85, 42.40 and 22.86%, respectively, compared with the recommended N chemical dose only. The positive effect of cyanobacteria inoculation upon nutrient uptake could be described to the high efficiency of bacteria presence in these bio fertilizers to fix atmospheric nitrogen and /or to produce some biologically active substances, e.g., IAA, gibberellins and cytokinins. Such substances would help in increasing the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment (El kramany *et al.* 2007). There was a remarkable promotion on chemical quality parameters with increasing cyanobacteria concentrations from 15 to 30L/fed as soil drench.

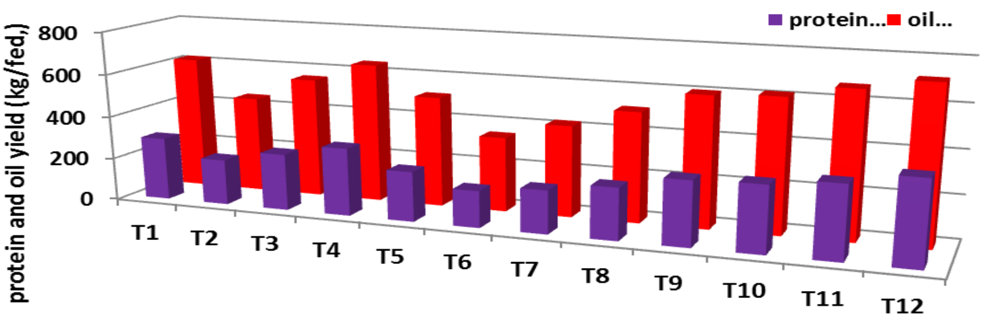


Fig. (3) protein and oil yield (kg/fed,)as affected by combinations of chemical, organic and bio-fertilizers

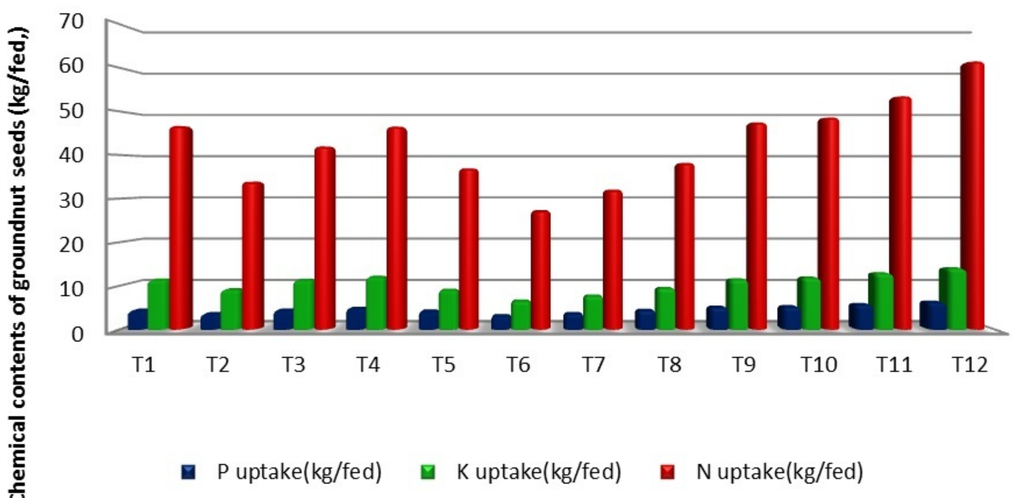


Fig. (4) Chemical contents of groundnut seeds as affected by combinations of chemical, organic and bio-fertilizers

