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Maximizing Productivity of Peanut (*Arachis hypogaea* L.) Plants in Sandy Soils Using Environmental Safe Fertilizers

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RECENT fertilization strategies in the world show that the use of environment safe fertilizers is of great importance to decrease the harmful effects of fertilizers on environment and human health, especially in the newly reclaimed soils. Therefore, this study was carried out to evaluate the effect of some environmental safe fertilizers (*i.e.,* organic and bio fertilizers) in different sources on sandy soil productivity of peanut plants (*Arachis hypogaea* L.). The used organic fertilizers were farmyard manure (FYM), solid plant compost (SPC), enriched compost tea with humic substances (ECT) and mixture of FYM and ECT, while the used bio- fertilizers were B1 (*Azospirillum braselinse*+ *Bacillus megatherium* + *Azotobacter chroococcum*) and B2 (*Bradyrhizobium sp.* USDA 3456+ *Serratia marcescens* MH6+ *Psuedomonas fluorescens* IFO 2034. The obtained data showed the superior increase effect of ECT followed by FYM+ECT applications straw, pods and seed yields straw and seeds contents of N, P and K as well as seeds contents of protein and oil. Similar increase for all determined parameters were found in the plants inoculated by B2 compared to that with B1. Thus, use of both organic and bio- fertilizers in the fertilization strategy of sandy soil is very important and also may be economically.

Keyword: *Azospirillum braselinse*, Organic fertilizers, Bio–fertilizers, *Bacillus megatherium*.

Introduction

Peanut (*Arachis hypogaea* L.) is one of the most valuable oil leguminous crops in Egypt. Its seeds are characterized by high content of oil (45 to 50%), protein (22 to 28%), carbohydrate (20%) and 5% fiber and ash (Fageria et al., 1997 and Zaki et al., 2017). Besides its high nutritional value for humans, peanut byproducts are also important for livestock feeding such as produced cake as well as the green leafy straw (Shah et al., 2012).

In Egypt, peanut is mainly grown in the northern part of the country in the newly reclaimed desert areas of East and West Nile Delta. These areas are mainly sandy soils, which have low organic matter content, poor physical conditions and low content of available and total essential nutrients (Ghabour et al., 2018). Due to low levels of available nutrients in sandy soils, high rates of NPK mineral fertilizers are used to maximize seed and straw yields, which used for human and animal feeding, respectively (El-Behlak, 2016). Mineral fertilizers application resulted in a significant increase in yield and yield components, while very high rates of their application can cause soil and water pollution and need to be reduces (Mengel et al., 2001). Organic manures and bio-fertilizers are alternatives to increase soil productivity of different crops without polluting the environment in a sustainable production system (Faiyad, 2014). Bio-fertilizers are eco-friendly and have several advantages over conventional chemicals. It is safer than many of the chemicals, not toxic substances, does not accumulate in the food chain

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and not considered harmful to the environment or ecological processes. Self-replication of microbes circumvents the need for repeated application (Wua et al., 2004). Application of organic manures is widely recommended especially in sandy soils deficient in soil organic matter. Application of organic fertilizers to such soil types (sandy) found to improve physical, chemical and biological properties and increase nutrient availability (Helmi, 2018). Abou Hussien et al. (2019) reported that application of composted three organic materials improves soil chemical properties and its content of available nutrients as well as yield of wheat. Combined application of organic and bio-fertilizers is widely recommended to improve physical, chemical and biological properties of soil and to achieve high yields free from undesirable pollutants (Ansari and Mahmood, 2017 and Gao et al., 2020). Zaki et al. (2017) found that application of both bio- and organic fertilizers to different peanut cultivars grown in sandy soil resulted in improved yield and yield components. Increasing the yield of peanut by applying integrated action of both mineral and bioorganic fertilizers was reported before that by Subrahmaniyan et al. (2000) and El-Howeity et al. (2019).

The present study aims at developing a suitable fertilization management system that integrates the use of environmental safe bio and organic fertilizers to maximize yield of peanut plants cultivated in a sandy soil.

Materials and Methods

A field experiment was carried out on a sandy soil of Experimental Farm, Ismailia Research Station, Soils, Water and Environment Research Institute, Agricultural Research Center (ARC), Egypt, during two successive growth summer seasons (*i.e.,* 2016 and 2017) to study the effect of environmentally friendly fertilizers (bio and organic) on peanut (*Arachis hypogaea* L.) Giza 5 cv. yield quantity and quality as well as N, P and K uptake.

Before planting, soil samples at soil depth of 0-20 cm were taken from the experimental soil, air-dried, ground, mixed thoroughly, sieved through a 2 mm sieve, kept and analyzed for some physical and chemical properties and its content (total and available) of N, P and K according to the methods described by Cottenie et al. (1982); Page et al. (1982) and Klute (1986). The obtained data are recorded in Table 1.

