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Response of peanut to replacement part of mineral fertilizers by drinking water purification residuals and organic fertilizers.

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Intensive farming practices, that warrant high yield and quality, require the extensive use of chemical fertilizers, which are costly and create environmental problems. Therefore, more recently there has been a resurgence of interest in environmental friendly, sustainable and organic agricultural practices. Bio fertilizers have some microorganisms which convert elements to available nutrient for plant's roots. There is no doubt that the trend to rationalize the use of chemical fertilizers, with the expansion of the use of safe alternatives, such as drinking water purification residuals which called rouba within a good system known as clean agriculture or within organic farming programs. Because of its advantages that contribute to improve productivity, quality and producing safe crop, in addition to preserve the environment. Two field experiments were conducted in 2015 and 2016 seasons. The objectives of this research were to study the role of fertilizers (mineral, organic and bio) and/or drinking water purification residuals on growth and some chemical parameters of peanut (*Arachis hypogaea* L.) plants grown in sandy soil. Each experiment included eight treatments: T_1 (Control; 100% NPK mineral fertilizer [60kg N, 45kg P_2O and 50kg K_2O per faddan] added as soil application). T_2 (Bio fertilizer with *Bacillus magisterium*, as phosphate dissolving bacterium, *Bacillus cerulean*, as potassium realizing bacterium and *Bacillus polymerase*, as a N_2 fixing bacterium were applied as seed inoculation and soil application, at rate 400g /faddan). T_3 (Compost, added as soil application at rat 12 ton/faddan). T_4 (Rouba wastes; the residues of drinking water purification), as rate 20 m^3/faddan).T_5 (50% NPK mineral fertilizer+biofertilizer).T_6 (50% NPK mineral fertilizer+compost).T_7 (50% NPK mineral fertilizer+rouba).T_8 (50% NPK mineral fertilizer+biofertilizer+compost+rouba).A randomized complete blocks design with three replications was used. The results indicated that T_8 induced superior plant in most of the growth and chemical characteristics (No. of pod/plant, pod yield/plant, seed yield/plant, shelling percentage, weight of 100 seed, total pod yield, total seed yield, oil and protein percentage of the seed) of the peanut.Therefore, we can use T_8 (50% NPK mineral fertilizer+biofertilizer+compost+rouba) as a safe alternatives and cheap in agricultural practices for its advantages that contribute to improve productivity, quality and producing safe crop, in addition to preserve the environment

Keywords: Peanut, *Arachis hypogaea* L., Rouba, Drinking water purification residuals.