Table 6

V-Soil biological activity

Data in Table (7) indicate the effect of inoculation with cyanobacteria combined with N- mineral and/or compost combined with cyanobacteria on the soil biological activity in terms of total count bacteria, cyanobacteria counts, CO_2 evolution, dehydrogenase and nitrogenase activity. Cyanobacteria inoculation, generally, enhanced the soil biological activity in terms of increasing the CO_2 evolution, dehydrogenase activity, nitrogenase, total cyanobacteria counts and total bacterial counts under both levels of nitrogen (75 and 50%N) compared to the untreated treatments(100% mineral N). The maximum microbial activity was achieved by the combined effect of soil drench application with 75% as organic N followed by 75% mineral N. These results are in agreement with those of Mahmoud *et al.* (2007) who stated that cyanobacteria inoculation generally enhanced the soil biological activity. However, the use of 50% mineral N + 50% as organic N with 30L/fed cyanobacteria gave the highest values of total count bacteria, CO2 evolution, dehydrogenase activity and nitrogenase activity in peanut soil. Caire *et al.* (2000) established that cyanobacteria can increase the soil enzymatic activity. Aref and El-Kassas (2006) found that cyanobacteria inoculation to maize field enhanced significantly any of total count bacteria, cyanobacteria count, CO_2 evolution, dehydrogenase and nitrogenase activities compared to the control treatment received no inoculation. They explained that bio fertilization with cyanobacteria led to increase microorganisms' community and in turn soil biological activity in soil through increasing the organic matter and microbial activity.

In conclusion, results from the present study indicate that the application of cyanobacteria and compost fertilizer can positively affect the peanut yield and its attributes, especially for the treatment received 50% mineral N + 50% as organic N + cyanobacteria 30L/fed). which can reduce the need for chemical fertilizers and subsequently reduce environmental pollution compared with other mineral chemical fertilizers.

CONCLUSION

In conclusion, the results of the present investigation revealed beneficial role of cyanobacteria in improving the status of the soil in terms of physical, chemical and nutritional properties. Hence, cyanobacteria bio fertilizers are recommended to be used as renewable natural nitrogen resources for different crop plants in agriculture. They are non-polluting, inexpensive; utilize renewable resources in addition to their ability in using free available solar energy, atmospheric nitrogen and water. The findings of this study have clearly showed that combined application of cyanobacteria along with 50% recommended dose of mineral N + 50% as organic N has resulted in obtaining the highest plant growth, yield and yield attributes. This combination may also reduce 50% the amount and cost of N-mineral fertilizer application in peanut under sandy soil conditions and finally sustain the soil health.

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تأثير التسميد النيتروجين العضوى والحيوى كبديل جزئى للنيتروجين المعدنى على محصول الفول السودانى و مكوناته

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الملخص العربى

أجريت تجربة حقلية بمحطة بحوث الإسماعيلية بمركز البحوث الزراعية خلال موسمين متتالين ٢٠١٣/٢٠١٤ وذلك لدراسة أثر التلقيح بالسيانوبكتريا المثبتة للنيتروجين بمعدلات مختلفة بمصاحبة مستويات مختلفة من التسميد المعدني والعضوي على إنتاجية الفول السودانى و بعض صفات المحصول ، وكذلك النشاط الحيوي على التربة الرملية .

أوضحت النتائج أن التلقيح بالسيانوبكتريا في وجود التسميد المعدني أو العضوي لعب دوراً هاماً في زيادة وجودة المحصول وكذلك أدى إلى تحسين التربة الرملية .

إضافة سلالات من السيانوبكتريا لنبات الفول السودانى أظهر فائدة اقتصادية حيث أمكن توفير حوالي ٥٠% من التسميد المعدني الذي يحتاجه الفول السودانى . وهذا التوفير كان أكثر وضوحاً عند استخدام٣٠لتر/فدان من السيانوبكتريا المثبتة للنيتروجين حيث ، كانت هناك زيادة معنوية ملحوظة في إنتاجية محصول الفول السودانى عن تلك المتحصل عليها باستخدام كمية التسميد المعدني أو العضوي الموصى بها منفردة.

وكذلك أدى التلقيح بالسيانوبكتريا بصفة عامة إلى تحسين النشاط البيولوجي للتربة الرملية، وقد اتضح ذلك في صورة زيادة معنوية لكل من العدد الكلي لكل من البكتريا و السيانوبكتريا ، وكمية ثاني أكسيد الكربون المتصاعدة ، نشاط كل من انزيمي الديهيدروجينيز والنيتروجينيز.