In this study, four sources of organic fertilizer were used. These fertilizers were:

1- Farmyard manure "FYM" which was taken from private farm of animal husbandry.

2- Solid plant compost "SPC" which was prepared at Agricultural Microbiology Research Department, Soils, Water and Environment Research Institute, Agricultural Research Center (ARC), Egypt, from rice straw and farmyard manure provided with bentonite, rock phosphate, elemental sulphur and urea, which were composted for three months.

TABLE 1. Some physical and chemical properties of the studied soil and its content of some nutrients

a. Physical properties											
Particle size distribution (%)											
Sand		Silt		Clay			Textural class				
90.6		4.6		4.8			Sandy				
b. Chemical properties											
Organic matter g kg $^{-1}$	$CaCO_3$ g kg $^{-1}$	pH	EC(dS m $^{-1}$)	Soluble ions mmole l $^{-1}$							
				Cation				Anion			
				Ca^{2+}	Mg^{2+}	K^+	Na^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
4.0	16	7.6	0.31	0.7	0.6	0.3	1.5	0.0	1.6	0.7	0.8
c. Nutrient contents (mg kg $^{-1}$)											
N				P				K			
Total	Available was extracted with 1 N KCL			Total	Available was extracted with 0.5 M $NaHCO_3$			Total	Available was extracted with 1 N ammonium acetate		
221.0	31.00			62.30	5.3			489.60	57.50		

Soluble ions mmole l-1 in 1:5 soil water extract; EC (dS m-1) in saturated soil past; PH (1:2.5) in soil: water suspension

3- Enriched compost tea "ECT", prepared from a well mature compost enriched with humic substances.

4- A mixture of farmyard manure and enriched compost tea "FYM" + "ECT".

Samples of FYM, SPC and ECT were taken and analyzed for their chemical composition according to the methods described by Cottenie et al. (1982) and Page et al. (1982). The obtained data are recorded in Table 2.

Enriched compost tea (ECT)

Aerated compost tea was prepared from a matured compost made from rice straw according to the method described by Abdel-Wahab et al. (2007) as follows: 10 kg of mature compost was blended with 1 kg molasses, 500g $(NH_4)_2SO_4$, 50g $MgSO_4.7H_2O$ and 10 g NaCl were put in a 150 liter plastic barrel and drenched in 100 litter tap water previously stored to avoid the harmful effect of Cl on microbial load of compost. Then the mixture was supplied with 2.5 mL/L of humic substances (prepared from steeping 10 kg solid compost in 100 litter of 0.5 N KOH solution).

Biofertilizers

Bio-fertilizers were performed by using two (B1 and B2) different mixtures (blends) of bacterial agents at a single dose, and supplied by Agricultural Microbiology Research Department, Soils, Water and Environment Research Institute, Agricultural Research Center (ARC), Egypt. All bacterial agents used as plant growth promoting rhizobacteria (PGPR) and represented by the following mixtures:

- B1 consist of *Azospirillum braselinse*+ *Bacillus megatherium*+ *Azotobacter chroococcum*.
- B2 consist of *Bradyrhizobium sp.* USDA 3456+ *Serratia marcescens* MH6+ *Psuedomonas fluorescens*IFO 2034.

The layout of the experiment was a split-plot design in three replicates. The experimental plots were 45 unit including four sources of organic fertilizers, plus control × two different mixtures of biofertilizer, plus control × three replicates. The area of each plot was 21 m² (7 m length × 3 m width), including 5 rows. The main plots were representing the biofertilizer treatments, whereas peanut seeds were inoculated with gamma irradiated vermiculite based inoculums at a rate of 300 g/50 kg seeds using 16% Arabic gum solution as a sticking agent. The sub main plots were treated with one of the organic fertilizer (control, FYM, SPC, FYM+ECT and ECT).

Before planting in 2016 and 2017 growth seasons, SPC and FYM were added at rate of 5 Mg /fed, where feddan area equal 4200 m^2 (0.42 hectare),while, ECT was added at a rate of 75 L/ fed in two equal doses, after 20 and 30 days of planting. The treatment of FMY+ECT was carried out at a rate of 2.5 Mg FYM / fed + 37.5L ECT/ fed. At final soil preparation, all plots were fertilized byordinary super phosphate (15.5 % P_2O_5) at a rate of 200 kg / fed + 500 kg / fed of agricultural gypsum. Ammonium sulphate $(NH_4)_2SO_4$ (20.3 %N) was applied as source of N fertilizer at a rate of 25 kg N/fed corresponding to123.15 kg $(NH_4)_2SO_4$ / fed. It was added in two equal doses, i.e. after 20 and 30 days of planting. At the same time of mineral N fertilization, all plots received potassium fertilizer in the form of potassium sulphate (48 % K_2O) at a rate of 100 kg/ fed.