INTRODUCTION

Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. It is well known fact that increased dependence on agro chemicals including fertilizers has led to several ill effects on the environment and also results in decrease of soil fertility. Applications of organic manure play an important role on yield and its attributes as well as nutrient uptake and directly increase the soil physical condition. It lowers soil bulk density, Increases water holding capacity, build up beneficial soil microbes, improve good soil structure and enhance stable soil aggregates (Doran, 1995 and Drinkwater et al., 1995). Use of biofertilizers and organic manure in agriculture is becoming popular nowadays for not only in order to reduce the cost of chemical fertilizers but also to decrease the adverse effects of chemical fertilizers on soil and plant environment and to ensure more crop productivity (Verma, 1995). In many situations combination of organic and inorganic fertilizers have produced higher yields than alone (Blackshaw, 2005). Peanut is one of the most important annual crops in the world growing on for peanut butter, direct consumption and edible oil. Peanut seeds have high nutritive value for human consumption and for cake production as well as the green leaf is used ashy for livestock (Abdalla et al., 2009). The cultivated area of peanut in Egypt during 2014 season was about 165000 fad^{-1} (FAO, 2015). Peanut can be grown successfully in newly reclaimed sandy soils, this approach matches with many researchers in this order (Shaban et al., 2009), which play an important role to improving quality and seed yield of peanut. El-kramany et al. (2007) stated that, using high rates of NPK chemical fertilizers increased seed and straw yield of peanut. Compost (assoil conditioner) and/or mineral fertilizers are mixed into water treatments residuals increased plant growth (Basta et al., 2000; Hyde and Morris, 2004 and Mahmoud and Elbaroudy, 2009). Drinking water treatment residual (water purification stations) increased growth of tomatoes (Xie and kurosawa, 2016). Dayton and Basta (2001), bold gourds (Kakuta et al., 2003) and strawberries (Ohta et al., 2011). New reclaimed areas in Egypt are mostly sand soil and usually deficient in organic matter and poor in plant nutrients (Abdel-Wahab et al., 2003). Due to the intensive farming, Egypt is known as a heavy consumer of chemical fertilizers. The coincident application of organic manures is frequently recommended firstly for improving biological, physical and chemical properties of soil and secondary to get high and clean agricultural yield produced free from undesirable high doses of heavy metals and other pollutants. NPK from organic sources can be used as sole source or as a substitute for inorganic fertilizers (Citation). Integrated action of both chemical and organic fertilizers increased the yield of groundnuts (Subrahmaniayn et al., 2000). The composting process significantly changes the physiochemical properties (bulk density, pH, nitrogen, phosphorus ratio, total carbon, carbon: nitrogen ratio, total nitrogen content and plant available nitrogen) of organic wastes (Citation). Nitrogen mineralization is controlled by compost properties including organic carbon content, C: N, total nitrogen and plant available nitrogen, soil moisture, microbial activity, and soil texture (Eghball et al., 2002; Agehara and Warncke, 2005 and Cabrera et al., 2005). The application of organic amendments to soils has been shown to increase soil phosphorus content and plant available phosphorus (Eghball et al., 2004).

The objectives of this research were to study the role of fertilizers (mineral, organic and bio) and/or drinking water purification residuals on growth and some chemical parameters of peanut (*Arachis hypogaea* L.) plants grown in sandy soil.

MATERIALS AND METHODS

Two field experiments were conducted during the successive summer seasons of 2015 and 2016at private from in Wadi El-Natroon, El-Beheira Governorate, and Egypt. The mechanical and chemical analysis of the experimental soil was done according the method described by **Jackson (1973)** and is shown in Table (1).

Peanut (*Arachis hypogaea* L.) cv. Gerally seeds was sown on 28 April in the first season (2015) and 4 May in the second season (2016), then grown in rows under drip irrigation system with GR drippers, 30 cm between drippers and the distance between each his were 20 cm and 60 cm between Routs. Plants were thinned to one plant per hill. Each plot included four rows, 10 meter per each; the plot size was 2.4 m × 10 m.

The experimental treatments were conducted as follows:

T_1: (Control; 100% NPK mineral fertilizer [60kg N, 45kg P_2O and 50kg K_2O per faddan] added as soil application).

T_2: (Biofertilizers with *Bacillus magisterium*, as phosphate dissolving bacterium, *Bacillus cerulean*, as potassium realizing bacterium and *Bacillus polymerase*, as a N_2 fixing bacterium were applied as seed inoculation and soil application, at rate 400g /faddan).

T_3: (Compost, added as soil application at rat 12 ton/faddan).
T_4 :(Rouba wastes; the residues of drinking water purification), as rate 20 m^3/faddan).
T_5: (50% NPK mineral fertilizer+biofertilizer).
T_6: (50% NPK mineral fertilizer+compost).
T_7: (50% NPK mineral fertilizer+rouba).
T_8: (50%NPK mineral fertilizer + biofertilizer + compost + rouba).

Compost was obtained from Al-Sadat factory, 10th of Ramadan city, Egypt. The main chemical and biological properties are shown in Table (2). Compost and rouba were applied as soil application during soil preparation before planting. The main properties of rouba are shown in Table (3).The NPK fertilizers were added in the slow realize fertilizer from 20/15/15 NPK, as a soil application before planting. Strain of bacteria was kindly obtained from Dep. of Agriculture Microbial, Agriculture Research Center, Giza.

