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IMPROVING PEANUT PRODUCTIVITY IN SANDY SOIL BY USING DRINKING WATER PURIFICATION RESIDUALS AND P, K NATURAL ROCK WITH BIO FERTILIZERS

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Abstract

Peanut (*Arachis hypogaea* L.) One of the most important leguminous crops is due to the high nutritive value of its seeds while rich in protein (up to 30%) and oil% from 38 to50%. Recently has been a resurgence of interest in environmental friendly, sustainable and organic agricultural practices. Two field experiments were layout in provide farm at Orabi Association Farm, Ismailia high way, Egypt during the two season (2017-2018) using bio fertilizer which have some microorganisms had the ability to convert elements to available nutrient for plant's roots. Adding the drinking water purification residual (DWPR or Rouba) as a source for Bio-organic natural (some elements, microorganisms...etc.).In combination with or without natural mineral rocks as a source for natural forms of elements (P and K). The study included 8 fertilizer treatments, (T_1)full dose of mineral N P K fertilizer (T_2) rouba at 20m^3 fad^{-1}, (T_3) rouba 30 m^3 fad^{-1}, (T_4) rouba 20m^3 fed^{-1} + NR, (T_5) rouba 30m^3 fed^{-1}+ NR, (T_6) natural rock (NR)+ bio fertilizer, (T_7) rouba 20m^3 fed^{-1} + NR + bio fert. and (T_8) rouba 30 m^3 fed^{-1} + NR+ (bio fert.) were treated under sandy soil conditions. The obtained result clearly indicated that the experimental side have a few number of nodules formed on roots of peanut plants and application of various fertilizer treatments have a positive effect on nodules formed and led to scored significant increases between them. Application of bio fertilizers, NR in combination with rouba gave higher values for the most of growth and yield parameters tested. The results revealed that the treatment which received rouba at 30m^3 fed^{-1} +NR in combination with bio fertilizers had a superior plant in the growth and chemical characteristics (number of nodules, plant dry weight, N Percentage and plant-N content) as well as yield parameters yield of pod g $plant^{-1}$ & ton fed^{-1}, seed yield g $plant^{-1}$& ton fed^{-1}, seed index, shelling% and oil and protein content (%). Application of the fertilizer treatment which received rouba 30m^3+ NR + bio fertilizer as a safe, finally environment and cheap in agricultural practices for advantage that contribute to improve productivity quality and producing safe crop in addition to pressure the environment.

Keywords: Peanut, drinking water purification residuals, rouba, bio-fertilizers, natural rocks.

Introduction

Concerning the gradual increases in climatic changes risks. The better use of the natural resource base less use of agrochemical and efficient water has become increasingly important goals of sustainable agriculture. Peanut (*Arachis hypogaea* L.) can play an important part in increasing edible oil production in Egypt. Its seeds are not only rich in oil (42-52%) but also in protein (25-32%) and 18% carbohydrate. Peanut seed have high nutritive value for human consuming as well as the green leaf is used a shy for livestock Abdalla *et al*. (2009) and FAO October (2015).

Application of organic and bio fertilizer are frequently recommended for improving biological, physical and chemical properties of soil as well as plant nutrition's. Elkarmany *et al*. (2007) have shown that combining organic fertilizers with bio-fertilizers and 25 % from recommended dose of mineral N,P and K fertilizers resulted in the highest pod and seed yield of peanut crop as well as oil and protein content(%) in poor sandy soils. Sulfab *et al*. (2011) reported that either organic fertilizers alone or with bio – fertilizers plus 20kg N ha^{-1} significantly increased peanut modulation and yield and yield components significantly as compared to control treatment. Mahrous *et al*. (2015) found that application of organic fertilizer in combination for peanut crops under conditions of sandy saline soil and the drip irrigation system.

Drinking water treatment processes that are used to produce safe drinking water generate a wide variety of residual products depending on the untreated water source, chemical used for purification and types of unit operations used Ippolito *et al*. (2011).