TABLE 2. Some chemical properties of the used three organic fertilizers

Source of organic fertilizers	Organic C	Organic matter	Total N	C/N ratio	pH	EC	Total P	Total K
Farmyard manure "FYM"	22.05 %	38.01 %	1.20 %	18.37	8.38	3.80	0.70 %	1.90 %
Solid plant compost "SPC"	18.00 %	31.03 %	1.42 %	12.68	7.79	3.53	0.46 %	1.60 %
Enriched compost tea "ECT"	58.0 g/l	99.9 g/l	4.10 g/l	14.15	6.85*	3.89*	5.70 g/l	8.20 g/l

*Measured in their solutions; pH: (1:10) of water suspension and EC (dS m^{-1}): (1:10) of water extract.

Directly after inoculation, peanut (Giza 5 cv.) seeds, (kindly provided by Field Crop Research Institute, Agricultural Research Center, Giza, Egypt) were planted with seeding rate of 50 kg seeds / fed at 10th and 15th of May 2016 and 2017 in order. Each hole was planted by two seeds at 2 cm depth and distance of 20 cm between holes. After 15 day of planting, the plants of each hole were thinned to one plant. At maturity stage of pods (122 days from planting) in the two growth seasons, the plants of one length meter of each replicate were randomly harvested and separated into shoots and pods, air-dried, oven-dried at 70 °C for 48 h, to determine dry weight of straw and pods yield (kg fed^{-1}). Seeds were separated from the pods and weighed separately and shelling (%) {= (weight of seeds / weight of pods) ×100} of peanut plants was calculated.

A 0.2 g of each dried fine plant materials, *i.e.* shoots and seeds were digested in 10 mL mixture of concentrated H_2SO_4 and $HClO_4$ at a ratio of 3:1 at 250 °C. The clear digest was diluted to 100 ml with distilled water (Chapman and Pratt, 1961). The contents of N, P and K (%) in the diluted digest were determined following the methods described by Cottenie et al. (1982). Seed crude protein percentage was calculated by multiplying the concentration of N (%) by 6.25 (AOAC,1990). Oil percentage in seeds was determined by using Soxhlet apparatus and petroleum ether as an organic solvent as described by AOAC (1990). Finally, the relative change (%) of the obtained data were calculated.

Where: The relative change "RC" (%) = {(Parameter value with treatment –Parameter value with control) / Parameter value with control} × 100.

Statistical analyses

Statistical analysis was done using Costat package program, version 6.4 (Cohort software, USA). The differences among the means of different treatments were tested using the least significant differences (LSD) at probability 5% as described by Snedecor and Cochran (1980).

Results and Discussion

Straw and pod yields

Data in Table 3 showed the yield of peanut straw and pods (kg fed^{-1}) as affected by application of different types of organic fertilizers and mixtures of bio-fertilizers. Presented data showed that sole application of organic fertilizers and in combination with different bio-fertilizers mixtures resulted in a significant increase in both straw and pods yields of peanut grown in sandy soil. It was clear that there were a wide variations in response of peanut to different used organic fertilizers where the maximum response was obtained with the treatment of ECT followed by FYM + ECT, while the lowest was recorded for FYM treatment. For example, the straw and pods yield as a result of organic fertilizers application alone was 2554, 2319; 2120, 2077; 1958, 1968 and 1796, 1769 kg fed^{-1} for the treatments of ECT, FYM+ECT, SPC and FYM, respectively. The effect of organic fertilizers may also be cleared from the positive values of RC (%) of both straw and pod yield (Table 3). Hammad (2019) pointed out the importance of added organic fertilizers on plant (common been) growth and productivity. Baddour et al. (2017), Helmi (2018), Abou-Hussien et al. (2019) and Tantawy et al. (2019a) also showed that plant growth was increased due to organic fertilizers application.Bio fertilizers in the two mixtures (B1 and B2) showed a significant increase in peanut straw and pod yield compared to control. It was clear that with all the studied organic fertilizers, application of bio-fertilizers resulted in increase in both straw and pod yield of peanut. The obtained data also, show that there is superior effect of B2 application on the increase of straw and pod yields compared with that resulted from B1 application. On average of all different organic fertilizers, the straw yield of peanut as a result of B1 application was 2291 kg fed^{-1} while it was 2388 kg fed^{-1} with B2 application. This trend may be cleared from the higher RC (%) values with B2 compared with that of B1. These increases resulted from the enhanced effect of bio fertilization on nodulation efficiency and nutrients uptake. In this respect, similar results were obtained by Abdel-Salam (2019), Marei (2019) and Tantawy et al. (2019b).