At harvesting (150 days after sowing) samples of ten guarded plants were taken from each plot to measure the following characters: pod number/plant, pod weight/plant, seed weight/plant, shelling percentage and weight of 100 seed. Whole plants in each plot (24m^2) were harvested to determine pod and seed yields/plot (kg/faddan) then it was converted to faddan to determine weight of pod and seed yields (ton/faddan).

Table (1): Physical and chemical properties of the experimental soil during 2015 and 2016 seasons.

Analysis	1st season (2015)	2nd season (2016)
Physical analysis:		
Sand	85.9	86.3
Silt	12.2	12.1
Clay	1.9	1.6
Texture	Sandy	Sandy
Chemical analysis:		
Total nitrogen(mg/kg)	58	50
Phosphorus(ppm)	9	6
Potassium(ppm)	155	168
Calcium (ppm)	1457	1622
Magnesium (ppm)	98	112
Manganese (ppm)	41	10
Sulfur (ppm)	12	24
Boron (ppm)	1.11	1.11
Copper (ppm)	1.0	1.0
Iron (ppm)	33	82
Molybdenum(ppm)	0.04	0.02
Zinc (ppm)	1.8	1.8
pH	8.7	8.7
EC (mmhos)	1.25	1.2
Sodium (ppm)	73	32
Total $CaCo_3$ (%)	<1	4.0
Organic matter (%)	0.8	1.3

Chemical analysis

Soil, rouba and compost properties were determined according to (Piper, 1950 and Peg et al., 1982).The seed cured protein percentage and oil percentage in seed was determined according to (AOAC, 2000).

Statistical analysis

All data were subjected to statically analysis by the technique of analysis of variance of the randomized complete block design with three replications. The least significant difference (LSD) test at probability level of 5% was used to determine the statistical differences between means when the F value was significant (Steel et al., 1997).

Table (2): The physical and chemical analysis of the compost used in 2015 and 2016 seasons.

Characterization	1st season (2015)	2nd season (2016)
Bulk density (kg/m^3)	601	614
Moisture content (%)	23	24
pH	8.59	8.74
EC (dS·m^{-1})	5.5	5.6
Organic matter (%)	33.96	34.2
Ash	78	76
Total nitrogen (%)	1.14	1.11
Ammonium nitrogen (ppm)	47	42
Nitrate nitrogen(ppm)	-	-
C/N ratio	1:18	1:18
Total phosphorus (%)	0.58	0.59
Total potassium (%)	1.11	1.09
Nematode (warm)	Nile	Nile
Weed (seed)	Nile	Nile
Total E-Coli	Nile	Nile

Table (3): Analysis of rouba (drinking water residues purification) in 2015 and 2016 seasons.

Analysis	Seasons		Maximum limit
	2015	**2016**	
Color materials (%)	Nil	Nil	No color
Sold materials(mg/L)	1180	1175	1200
pH	7.3	7.4	8:6
NH_3 (mg/L)	0.19	0.18	0.5
NO_3 (mg /L)	25	29	30
Fe (mg/L)	0.196	0.188	No more 1.0
Zn (mg/L)	0.79	0.85	No more 1.0
Mn (mg/L)	0.16	0.20	No more0.5
Cl (mg/L)	0.39	0.32	1.0
Pb (mg/m^3)	Nil	Nil	No more 300
Cd(mg/m^3)	Nil	Nil	No more 20
Ni (mg/m^3)	Nil	Nil	No more 90
Cr (mg/m^3)	Nil	Nil	No more 400

