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EFFECT OF BIO-FERTILIZATION AND SOIL THERMAL PROPERTIES ON AVAILABILITY OF SOME NUTRIENTS FROM NATURAL DEPOSITS FROM PEANUT

Amal E. Ahmed* and M.H. Zaky**
*Soil Fertility and Microbiology Department.
**Soil Chemical and Physical Department.
Desert Research Center, Mataraiya, Cairo, Egypt.
***E-mail - monaelshazly2011@gmail.com**

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ABSTRACT

A field experiments was conducted at El-Khattara sandy soil (the northern fringe of El-Sharkia Governorate) to evaluate the effect of soil thermal properties and bio fertilizers on availability of some nutrients from shale as natural sediments for peanut plants. Biofertilization treatments were mixture of *Azotobacter chroococcum, Bacillus megatherium* and *Bacillus circulans*. The results revealed that the yield parameters of peanut increase with increasing shale applied and bio-fertilizers application. The superior treatment in this study was Shale at 20ton/fed with bio-fertilizers which achieved 4.68, 2.76, and 3.76 ton/fed for Hay, Seeds and Pods respectively. The increasing shale addition resulted in increasing soil heat capacity, heat content, soil bulk density and available moisture by 9.7, 11.87, 3.7 and 14.5% respectively. While, biofertilization treatments resulted in increase the antecedent properties for the last same sequence by 7.8, 7.74, 1.8 and 1.26%. Mean time the superiority increase was achieved by interaction and the values of percent increasing 17.4, 19.7, 6.2 and 16.35% respectively. Increase heat capacity and heat content increase availability of NPK by 46, 69 and 26% respectively. Microbial determinations were positively affected by shale concentration and biofertilizer application. Obtained data showed that,shale and biofertilizer application stimulated microbial communities at peanut rhizosphere. Also, enzymatic activities were increased in response to different treatments. We can concluded that, shale concentration 20 ton/fed improved heat capacity and heat content, improved peanut growth, yield, stimulate microbial community and enzymatic activity .

INTRODUCTION:

Loamy Sand soil are low in heat capacity, fertility levels and water holding capacity leading to frequent application of heat, nutrients and water to meet crop requirements **Abdullah.et al (2016)**. One of the best ways to improve these properties and prevent nutrient losses is to improve soil quality through application some natural amendments like shale.

Shale as a natural sediments had been used because of their applicability in supplying plants with heat, nutrients and water through its high content for each of them. Shale is low cost with positive charge attributed exchangeable cations (high CEC) such as Na^+, Ca^{2+}, K^+ and Mg^{2+}these cations are coordinated with the defined number of water molecules, and located on specific sites in framework channel.

Soil temperature is one of the important factors that influence soil properties processes involved in plant growth. It governs the soil physical, chemical and biological processes **(Buchas, 2001).**

Regard to bio fertilizer effect on yield components of peanut plant , **Mahrous et al.,(2015)** reported that the highest weight of yield components were resulted from 1/2 NPK + 12 ton compost + Bio fertilizer with Gregory cultivar. Finally, the data indicated that growing peanut in such newly reclaimed soil under balanced nutrition is profitable. **Zaki et al.,(2017)** decided that the best treatment for all characters of peanut under study was 10 ton/ fed., chicken manure+ Yeast + Azotobacter followed by 5 ton/ fed., chicken manure + Yeast + Azotobacter except oil percentage.

Soil heat is a fundamental physical property that influences the availability of nutrients from natural sources. **Yilvaiaio et al., (2012)** observed that water-soluble phosphorus increased with soil temperature from $50c^o$-$250c^o$ due to the increase in the movement of phosphorus in the soil controlled by diffusion. Soils with low temperature have low availability of phosphorus because the release of phosphorus from amendment is hindered by low temperature **Gahoonia et al., (2003).** Low soil temperatures reduce K availability and uptake rate by crops. The optimum soil temperature for K uptake for a crop such as corn is about 85ºF **LENN, (1998).**

Shale increase resulted in increase available moisture content in this context El**-Sersawy (1989) and magdy (1999)**, reported that increase shale increase soil heat capacity, bulk density and available moisture comparing to control.