Seed yield and shelling percentage

Data of peanut seed yield and shelling percentage and their relative change as affected by application of different organic and bio fertilizer are presented in Table 4. These data show that seed yield and shelling percentage significantly responded to the application of different types of organic fertilizers and/ or bio fertilizer mixtures. Seeds yield response to application of organic fertilizers varied widely as cleared from RC (%) values of different organic fertilizers application. For example, seeds yield increased from 318.4 kg fed^{-1} in the control treatment to 963, 1346, 1560 and 1938 kg fed^{-1} with the application of FYM, SPC, FYM+ECT and ECT treatments with corresponding RC values of 66.94,76.59, 79.59 and 83.57 %, respectively. It is clear that, the treatment of ECT resulted in the superior increase in seed yield followed by the treatment of FYM+ECT whereas as the lowest increase

resulted from FYM application. Similar effect of organic fertilizers on the increase of crops productivity was found by Abou-Hussien et al. (2017) on barely, Helmi (2018) on sugar beet, Hammad (2019) on common beans and Tantawy et al. (2019a) on barely under different newly reclaimed soils of Egypt.

Application of bio fertilizer mixtures (B1 and B2) significantly increased seed yield peanut as compared with un-inoculated plants (B0). With the same treatments of organic fertilizers, seed yield of peanut plants treated with B2 was higher than that found with B1. The superior effect of B2 may also be cleared from the higher corresponding RC (%) values. For example, the average yield of peanut seeds of different organic fertilizers increased from 1225 kg fed^{-1} in the B0 treatment to 1410 and 1627 kg fed^{-1} in the treatments of B1 and B2, respectively. In thisrespect similar results were obtained byEl-Noamany (2013), Ghaly et al. (2018) and Marie (2019).

Shelling percentage of peanut crop is considered an important parameter of its yield quality. Data in Table 4 showed the effect of the studied treatments on shelling percentage of peanut grown on sandy soil. All fertilization treatments resulted in clear significant increase in shelling percentage, where their relative change values were positive. Organic fertilization by different sources individually or in combination with bio fertilizer mixtures resulted in a significant increase in shelling percentage compared with the control treatment. The highest shelling percentage and its relative changes were found with the plants fertilized by ECT compared with other used organic manures. Increase in peanut yield and quality is due to improved soil physical and chemical properties and enhanced soil biological activities such as, soil enzymes and activity and increased microbial biomass as a result of organic fertilizers application (Lin et al*.,* 2010 and Abd El-Halim et al., 2016). Abdel-Salam (2019) and Hammouda et al. (2019) found that application of bio- and organic fertilizers increased the seed weight percentage of total yield of peanut.

TABLE 3. Straw and pod yield of peanut kg fed^{-1} and their relative changes as affected by bio- and organic fertilizers

Treatments		Straw yield		Pods yield	
Biofertilizer	Organic	kg fed^{-1}	RC (%)	kg fed-1	RC (%)
B0	O0	1526.9m	--	1000.3h	--
	FYM	1796.0j	14.98	1769.1efg	43.46
	SPC	1958.8i	22.05	1968.7cdefg	49.19
	FYM+ ECT	2120.8h	28.00	2077.1bcdef	51.84
	ECT	2554.2e	40.22	2319.8 bcd	56.88
B1	O0	1643.0l	--	1520.0g	--
	FYM	1973.3i	16.74	1906.5defg	20.27
	SPC	2338.4g	29.74	2025.0cdef	24.94
	FYM+ ECT	2597.3d	36.74	2183.4bcdef	30.39
	ECT	2906.1b	43.46	2503.8ab	39.29
B2	O0	1688.9k	--	1731.8fg	--
	FYM	2121.0h	20.37	2006.6cdef	13.70
	SPC	2434.7f	30.63	2213.1bcde	21.75
	FYM+ ECT	2683.4c	37.06	2393.0bc	27.63
	ECT	3016.5a	44.01	2923.4a	40.76
Average Biofertilizer	B0	1991.3c	--	1827.0c	--
	B1	2291.6b	15.08	2027.7b	10.99
	B2	2388.9a	19.97	2253.6a	23.35
Average organic	O0	1619.6e	--	1417.4d	--
	FYM	1963.4d	21.22	1894.1c	33.63
	SPC	2244.0c	38.55	2069.0bc	45.97
	FYM+ ECT	2467.1b	52.32	2217.9b	56.48
	ECT	2825.6a	74.45	2582.3a	82.19

TABLE 4. Seed yield kg fed^{-1} and shelling percentage of peanut and their relative changes as affected by bio- and organic fertilizers