RESULTS AND DISCUSSION

Results in Table (4) revealed that the No. of pod/plant in both seasons (2015 and 2016). T_8 show the most effective treatment in increasing the No. of pod/plant with a significant effect ($p \leq 0.05$) as compared to all treatments except T_7 in season 2015. Meanwhile, in season 2016 there was a significant effect ($p \leq 0.05$) between T_8 as compared to all treatments except T_1 and T_7 (Table 1). T_8 increased pod yield/plant in both seasons (2015 and 2016), with a significant effect ($p \leq 0.05$) as compared to T_2 and T_3 and non-significant effect as compared to T_1, T_4, T_5, T_6 and T_7 in season 2015. While, in seasons 2016, T_8 increased significantly ($p \leq 0.05$) as compared to T_2, T_3, T_5 and T_6 and without significant effect as compared to T_1 and T_4 (Table 1). The increasing in pod yield /plant may be due to the gradually increasing in number of pod/ plant. T_8 increased the seed yield/plant in both seasons (2015 and 2016). Meanwhile in season 2015 there was a significant effect ($p \leq 0.05$) between T_8 as compared to T_2, T_3 and T_4 (Table 1). Also, T_6induced no significant effect ($p \leq 0.05$) as compared to T_1, T_5, T_6 and T_7. But in season 2016, there was a significant effect ($p \leq 0.05$) between T_8 as compared to all treatments except with T_7 (Table 1).These results in general are in agreement with those obtained by Basta et al., 2000; Mahmoud and Elbroudy, 2009; Hyde and Morris, 2004 and Xie and Kurosawa, 2016.

The results in Table (5) reported that, T_8 increased the chelling percentage in both seasons (2015 and 2016). Also, in season 2015 there was a significant effect ($p \leq 0.05$) between T_8 as compared to T_2, T_3, T_4 and T_5 and non-significant effect as compared to T_1, T_6 and T_7 (Table 5). Meanwhile, in season 2016 there was no significant effect between T_8 as compared with all treatments (Table 5). The increase in shelling percentage may be attributed to the considerable increase in number of pods, pod and seed yields/plant in both seasons. T_6 increased 100 seed weight in season 2015 (Table 5). However there was a significant effect ($p \leq 0.05$) of T_6 as compared to T_2 and T_3 and a non-significant effect ($p \leq 0.05$) as compared with T_1, T_4, T_5 and T_8 (Table 5). T_8 increased 100 seed weight in season 2016 (Table 5), with a significant effect ($p \leq 0.05$) as compared to all treatments except T_1 and T_7 (Table 5). Increasing 100-seed weight was generally associated with increased shelling percentage. These results are in general accordance with those obtained by Mahrous et al., 2015; Xie and Kurosawa, 2016; Kakuta et al., 2003 and Ohta et al., 2011.

The results in Table (6) showed that, T_8 increased total pod yield in both seasons (2015 and 2016). T_8 showed a significant effect ($p \leq 0.05$) as compared with all treatments except T_1 and T_7 in both season (2015 and 2016). Such increase may be due to the increase in number and yield of pods/plant, as well as, weight of 100 seed. The results in Table (6) showed that, T_8 increased seed yield in both seasons (2015 and 2016). T_8 induced a significant effect ($p \leq 0.05$) as compared with all treatments except T_1, T_6 and T_7 in both seasons (2015 and 2016). These results are in harmony with those recorded by Basta et al., 2000; Kakuat et al., 2003; Hyde and Morris, 2004; Mahmoud and Elbroudy, 2009 and Xie and Kurosawa, 2016. Increasing the availability and supplying of nutrients or to its indirect effects by modifying soil physical properties that can improve the root environment, increase plant uptake of nutrients and consequently stimulate plant growth. The results are in agreement with those obtained by Eghball et al., 2004; Agehara and Warncke, 2005; Cabrera et al., 2005 and Mahrous et al., 2015.

The results in Table (7) showed that, T8 in season 2015 increased significantly ($p \leq 0.05$) the seed oil percentage as compared with all treatments except T_1 and T_7. But in seasons 2016, T_7 increased the seed oil percentage significantly ($p \leq 0.05$) as compared with all treatments except with T_1, T_6 and T_8 (Table 6).

The results in Table (7) showed that, T_8 in season 2015 increased significantly ($p \leq 0.05$) the seed protein percentage as compared with all treatments except with T_5, T_6 and T_7. But in seasons 2016, T_7 has a non-significant effect ($p \leq 0.05$) with all treatments except with T_2 (Table 6).These results in general agreed with those obtained by Hyde and Morris, 2004; Mahmoud and Elbaroudy, 2009 and Xie et al., 2015; Mahrous et al., 2015 and Xie and Kurosawa, 2016, who found that, using compost and/or mineral fertilizer increase plant growth and quality.