Drinking water purification residuals (DWPR) and the local name in Egypt rouba. It effective in sandy and pollution soil as well as had a positive effect on build up soil fertility Zhao yuan *et al*. (2017) and Tay Yiyuan *et al*. (2017). Mahmoud and El Baroudy (2009) study the effect of using organic fertilizer in combination with rouba on heavy metals immobilization in contaminated soils and plant growth of canola as oil crop and found that the interaction between organic fertilizers and rouba had been successfully used to lower the bio availability and increase the agrochemical stability of the pb, Cd, Zn in the contaminated soil and increasing yield and yield complimented of canola plants. Mahrous *et al*. (2018) a reported that the application of rouba in combination with both organic and/or bio fertilizers induce superior peanut plant in the most of the growth and chemical characteristics *i.e.* number of pod $plant^{-1}$, pod yield g $plant^{-1}$, seed yield g $plant^{-1}$, shelling percentage, weight of 100 seed, total pod yield ton fed^{-1}, total seed yield ton fed^{-1} and oil and protein percentage (%) of seed. Application of the naturally deposited materials (natural mineral rock) instead of chemical fertilizer will be very beneficial for the formers compared to natural mineral rocks Clark and Ball, (2000). Mariam Sabry, (2014) reported that application of organic fertilizers in combination and bio-fertilizers with Natural mineral rock *i.e.* feldspars and rock phosphate gave a positive effect on both soil fertility and increase plant growth and yield parameters of sunflower (seed yield ton fed^{-1} and oil percentage %).

The aim of this work was to study the response of peanut plants to applied rouba (DWPR) in combination with bio-fertilizers and with or without natural rocks under sandy soil conditions.

Materials and Methods

Two field experiments were carried out in Orabi association farm, Ismailia high way, Egypt during the two summer seasons (2017 & 2018). Analysis of chemical and physical soil properties of soil samples were found in table (1) according to Jakson (1973).

Table 1 : Some Physical and chemical properties of the experimental soil during 2017 and 2018 seasons:

Physical Analysis		
Analysis	**Season 1**	**Season 2**
Cross Sand	34.1	32.1
Fine Sand	43.6	44.7
Silt	12.5	13.3
Clay	9.8	9.9
Texture	sand	Sand
Chemical Analysis		
Analysis	**Season 1**	**Season 2**
PH	8.0	7.9
E.C	1.02	0.77
Nitrogen total (mg/kg)	666	735
Phosphorus (ppm)	21	27
Potassium (ppm)	444	401
Calcium (ppm)	4035	4609
Magnesium (ppm)	722	570
Boron (ppm)	1.64	1.76
Sodium (ppm)	196	151
$CaCO_3$ total %	1.0	1.0
Manganese (ppm)	123	173
Copper (ppm)	6.6	6.9
Zinc (ppm)	5.7	6.5
Iron (ppm)	179	145
Molybdenum (ppm)	0.64	0.56
Sulphur (ppm)	89	113

Seed peanut variety gerally (NC) were kindly obtained from agronomy department of faculty of agriculture, Cairo University. Peanut were cultivated on 30th May and 18th May for first and second seasons, respectively.

Fertilizers:

(A) Bio-fertilizers:

(A.1) Rhizobia inoculation:

The seed of peanut inoculated with *Bredyrhizobium sp* as symbiotic N_2- fixing bacteria to form root nodule and fix atmospheric nitrogen at rate of 400g/ 40 kg seed.

(A.2) Three types of association bacteria namely *Bacillus megastrium* (BM) as phosphate dissolving bacterium, *Bacillus cerculance* (BC) as potassium reducing bacteria and *Bacillus Polymaxa* (Bp) as N_2- a symbiotic N-fixing bacteria, were applied as seed coating inoculation (at rat of 4g/100g seed) and /or soil inoculation method (at rate 400g fed^{-1}). These bacteria were kindly obtained from department of agricultural microbiology, Soil, Water and Environmental Research Instate (SWERI), Agricultural Research Center (ARC), Giza, Egypt.

(B) Drinking water purification residual (DWPR) or rouba :

It was obtained from island El-Dahb station of drinking water purification, Giza government, Egypt. Rouba was added at two rates 20 m^3 and 30 m^3 fed^{-1} during preparation of soil before planting. The main chemical and biological properties one shown in table (2).

Table 2 : Analysis of rouba (drinking water treatment residues) in 2017and 2018 seasons.

Analysis	**Seasons**		**Maximum limit**
	first	**Second**	
Color materials (%)	Nil	Nil	No color
Sold materials (Mg/L)	1175	1170	1200
pH	7.4	7.3	8:6
P %	0.18	0.17	
N (total %)	0.35	0,34	
NH_3 (mg/L)	0.18	0.19	0.5
NO_3 (mg /L)	29	25	30
Ca %	2.612	2.713	

K (mg/L)	0.35	0.32	
Mg (mg/l)	0.08	0.09	
Na %	0.24	0.23	
Cu (mg/l)	4.8	5.1	
Fe (mg /L)	0.188	0.193	No more 1
Zn (mg /L)	0.85	0.86	No more 1
Mn (mg /L)	0.20	0.09	No more 0.5
Cl (mg /L)	0.32	0.34	No more 1
Co	Nil	Nil	No more 400
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