Treatments		Seed yield		Shelling percentage	
Biofertilizer	Organic	kg fed^{-1}	RC (%)	%	RC (%)
B0	O0	318.40l	--	33.05g	--
	FYM	963.04ij	66.94	56.14def	41.13
	SPC	1346.72fg	76.36	68.94abcde	52.06
	FYM+ ECT	1560.32de	79.59	78.18ab	57.73
	ECT	1938.08bc	83.57	84.73a	60.99
B1	O0	725.44k	--	47.70fg	--
	FYM	1138.56hi	36.28	59.91cdef	20.38
	SPC	1419.84ef	48.91	71.60abcd	33.38
	FYM+ ECT	1666.80d	56.48	78.46ab	39.20
	ECT	2103.44b	65.51	84.92a	43.83
B2	O0	902.24j	--	51.99ef	--
	FYM	1241.84gh	27.35	63.17bcdef	17.70
	SPC	1597.60d	43.53	74.28abc	30.01
	FYM+ ECT	1907.60c	52.70	79.68ab	34.75
	ECT	2487.92a	63.74	85.34a	39.08
Average Biofertilizer	B0	1225.31c	--	64.21b	--
	B1	1410.82b	15.14	68.52a	6.71
	B2	1627.44a	32.82	70.89a	10.40
Average organic	O0	648.69e	--	44.25d	--
	FYM	1114.48d	71.80	59.74c	35.01
	SPC	1454.72c	124.26	71.61b	61.83
	FYM+ ECT	1711.57b	163.85	78.77ab	78.01
	ECT	2176.48a	235.52	85.00a	92.09

Inoculation of peanut plants by B1 and B2 individually and in combination with organic fertilizers resulted in significant increases in shelling percentage. With the same treatment of organic fertilization, shelling percentage of peanut plants fertilized by B2 was higher than the treatment associated with the treatment of B1. This trend is in harmony with the effect of these fertilizers on plant growth and seeds yield. The enhanced effect of bio fertilization on the seeds yield of peanut plants was pointed by Abdel-Wahab et al. (2006) and Abdel-Salam (2019). These resulted may be cleared from RCB (%), where RCB of shelling percentage in the plants fertilized by B2 were higher than those found in the plants fertilized by B1 with their individual application as well as in their combined applications with organic fertilizers. Increase in peanut yield and its components as a result of bio-fertilizer application may be attributed to increase in N availability via biological fixation. Nitrogen plays important roles in plant such as increasing photosynthesis rate, vegetative growth and subsequently yield and quality of peanut plants Moreover, N-fixation reduces the soil pH and thus indirectly increase availability of macro- and micro-nutrients. Awadalla and Abbas (2017) and El-Akhdaret al. (2018) obtained similar results.

Nutrient content

Data in Tables 5 and 6 showed N, P and K concentration (%) and uptake kg fed^{-1} of peanut plants. There was significant response in both nutrient concentration and uptake of straw and seeds of peanut plant to the studied treatments. Application of different types organic fertilizers significantly, increased nutrient concentration and uptake compared the control treatment however, their effect varied widely from type to another. The maximum increase in nutrient content uptake and resulted from the treatment of ECT while the lowest was resulted from the FYM treatment. For example, adding ECT increased the nitrogen uptake from 14.96 and 11.75 kg fed^{-1} in the control treatment to 32.18 and 89.93 kg fed^{-1} by peanut straw and seeds respectively, in the un-inoculated plants. Peanut content of P and K followed similar trends. According to

straw and seeds content of N, P and K the added organic fertilizers write followed the descending order of ECT > FYM+ECT > SPC > FYM. Organic fertilizers application to soil improved soil physical and chemical properties, increased availability of essential macro- and micro-nutrients and hence increased nutrients uptake by peanut. These results are in the harmony with the effect of these organic fertilizers on soil fertility (Mahmoud, 2017 and Bekele et al., 2019) as well as their effect on plant growth (Emam, 2018 and Abou- Hussien et al., 2019).