Table (4): Effect of different treatments on number of pod/plant, pod yield/plant (g) and seed yield/plant (g) of peanut, in 2015 and 2016 seasons.

Treatments	No. of pod/plant		Pod yield/plant (g)		Seed yield/plant (g)	
	2015	2016	2015	2016	2015	2016
T_1	38.33	54.48	60.97	98.92	30.77	72.60
T_2	29.53	38.6	55.65	68.31	23.82	66.32
T_3	32.28	42.28	55.95	75.37	27.97	68.80
T_4	35.00	44.25	60.00	99.30	27.86	73.35
T_5	34.75	47.38	63.15	81.65	28.77	71.25
T_6	36.35	50.45	62.33	86.58	29.95	72.57
T_7	41.53	56.03	61.82	91.85	32.32	76.17
T_8	43.50	61.48	63.82	101.52	33.15	78.13
$LSD_{5\%}$	**2.67**	**9.09**	**3.74**	**4.48**	**2.48**	**4.72**

Table (5): Effect of different treatments on shelling percentage and weight of 100 seed (g) in 2015 and 2016 seasons.

Treatment	Shelling (%)		Weight of 100 seed (g)	
	2015	2016	2015	2016
T_1	69.25	70.6	58.58	82.6
T_2	64.65	71.35	53.15	71.65
T_3	67.68	72.05	53.45	73.85
T_4	68.10	72.00	57.50	78.32
T_5	68.33	72.10	56.95	76.45
T_6	69.15	72.10	59.83	77.97
T_7	69.85	72.73	58.68	83.50
T_8	70.35	73.52	58.73	83.60
$LSD_{5\%}$	**3.16**	**3.01**	**3.52**	**4.77**

Table 6.Effect of different treatments on pod yield (ton/ fad) and seed yield (ton/fad) of peanut in 2015 and 2016 seasons.

Treatments	Pod yield (ton fad^{-1})		Seed yield(ton fad^{-1})	
	2015	2016	2015	2016
T_1	2.47	2.49	1.71	1.81
T_2	2.10	1.98	1.37	1.39
T_3	2.21	2.15	1.5	1.53
T_4	2.31	2.32	1.57	1.67
T_5	2.34	2.22	1.60	1.64
T_6	2.37	2.44	1.68	1.76
T_7	2.48	2.54	1.64	1.85
T_8	2.60	2.61	1.83	1.92
$LSD_{5\%}$	**0.18**	**0.13**	**0.21**	**0.17**

Table 7.Effect of different treatments on oil and protein percentage of peanut seedin 2015 and 2016 seasons.

Treatments	Seed oil (%)		Seed protein (%)	
	2015	2016	2015	2016
T_1	49.97	47.25	25.63	23.83
T_2	41.36	40.67	24.53	23.18
T_3	43.65	43.48	24.43	23.48
T_4	44.88	44.96	25.38	23.86
T_5	45.18	44.60	26.13	23.50
T_6	48.05	45.70	26.21	23.80
T_7	50.8	47.33	26.21	24.35
T_8	51.96	46.50	26.83	24.17
$LSD_{5\%}$	**3.60**	**2.23**	**0.86**	**0.71**

CONCLUSION

The results indicated that T_8 induced superior plant in most of the growth and chemical characteristics (No. of pod/plant, pod yield/plant, seed yield/plant, shelling percentage, weight of 100 seed, total pod yield, total seed yield, oil and protein percentage of seed) of the peanut plants. Therefore, we can use T_8 (50% NPK mineral fertilizer+biofertilizer+compost+rouba) as a safe alternatives and cheap in agricultural practices for its advantages that contribute to improve productivity, quality and producing safe crop, in addition to preserve the environment.

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

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