Peanut is an oil seed crop with 40-50% oil contents. The remaining portion can be used as feed (30-50% proteins) **Shiri et al.,2012.**

Peanut (*Arachis hypogaea* L.) a member of of family Leguminosae is usually nodulated by rhizobia of.genus Bradyrhizobium as demonstrated by**Van Rossum et al.,(1995)** Rhizobia is a symbiotic bacteria that elicit on the roots of specific legume hosts the formation of new organs i.e. nodule, within which the bacteria proliferates, differentiate into bacteroids and subsequently fix the atmospheric nitrogen into ammonia.

Use of soil microorganisms which can either fix atmospheric nitrogen or solublize phosphate affect on plant growth through synthesis of growth promoting substances or by enhancing the decomposition of plant residues to release vital nutrients and increase humic content in soils and will be environmentally begin approach for nutrient management and ecosystem function **(Wu et al., 2005).** Phosphate solubilizing bacteria have the ability to increase the available phosphorous for plant through production of organic acids **(Mehana and Farag, 2000).** The microorganisms involved in P solubilisation can enhance plant growth by increasing the efficiency of biological nitrogen fixation, enhancing the availability of other trace elements and by production of plant growth promoting substances **(Gyaneshwar et al, 2002).** Therefore, the main objectives of this study is to investigate the effect of interaction between shale additions and biofertilizers on soil heat capacity, soil heat content, available moisture , soil bulk density and microbial activity

MATERIALS AND METHODS

A field experiment was carried out on summer peanut crop, in split design in which the main plot was represented by three application rates of shale, i.e.0, 10 and 20 ton/fed. Sub-main plots were represented by two levels of bio fertilizers with and without bio fertilizers (mixture from *Azotobacter chroococcum* as nitrogen fixer, *Bacillus megatherium* as phosphate solubilizers and *Bacills circulanus* as potassium solubilizers), Also, *Badyrhizobium japonicum* used as base treatments to enhance nodule formation, with three replicates for each treatment. Thus, the experimental design is as follow: (3 rates for shale) x 2(bio) x 3(replicates) =18 plots. After soil preparation, plots were divided into (5 lines/ plot) and sown by peanut (Giza 190.) after seeds soaked in liquid culture of rhizobium for about six hours, at (14 pits / line) at ^{20th} April 2018. Nitrogen as 80 kg/fed, P 40 kg/fed, and 70 kg/fed K were applied to soil peanut plants to approach the sufficient levels of nutrients for peanut crop, this applied one treatment for all microbiological treatments. Organic matter was incorporated into the surface soil layer of the loamy sand location during seedbed preparation. Phosphorus was added during seedbed preparation with all P added pre-planting. Nitrogen and potassium fertilizers were split into three equal doses that were applied every 15 days after sowing for the first and second doses, while the third was added after 50 days from sowing.

Measurements:

The soil heat capacity and content were measured using copper calorimeter method described by **Partington (1954).** Soil available moisture percent determined according to **Singh (1980).** Bulk density determined according to **Richard (1954).** Ca, Mg determined according to **Jackson (1973)**. Electrical conductivity determined using 4075Conductivity TDS meter described by **Jackson (1973)**. The pH values of soil solution were determined by 3010 pH meter According to **Black, et al., (1983).** The initial physical and chemical properties of soil and shale shown in table (1).

Table (1):- physical and chemical properties of soil and shale.

Characters	Sandy soil	Shale
Particle size distribution		
Sand%	84.6	24.35
Silt%	7.1	40.83
Clay%	8.3	34.82
Textural class	Loamy sand	clay Loam
Chemical properties		
CEC mg/100g soil	13.23	110.5
EC dS/m	2.9	17.6
pH	7.20	7.85
N ppm	0.42	220.5
P ppm	0.33	35
K+ ppm	0.51	1800
Ca++ meq/l	4.1	22.80
Mg++ meq/l	1.9	17.7

Biofertilizer preparation

Fresh liquid culture of *Badyrhizobium japonicum* used for seed inoculation *A. chroococcum, B.megaterium* ***and*** *Bacillus circulans* were used for soil inoculation as a mixture at the rate of . 10^8 colony forming unit (cfu)/ml

Microbial determinations

Soil samples from peanut rhizosphere were collected and analyzed for:

Total microbial counts on Bunt and Rovira medium according to **Nautiyal 1999** using the decimal plate method technique, For counting and growing phosphate dissolving bacteria using Bunt and Rovira medium after addition of 5 ml sterile solution of 10 % of K_2HPO_4 and of 10 ml of sterile solution of 10 % $CaCl_2$ to each 100 ml of the medium, *Azotobacter* on nitrogen deficient medium Ashbys medium **Abd El-Malek and Ishac,(1968)** used for Azotobacter densities. Soil samples were analyzed for determination of phosphatase activity disodium phenylphosphate served as enzyme substrate **(Õhlinger, 1996). Dehydrogenase activity** was determined according to method described by **(Casida *et al*.,1964). Nitrogenase activity** was determined according to **(Haahtela et al., 1981).**

RESULTS AND DISCUSSION

Effect of shale and bio fertilizers interaction on some soil physical properties:

Heat capacity:

Heat capacity defined as the amount of heat required to raise the temperature of a unit mass of soil by 1C^o (cal/g/C^o) and play a major role in availability of nutrients and increase available moisture and uptake by plant.

Table (2) and Fig (1) illustrate that heat capacity increase by 7.8, 9.7, and 17.4% for bio, shale and their interaction respectively. The values of both simple and multiple correlations were: r= 0.715**, r= 0.691* and R=0.994***, for bio fertilizer, shale and their inter action sequently. And the multiple regression is: $y= 0.154+ 0.013x_1+ 0.0007x_2$, where y, x1 and x2 are heat capacity, bio fertilizer and shale respectively. The aforementioned data of heat capacity declare that bio fertilizer has the main role in enhancing heat capacity where it increase by 0.013cal/g by using bio fertilizers while the minimum value of increasing (0.0007cal/g) achieved by increase shale additions.

Table (2) soil physical properties and NPK available affected by shale concentration and bio fertilizer.

Bio treatments	Shale ton/Fed.	Heat capacity cal/g	Bulk density	Heat content mcal/Fed	Available moisture%	N	P	K
Without biofertilizers	Zero	0.155	1.61	2325	1.59	116	10.2	221
	10	0.160	1.64	2416	1.71	129	10.9	239
	20	0.170	1.67	2601	1.82	141	12.2	245
With biofertilizers	Zero	0.167	1.62	2505	1.61	124	12.6	233
	10	0.174	1.68	2627	1.78	155	14.1	269
	20	0.182	1.71	2784	1.85	170	17.3	280
$LSD_{0.05}$ Bio-fertilizers		0.0006	0.0024	10	0.007	1.3	0.16	1.39
$LSD_{0.05}$ Shale		0.0007	0.0029	12	0.004	1.5	0.19	1.70
$LSD_{0.05}$ 2 factors		0.0010	0.0041	18	0.012	2.2	0.27	2.41

Heat content:

Heat content or Soil temperature is the function of soil heat capacity and heat flux in the soil as well as heat exchanges between the soil and atmosphere ***Elias et al.(2004)***. The data in table(2) point out that the inter action between shale and bio fertilizers has the majority effect on soil heat content followed by the solo treatment of shale and bio fertilizers (19.7, 11.87 and 7.7%) by the same sequence. Fig (1) show the solitary and combination effect of shale and bio where, the single and multiple correlations were, r= 0.759**, r= 0.641* and R= 0.993*** respectively for shale, bio and interaction and the multiple regression was, $y= 2308.5 +13.87x_1 + 191.35x_2$ where y, x_1 and x_2 are heat content, shale and bio respectively. The coefficient values of x_1 and x_2 assure that heat content increase by 1 cal/g for 13.87 unit of shale and 191.35 unit of bio fertilizers.