In addition, biofertilization with the, respectively two different sources *i.e.,* "B_1" *i.e. A.braselinse+B.megatherium +A.chroococcum* and "B_2" *i.e.* consist of *Bradyrhizobium. sp+ S.marcescens+P.fluorescens* resulted in significant increases in nutrient in both shoots and seeds concentrations (%) and their corresponding uptake values (kg fed^{-1}), as cleared from corresponding positive RC (%) values. In both straw and seeds of peanut plants nutrient content (%) and uptake (kg fed^{-1}) in the plants fertilized by B_2 were higher than the corresponding fertilized with the treatment B_1. Effect of added bio-fertilizer mixtures on nutrients uptake from RC of nutrient uptake by shoots and seeds as a result of B_1 and B_2 applications. For example, the average content of N, P and K of increased from 1.12, 0.22 and 0.65% in the control treatment to 1.25, 0.31 and 0.46% with B1 application and to 1.33, 0.34 and 0.787 % with B2 application. Increase in nutrient concentration as a result of bio-fertilizer application may be due to the role of bi-fertilizers in increasing available nitrogen and production of plant growth stimulants which improve cell division, root length, root biomass, plant growth and consequently nutrient absorption (Ravikumaret al. 2004; Zaki et al., 2017 and El-Naqme et al., 2019). Similar significant effects of bio-fertilizers application on nutrient content of different plants was reported by Singh et al. (2009); Abdel-Salam (2019) and Marie (2019).

Oil and protein content

Crude protein content (%) in the seeds of peanut plants presented in Fig. 1 in relation with different fertilization treatments of bio and organic fertilizers seemed to follow an almost similar pattern to that mentioned with the seeds content of N. For example, crude protein content (%) in the seeds of peanut plants received the treatment of ECT increased from 23.06% in the control treatment to 29.00 % in the uninoculated plants. Crude protein content was maximum in the treatment of ECT in both inoculated and uninoculated plants. Similar trend was observed with the oil content of peanut seeds. El-Kramany et al. (2007), Mahrous et al. (2015) and Hammad (2019) obtained similar results.

Data in Fig. 2 show peanut seeds content (%) of oil as affected by individual and combined applications of bio and organic fertilizers under sandy soil conditions. These data show significant increases duo to these fertilization treatments on oil content of seeds of peanut under study. Therefore, all RC values of oil content in relation with the studied treatments were positive. Individual applications of organic fertilizers increased the seeds content of oil from 40.76 % in the control treatment to 41.38, 41.96, 42.11 and 42.40 % with RCO values of 1.50, 2.94, 3.21 and 3.87 % with the treatments of FYM, SPC, FYM+ECT and ECT respectively. The increases in the seeds content of oil resulted from the added fertilizers effect on enzymes activities and other biochemical reaction within different plant tissues (Badole et al. 2001 and 2004; Mahrous, 2015). Also, biofertilization by B_1 *i.e. A.braselinse+B. megatherium+A.chroococcum* and B_2 *i.e. Bradyrhizobium. sp+ S.marcescens+P.fluorescens* increased the seeds content of oil from 41.72 % in the control treatment to 45.38 and 46.99 %, respectively. Application of bio- and organic fertilizers resulted in improved soil chemical, physical and biological properties as well as enhanced plant growth and nutrients uptake which finally reflected positively on peanut content of oil and protein. These results indicated that combined application of bio- and organic fertilizers increased both yield and quality of peanut plants grown on sandy soils. These results are in harmony with those obtained by Awadalla, and Abbas (2017) and Zaki et al. (2017).

Conclusion

In conclusion, the obtained results emphasized that organic fertilizers application increased sandy soil productivity of peanut as well as quality of produced yield. Incorporation of bio-fertilizers along with bio-fertilizers resulted in superior increase in peanut yield and quality parameters. These results emphasized the hypotheses of this study that integrated fertilization approach can be used as an alternative approach for increasing productivity while sustaining environment and maintaining soil health.

TABLE 5. Nutrient concentration (%) and uptake kg fed^{-1} of peanut straw and their relative changes as affected by bio- and organic fertilizers