Seed of peanut were grown in rows under drip irrigation system with GR dripper 30 cm between dripper and the distance were 20 cm and 60cm between routs. Plants were third to one plant per hill. The plot size was (2.5 ×2.5=6.25 m^2) and (2×2.5=5 m^2) for season one and season two respectively. With 8 treatments at 3 replication were conducted as follows:

T_1: control, 100% NPK mineral fertilizer (60 kg N, 45 kg P_2O and 50 kg K_2O). (NPK)

T_2: rouba (the drinking water purification residuals), as rate 20 m^3/fed. (DWPR1)

T_3: rouba (the drinking water purification residuals), as rate 30m^3/fed. (DWPR2)

T_4: rouba, (the drinking water purification residuals) as rate 20 m^3/fad + natural rocks were mixed with phosphate rock and feldspar as rock potassium. (DWPR1+NR)

T_5: rouba, (the drinking water purification residuals) as rate 30 m^3/fad + natural rocks (DWPR2+ NR)

T_6: Natural mineral rocks + bio fertilizer with *Bacillus megastrium* (BM) as phosphate dissolving bacterium, *Bacillus cerculance* (BC) as potassium dissolving bacterium and *Bacillus polymexa* (BP) as N_2 fixing bacterium were applied as seed inoculation and soil application, at rate 400 g/ Fadden (NR + bio fert.)

T_7: rouba, as rate 20 m^3/fad+ natural rocks+ bio fertilizer (DWPR1+NR + bio fert.)

T_8: rouba, as rate 30 m^3/fad + natural rocks+ biological fertilization. (DWPR2+ NR + bio fert.)

Characters studied

I. Vegetative growth stage the planting the samples of soil and plant were taken at 60 Days After Planting(DAP) to determining:
   1. Number of bacteria nodule per plant (no.$plant^{-1}$)
   2. Shoot plant dry weight (gm. $plant^{-1}$)
   3. Plant nutrients up take N%, P %and K %

II. Harvest stage (150 days after planting) the samples of ten guarded plants were taken from each plot to measure the characters follow according to A.OC.A (2004) :

1. Pod yield /(g) plant
2. Seed yield (g) /plant
3. Seed index (weight 100 pod .g)
4. Shelling%
5. Pod yield (ton/Fadden)
6. Seed yield (ton/Fadden)
7. Seed protein %
8. Seed oil %
9. Nitrogen %, potassium % and phosphate % of soil at harvest.
10. Nitrogen %, potassium % and phosphate % of soil at ADP.

Statistical analysis:

The data were subjected to statically analysis by the technique of analysis of variance of the randomized complete block design with 3 replication by MASTAT program. The least significant difference (LSD) test at probability level of 5% was used to determine the statistical between means accorded to Freed *et al*. (1989).

Results and Discussion

Effect of Varietal Differences:

The results in table (3) showed that, there were differences between the tested fertilizers treatments in the all studied parameters in peanut plants in respect to number of nodules the obtained data indicated that the experimental side have a few number of nodules per plants application of various fertilizer treatments led to scored higher values and recorded significant differences and the treatment which received rouba (30m^3 fed^{-1}), NR and bio-fertilizers gave the highest value of nodule number up to 74 nodule $plant^{-1}$. On the other hand, season two recorded higher values as compared to their values obtained at season one. For plant dry weight (g $plant^{-1}$) application of different fertilizers treatments resulting significant differences as compared to treatment which received fell does of mineral N,P and K fertilizers the treatments treated with Rouba (20 and 30 m^3), NR in combination with bio-fertilizers led to give higher values and recorded significant increases as compared to other tested treatments and the highest values was 25.23g $plant^{-1}$ and 29.76g $plant^{-1}$ at treatment which received rouba 30 m^3, NR and bio-fertilizers in the season one and season two respectively. Plant N percentage (%) and plant N content the results were found in table (3) revealed that application of different fertilizers treatments did affect and gave significant increases as compared to N, P and K mineral fertilizers treatment in both season one and season two and the highest values were found at the treatments which fertilized by rouba (20 and 30m^3) and NR in combination with bio-fertilizers and plant N content values were 555.1

and 686.5 mg plant^{-1} at season one and season two respectively. The data are in agreement with (EL-habbasha *et al*. (2005), Abdalla *et al.* (2009), Sulfab *et al*. (2011), Sujanya and Chandra (2011) and Mahrous *et al*. (2018) who reported that application of organic and bio fertilizer had a positive effect on nodulation number and dry weight and vegetative growth of peanut plants dry weight as well as plant N content. They added using drinking water purification residuals (DWPR-Rouba) had a stimulated effect on plant dry weight and plant mineral uptake.