أدى التلقيح بالسيانوبكتريا المثبتة للنيتروجين في وجود التسميد العضوى إلى زيادة معنوية في كل من النيتروجين والفوسفور والبوتاسيوم في الحبوب مقارنة بالغير ملقحة .

هذه الدراسة تهدف إلى زيادة الاهتمام بتطبيق تكنولوجيا التسميد بالسيانوبكتريا لمحاصيل البقوليات والذي يؤدى إلى تقليل الاعتماد على السماد المعدني المكلف للزارع والملوث للبيئة وزيادة الاتجاه إلى التسميد العضوى.

Table (4): Yield and yield attributes of peanut plants as affected by interactions of mineral, organic and bio-fertilizers(Combined of 2013 & 2014seasons).

Yield attributes Treatments	Plant height (cm)	Number of		Weight of (g/plant)		Weight of	
		Pods/plant	seeds/plant	pods	seed	100 pods	100seed
T_1-Chemical fert. Rec.(100%N)	65	62	89	92	63.3	220	79.88
T_2-75%Chem.+bio(15l/fed)	62	52	76	78	51.78	193	76.76
T_3-75%Chem.+bio(20l/fed)	64	55	80	88	59.07	198	79.1
T_4-75%Chem.+bio(30l/fed)	67	65	95	103	70.1	208	84.88
T_5-Organic manure (100%N)	57	47	68	76	49.32	194	78.21
T6-75%Org.+bio(15l/fed)	52	44	64	70	44.22	176	72.13
T_7-75%Org.+bio(20l/fed)	54	46	67	74	47.06	185	76.97
T_8-75%Org.+bio(30l/fed)	58	49	70	80	52.5	195	78.85
T_9-50%Chem.fert. +50%Org.	64	57	82	91	61.08	203	80.13
T_{10}-100%Chem.fert.+50%Org.+bio(15l/fed)	65	62	91	93	61.49	208	76.57
T_{11}-50%Chem.fert.+50%Org.+bio(20l/fed)	66	64	94	97	65.05	224	84.97
T_{12}-50%Chem.fert.+50%Org.+bio(30l/fed)	69	67	102	106	72.27	231	87.97
LSD 0.05%	3.67	5.30	4.09	4.84	2.91	6.33	2.91

Rec.: recommended bio-fertilizer: Cyanobacteria Org.: compost

Table (5): Groundnut yield and Chemical contents of peanut seeds as affected by combinations of mineral, organic and bio-fertilizers (combined of 2013&2014 seasons)

Yield attributes Treatments	Yield of(kg/fed)		Protein		oil	
	pod	Seed	%	Yield(kg/fed)	%	Yield(kg/fed)
T_1-Chemical fert. Rec.(100%N)	1984	1245.75	23.44	292.00	49.8	620.38
T_2-75%Chem.+bio(15l/fed)	1470	975.79	21.69	211.65	45.9	447.89
T_3-75%Chem.+bio(20l/fed)	1763	1183.50	22.19	262.62	47.0	557.66
T_4-75%Chem.+bio(30l/fed)	1850	1259.11	23.13	291.23	47.5	598.08
T_5-Organic manure (100%N)	1725	1119.53	20.63	230.96	45.8	512.75
T_6-75%Org.+bio(15l/fed)	1279	807.94	21.06	170.15	42.9	346.61
T_7-75%Org.+bio(20l/fed)	1465	927.20	21.56	199.90	45.7	423.73
T_8-75%Org.+bio(30l/fed)	1677	1100.45	21.69	238.69	46.2	508.41
T_9-50%Chem.fert. +50%Org.	1900	1275.28	23.31	297.27	47.3	603.21
T_{10}-100%Chem.fert.+50%Org.+bio(15l/fed)	1957	1293.97	23.56	304.86	47.6	615.93
T_{11}-50%Chem.fert.+50%Org.+bio(20l/fed)	2048	1373.39	24.38	334.83	48.7	668.84
T_{12}-50%Chem.fert.+50%Org.+bio(30l/fed)	2151	1466.55	26.25	384.97	48.8	715.68
LSD 0.05%	338.75	99.06	0.86	11.66	1.47	17.74