Treatments		N			P			K		
Biofertilizer	Organic	Conc. (%)	Uptake kg fed^{-1}	RC (%)	Conc. (%)	Uptake kg fed^{-1}	RC (%)	Conc. (%)	Uptake kg fed^{-1}	RC (%)
B0	O0	0.98g	14.96k	--	0.2g	3.05k	--	0.57g	8.70i	--
	FYM	1.08fg	19.40ij	22.89	0.21fg	3.77jk	19.10	0.6g	10.78ghi	19.29
	SPC	1.11efg	21.74ghi	31.19	0.22fg	4.31ijk	29.23	0.66defg	12.93fgh	32.71
	FYM+ ECT	1.17def	24.81fg	39.70	0.23f	4.88hij	37.50	0.69defg	14.63f	40.53
	ECT	1.26abcd	32.18cd	53.51	0.24f	6.13fgh	50.24	0.74cde	18.90cd	53.97
B1	O0	1.08fg	17.74jk	--	0.26e	4.27ijk	--	0.62fg	10.19hi	--
	FYM	1.19cdef	23.48gh	24.45	0.31de	6.12fg	30.23	0.67cdefg	13.22fg	22.92
	SPC	1.24bcde	29.00de	38.83	0.32cde	7.48de	42.91	0.73cdef	17.07de	40.30
	FYM+ ECT	1.34 ab	34.80bc	49.02	0.33abc	8.57cd	50.18	0.78bc	20.26c	49.70
	ECT	1.39a	40.39a	56.08	0.35ab	10.17ab	58.01	0.9 a	26.15b	61.03
B2	O0	1.26abcd	21.28hi	--	0.31de	5.24ghi	--	0.64efg	10.81ghi	--
	FYM	1.29abcd	27.36ef	22.22	0.32bcd	6.79ef	22.83	0.68cdefg	14.42ef	25.03
	SPC	1.33abc	32.38cd	34.28	0.34bc	8.28cd	36.71	0.76 cd	18.50cd	41.57
	FYM+ ECT	1.35ab	36.23b	41.26	0.35ab	9.39bc	44.20	0.86 ab	23.08b	53.16
	ECT	1.4 a	42.23a	49.61	0.37a	11.16a	53.05	0.96a	28.96a	62.67
Average Biofertilizer	B0	1.12b	22.62b	--	0.22b	4.43c	--	0.65b	13.19c	--
	B1	1.25ab	29.08a	28.56	0.31a	7.32b	65.24	0.74a	17.38b	31.77
	B2	1.33a	31.9a	41.03	0.34a	8.17a	84.42	0.78a	19.15a	45.19
Average organic	O0	1.11d	17.99e	--	0.26c	4.19e	--	0.61d	9.90e	--
	FYM	1.19cd	23.41d	30.13	0.28b	5.56d	32.70	0.65cd	12.81d	29.39
	SPC	1.23bc	27.71c	54.03	0.29b	6.69c	59.67	0.72bc	16.17c	63.33
	FYM+ ECT	1.29ab	31.95b	77.60	0.3a	7.61b	81.62	0.78b	19.32b	95.15
	ECT	1.35a	38.27a	112.73	0.32a	9.15a	118.38	0.87a	24.67a	149.19

TABLE 6. Nutrient Concentration (%) and uptake kg fed-1 of peanut seeds and their relative changes as affected by bio- and organic fertilizers

Treatments		N			P			K		
Biofertilizer	Organic	Conc. (%)	Uptake kg fed^{-1}	RC (%)	Conc. (%)	Uptake kg fed^{-1}	RC (%)	Conc. (%)	Uptake kg fed^{-1}	RC (%)
B0	O0	3.69c	11.75j	--	0.2g	0.64i	0.00	1.5g	4.78k	--
	FYM	3.92bc	37.75 hi	68.87	0.23fg	2.21h	71.04	1.56g	15.02ij	68.18
	SPC	4.53ab	61.01efg	80.74	0.24fg	3.23fgh	80.19	1.59f	21.41h	77.67
	FYM+ ECT	4.62a	72.09de	83.70	0.26f	4.06ef	84.24	1.68e	26.21fg	81.76
	ECT	4.64a	89.93bc	86.93	0.27f	5.23d	87.76	1.73de	33.53cd	85.74
B1	O0	3.70c	26.84i	--	0.31e	2.25h	0.00	1.72e	12.48j	--
	FYM	4.29abc	48.84gh	45.05	0.33de	3.76efg	40.16	1.75cde	19.92h	37.35
	SPC	4.67a	66.31def	59.52	0.35cde	4.97d	54.73	1.81bc	25.70g	51.44
	FYM+ ECT	4.71a	78.51cd	65.81	0.38abc	6.33c	64.45	1.82bc	30.34de	58.87
	ECT	4.82a	101.39b	73.53	0.4ab	8.41b	73.25	1.86ab	39.12b	68.10
B2	O0	3.80c	34.29i	--	0.33de	2.98gh	0.00	1.75cde	15.79i	--
	FYM	4.31abc	53.52fg	35.93	0.37bcd	4.59de	35.08	1.8bcd	22.35h	29.35
	SPC	4.77a	76.21d	55.01	0.39bc	6.23c	52.17	1.82bc	29.08ef	45.70
	FYM+ ECT	4.81a	91.76bc	62.63	0.41ab	7.82b	61.89	1.85ab	35.29c	55.26
	ECT	4.90a	121.91a	71.87	0.44a	10.95a	72.79	1.91a	47.52a	66.77
Average Biofertilizer	B0	4.28a	54.5c	--	0.24b	3.07c	--	1.61c	20.19c	--
	B1	4.44a	64.38b	18.13	0.35a	5.14b	67.43	1.79b	25.51b	26.35
	B2	4.52a	75.54a	38.61	0.39s	6.51a	112.05	1.83a	30.01a	48.64
Average organic	O0	3.73c	24.29e	--	0.28c	1.96e	--	1.66d	11.02e	--
	FYM	4.17b	46.70d	92.26	0.31b	3.52d	79.59	1.70c	19.10d	73.32
	SPC	4.66a	67.84c	179.29	0.33b	4.81c	145.41	1.74bc	25.40c	130.49
	FYM+ ECT	4.71a	80.79b	232.61	0.35a	6.07b	209.69	1.78b	30.61b	177.77
	ECT	4.79a	104.41a	329.85	0.37a	8.20a	318.37	1.83a	40.06a	263.52