Data presented in table (4) Plant phosphors and potassium content (%) clearly revealed that application of different natural bio-fertilizer treatments recorded higher values, and significant increases as compared to mineral fertilized treatment, alone and these values were (0.20 and 0.30%) and (0.40and 0.42%) for phosphorus at season one and season two at N,P and K mineral fertilizers and rouba, NR in combination with bio-fertilizers, respectively and the crossholding values for potassium were (0.70 and 1.17%) and (1.70 and 1.79%) in the same order. These data are in an agreement with Desoky *et al*. (2011) and Nasralla *et al*., (1998) who found that application bio organic fertilizers values of chemical composition of peanut in newly reclaimed sand soil.

Data presented in table (5) reveled that pod yield (g plant^{-1}), seed yield (g plant^{-1}) and shelling percentage(%) were affected by application the different fertilizer treatments, full dose of mineral N, P and K fertilizers recorded higher values for pod and seed yield (g plant^{-1}) as well as shelling % and these values were 58.23 , 38.38 and 66.08 for pod yield g plant^{-1}, seed yield g plant^{-1} and shelling % at season one and the crossholding values at season two were 74.48, 51.24 and 68.79 in the same order. Application of rouba, NR in combination with bio-fertilizers gave highest values and scored significant increases as compared to other tested treatments, and these values were (62.95 and 120.26), (45.53 and 94.45) and (72.30 and 78.53) for pod and seed yield (g plant^{-1}) and shelling % at season one and season two respectively.

Data presented in table (6) clearly showed that fertilizer treatments significantly increased the studied parameters (pod yield and seed yield ton fed^{-1}, oil seed percentage (%) and seed protein percentage (%)). Moreover, the data also indicated that the effect of rouba at rate 30m^3 + NR in combination with bio fertilizers was more pronounced than other tested fertilizers treatments and recorded the highest values among the all tested fertilizer treatments and these values were pod yield ton fed^{-1} (2.70 and 3.27) , seed yield ton fed^{-1} (1.93 and 2.12), seed oil (%) (48.76 And 49.30) and, seed Protein (%) (23.90 and 24.90) for season one and season two respectively. These results are in harmony with those obtained by Xie and Kurasawia (2015), Mahrous *et al*. (2015) and Mahrous *et al*. (2018) who observed positive response of peanut plants to fertilizer with different levels of Rouba in combination with bio-fertilizers and gave significantly increases in all yield parameters of peanut plants tested i.e. pod and seed yield ton fed^{-1}, shelling% as well as oil and protein content (%).

Application of various fertilizer treatments led to recorded the higher values of N, P and K % of soil content at 60 day after planting (60 DAP) and harvest time as shown at table (7). In respect to N and P% in soil, the treatments which received rouba (20 and 30 m^3), NR in combination with bio fertilizers led to scored higher values as compared to the treatments which received N, P and K mineral fertilizers as such and in the absent of applied the bio-fertilizers. At potassium (%) application of full dose of mineral N, P and K fertilizers gave the higher values of K% as compared to other fertilizer season two were superior as compared to these obtained at season one. In this respect this data are in agreement with Das and Singh, (2014) and Mansour *et al*. (2011) were reported that application of rouba and /or natural rock (NR) with different fertilizer treatments (organic and bio-fertilizers) in combination with mineral fertilizers led to scored higher values of soil N, P and K (%) content.

Table 3 : Number of nodules, plant dry weight, nitrogen percentage and plant N content of peanut plants as affect by application of various fertilizers treatments at 60 DAP

Parameters / Treatments	Number of nodules (no plant^{-1})		Plant dry weight (g plant^{-1})		Nitrogen (%)		Plant N-content (mg plant^{-1})	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	6.0	4.0	19.18	20.21	1.9	1.8	364.4	363.8
T_2	17.0	17.0	15.20	27.92	2.1	2.0	319.2	558.4
T_3	16.0	17.0	17.43	30.67	2.5	2.0	435.8	613.4
T_4	15.0	18.0	20.77	28.32	1.9	2.1	394.6	594.7
T_5	15.0	17.0	20.33	26.20	2.1	2.6	426.9	681.2
T_6	62.0	61.0	22.95	26.91	2.3	2.1	527.9	565.1
T_7	68.0	72.0	21.35	26.41	2.1	2.4	448.4	633.8
T_8	70.0	74.0	25.23	29.76	2.2	2.3	555.1	686.5
LSD	4.75	5.22	2.11	3.35	0.11	0.17	63.17	78.55

Table 4 : Phosphorous and potassium peanut plants content (%) as affect by application of various fertilizers treatments at 60 DAP.