Rec.: recommended   bio-fertilizer: Cyanobacteria   Org.: compost

Table (6): Chemical contents of peanut seeds as affected by combinations of mineral, organic and bio-fertilizers (combined of 2013&2014 seasons)

Yield attributes / Treatments	Macro nutrients (%)			Macro nutrients uptake(kg/fed)		
	N	P	K	N	P	K
T_1-Chemical fert. Rec.(100%N)	3.75	0.354	0.92	46.72	4.41	11.46
T_2-75%Chem.+bio(15l/fed)	3.47	0.370	0.94	33.86	3.61	9.17
T_3-75%Chem.+bio(20l/fed)	3.55	0.375	0.96	42.01	4.44	11.36
T_4-75%Chem.+bio(30l/fed)	3.70	0.385	0.99	46.59	4.85	12.09
T_5-Organic manure (100%N)	3.30	0.375	0.81	36.94	4.20	9.07
T_6-75%Org.+bio(15l/fed)	3.37	0.390	0.83	27.23	3.15	6.54
T_7-75%Org.+bio(20l/fed)	3.45	0.390	0.86	31.99	3.62	7.70
T_8-75%Org.+bio(30l/fed)	3.47	0.395	0.88	38.19	4.35	9.46
T_9-50%Chem.fert. +50%Org.	3.73	0.399	0.90	47.57	5.09	11.48
T_{10}-100%Chem.fert.+50%Org.+bio(15l/fed)	3.77	0.403	0.92	48.68	5.21	11.90
T_{11}-50%Chem.fert.+50%Org.+bio(20l/fed)	3.90	0.416	0.94	53.56	5.71	12.91
T_{12}-50%Chem.fert.+50%Org.+bio(30l/fed)	4.02	0.428	0.96	61.60	6.28	14.08
LSD 0.05%	0.14	0.01	0.05	1.86	0.08	0.57

Rec.: recommended bio-fertilizer: Cyanobacteria Org.: compost

Table (7): Soil biological activities as affected by combinations of mineral, organic and bio-fertilizers (combined of 2013&2014 seasons)

Treatments	Bact. counts (10^4cfu g soil^{-1})	Cyano. counts (10^2 cfu g soil^{-1})	CO2 evolution (mg100g soil-1 day-1)	Dehydrogenase activity (µg TPFg^{-1} dry soil hr^{-1}	Nitrogenase activity (µ mole C_2H_4 g soil-1hr.-1)
T_1-Chemical fert. Rec.(100%N)	15.20	6.78	15.21	2.12	8.66
T_2-75%Chem.+bio(15l/fed)	16.00	11.45	20.25	3.27	6.30
T_3-75%Chem.+bio(20l/fed)	16.64	14.11	26.50	3.45	10.83
T_4-75%Chem.+bio(30l/fed)	22.50	15.00	33.49	3.78	16.63
T_5-Organic manure (100%N)	25.00	20.74	34.29	4.12	17.65
T_6-75%Org.+bio(15l/fed)	34.01	20.00	36.52	4.36	18.66
T_7-75%Org.+bio(20l/fed)	35.00	19.60	40.00	4.91	20.92
T_8-75%Org.+bio(30l/fed)	36.00	21.36	40.55	5.49	22.60
T_9-50%Chem.fert. +50%Org.	34.50	17.11	40.76	5.61	23.51
T_{10}-100%Chem.fert.+50%Org.+bio(15l/fed)	42.55	23.00	41.94	5.64	25.66
T_{11}-50%Chem.fert.+50%Org.+bio(20l/fed)	43.50	26.70	42.90	6.68	26.57
T_{12}-50%Chem.fert.+50%Org.+bio(30l/fed)	46.00	27.00	45.92	8.99	29.82
LSD 0.05%	2.72	1.89	3.74	1.38	4.73

Rec.: recommended bio-fertilizer: Cyanobacteria Org.: compost