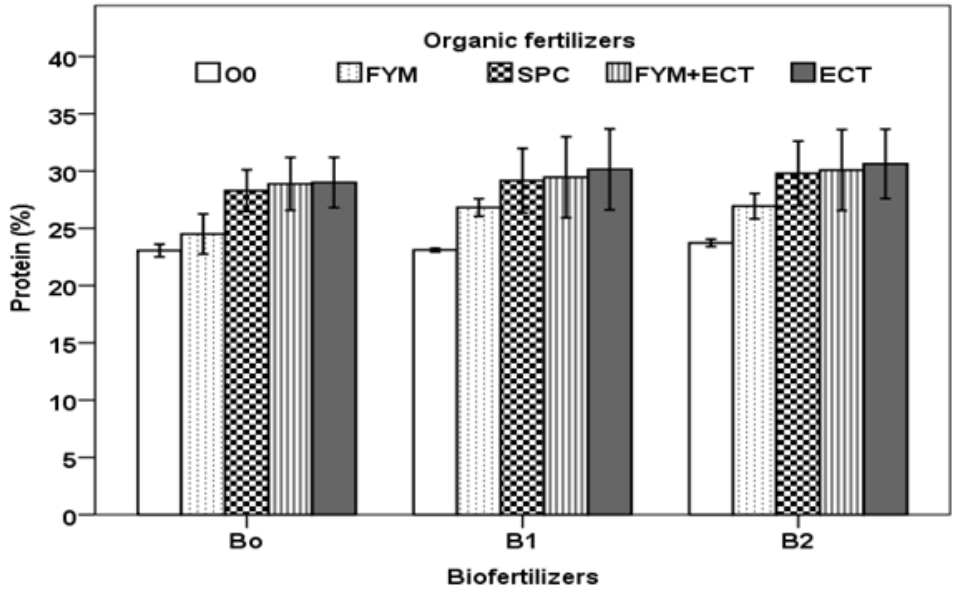

Fig.1. Crude protein content (%) of peanut seeds as affected by bio- and organic fertilizers

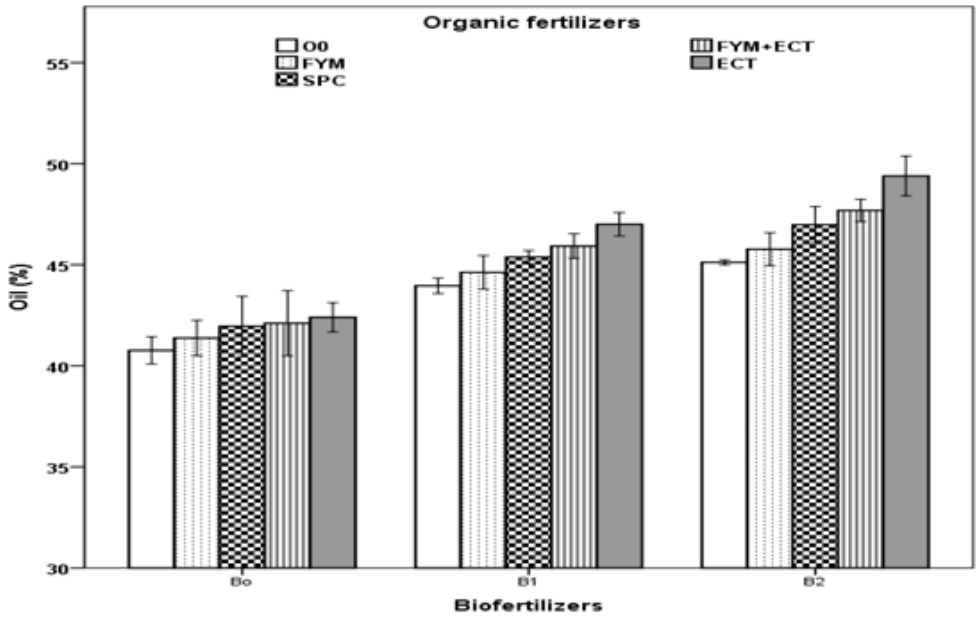

Fig. 2. Oil content (%) of peanut seeds as affected by bio- and organic fertilizers

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