Parameters / Treatments	Phosphorus content (%)		Plant potassium content (%)	
	S_1	S_2	S_1	S_2
T_1	0.20	0.30	0.70	1.17
T_2	0.16	0.21	0.80	1.26
T_3	0.18	0.22	0.90	1.32
T_4	0.21	0.27	1.10	1.36
T_5	0.22	0.28	1.20	1.36
T_6	0.29	0.36	1.20	1.43
T_7	0.30	0.38	1.70	1.76
T_8	0.40	0.42	1.70	1.76
LSD	0.12	0.08	0.22	0.16

Table 5 : Pod yield, seed yield (g plant^{-1}) and shelling % of peanut plants as affected by application of various fertilizers treatments

Parameters / Treatments	Pod yield (g plant^{-1})		Seed yield (g plant^{-1})		Shelling (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
T_1	58.23	74.48	38.48	51.24	66.08	68.79
T_2	58.02	67.22	37.84	49.20	65.22	73.51
T_3	54.90	65.91	35.77	48.47	65.15	73.54
T_4	59.35	78.02	41.57	59.15	70.03	75.81
T_5	60.45	110.01	41.76	82.16	69.08	74.68
T_6	60.32	96.91	43.41	60.69	71.95	72.94
T_7	61.79	119.54	44.65	93.43	72.24	78.15
T_8	62.95	120.26	45.53	94.45	72.30	78.53
LSD	1.20	3.09	1.38	1.21	3.37	1.49

Table 6 : Pod and seed yield (ton fed^{-1}), seed oil % and protein % of peanut plants as affected by application of various fertilizers treatments

Parameters / Treatments	Pod yield (ton fed^{-1})		Seed yield (ton fed^{-1})		Seed oil (%)		Seed protein (%)	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	2.20	2.63	1.86	1.88	47.15	48.30	23.10	24.12
T_2	2.12	2.36	1.63	1.72	48.60	49.10	24.20	22.11
T_3	2.45	3.00	1.72	1.94	48.80	48.90	22.80	23.10
T_4	2.30	2.68	1.77	1.99	47.27	48.50	23.10	24.11
T_5	2.42	2.74	1.80	2.07	47.30	48.90	24.10	23.19
T_6	2.11	2.34	1.68	1.83	46.85	47.11	23.10	24.10
T_7	2.59	3.26	1.89	2.05	48.50	49.20	24.10	24.19
T_8	2.70	3.27	1.93	2.12	48.76	49.30	23.90	24.9
LSD	0.29	0.35	0.06	0.36	n.s	n.s	0.11	0.13

Table 7 : Soil N, P and K content as affected by application various fertilizers treatments for peanut plants at 60 day after planting and harvest

Parameters / Treatments	Nitrogen %				Phosphorus%				Potassium %			
	At 60 DAP		Harvest		At 60DAP		Harvest		At 60 DPA		Harvest	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	0.07	0.06	0.08	0.08	0.078	0.88	0.026	0.122	0.060	0.050	0.065	0.065
T_2	0.06	0.05	0.07	0.06	0.104	0.096	0.104	0.132	0.060	0.070	0.040	0.045
T_3	0.05	0.06	0.065	0.05	0.103	0.089	0.130	0.165	0.045	0.655	0.040	0.055
T_4	0.07	0.06	0.06	0.09	0.052	0.066	0.146	0.158	0.020	0.060	0.020	0.045
T_5	0.08	0.07	0.06	0.07	0.026	0.045	0.078	0.056	0.020	0.033	0.060	0.060
T_6	0.08	0.09	0.07	0.07	0.078	0.102	0.052	0.066	0.040	0.046	0.060	0.060
T_7	0.08	0.08	0.07	0.06	0.156	0.140	0.086	0.120	0.060	0.065	0.060	0.060
T_8	0.08	0.08	0.07	0.08	0.108	0.125	0.130	0.125	0.060	0.060	0.040	0.053

Conclusion

Conclusion from the previous results, it is concluded that the treatment which received rouba at 30 m^3 fed^{-1} and material mineral rocks(NR), in combination with bio fertilizers gave the highest values of the all tested parameters of peanut plants under conditions of sandy soil and the drip system as compared to other fertilizers treatments tested.

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