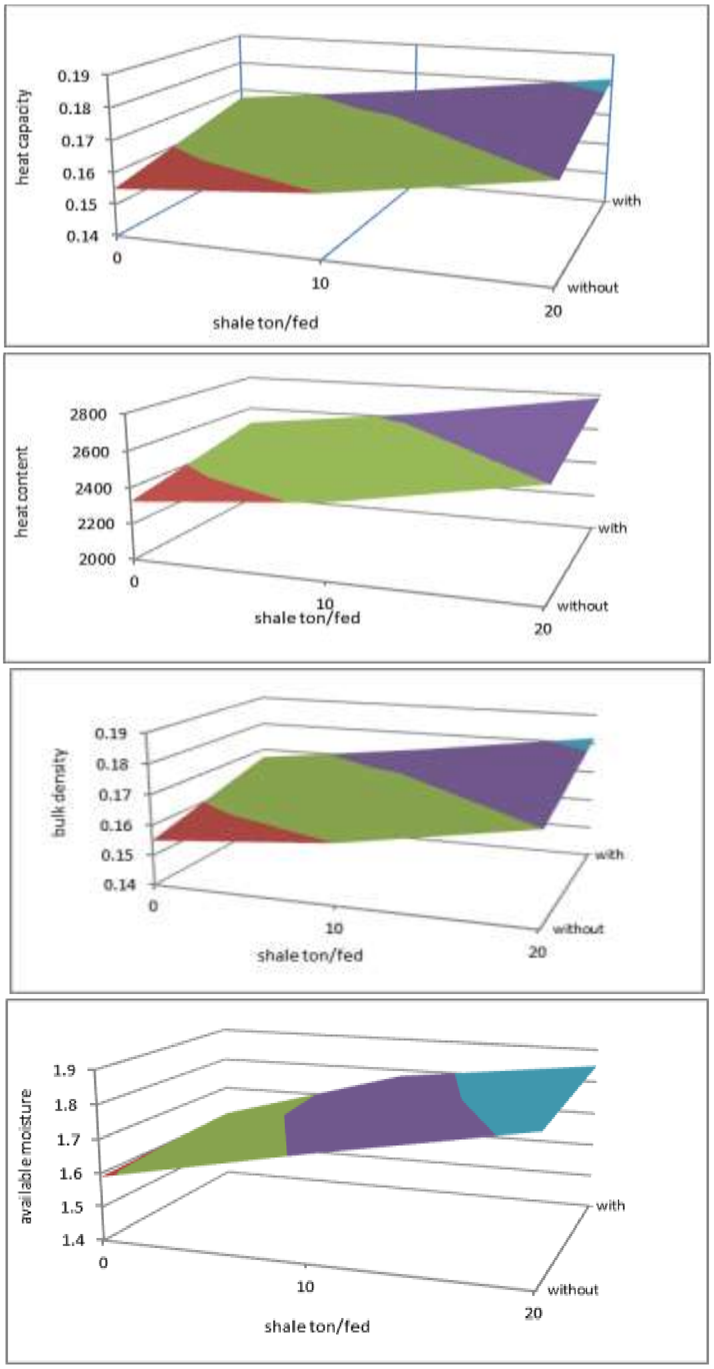


Fig (1) Soil heat capacity, content, bulk density and available moisture affected by shale and bio fertilizer

Bulk density:

High bulk density increases the soil surface by increases the amount of heat dissipated through the soil surface by increasing the rate at which heat energy passes through a unit cross-sectional area of the soil ***Nwankwo et al. (2012).*** Shale as a solitary treatment increase bulk density by 3.7% and out match bio fertilizers 1.8% meantime, the interaction is to surpass the tow single treatments which show 6.2% increase in soil bulk density table (2) and fig (1). Also, the simple and multibe correlation give the next order R= 0.973***, r= 0.824** and r= 0.428 NS for interaction, shale and bio respectively. And the multiple regression was $y= 1.6+ 0.004\ x_1 + 0.03x_2$. Where, y, x_1 and x_2 are bulk density, shale and bio. This mean that bulk density increased by 0.004 and 0.03g/cm^3 by increase shale and bio fertilizers, respectively.

Available moisture:

Moisture influences soil heat dissipation down the profile. The flow of heat is higher in a wet soil than in a dry soil where the pores are filled with air. The rate of heat dissipation increases with moisture content ***Ochsner et al.(2001)***.

Table (2) and fig (1) point out that available moisture increased by 16.35, 14.5 and 1.26% attributed the interaction, shale and bio, respectively. Meantime, the simple and multiple correlations were, R= 0.985***, r= 0.964*** and r=0.201NS for interaction, shale and bio, by the same sequent.

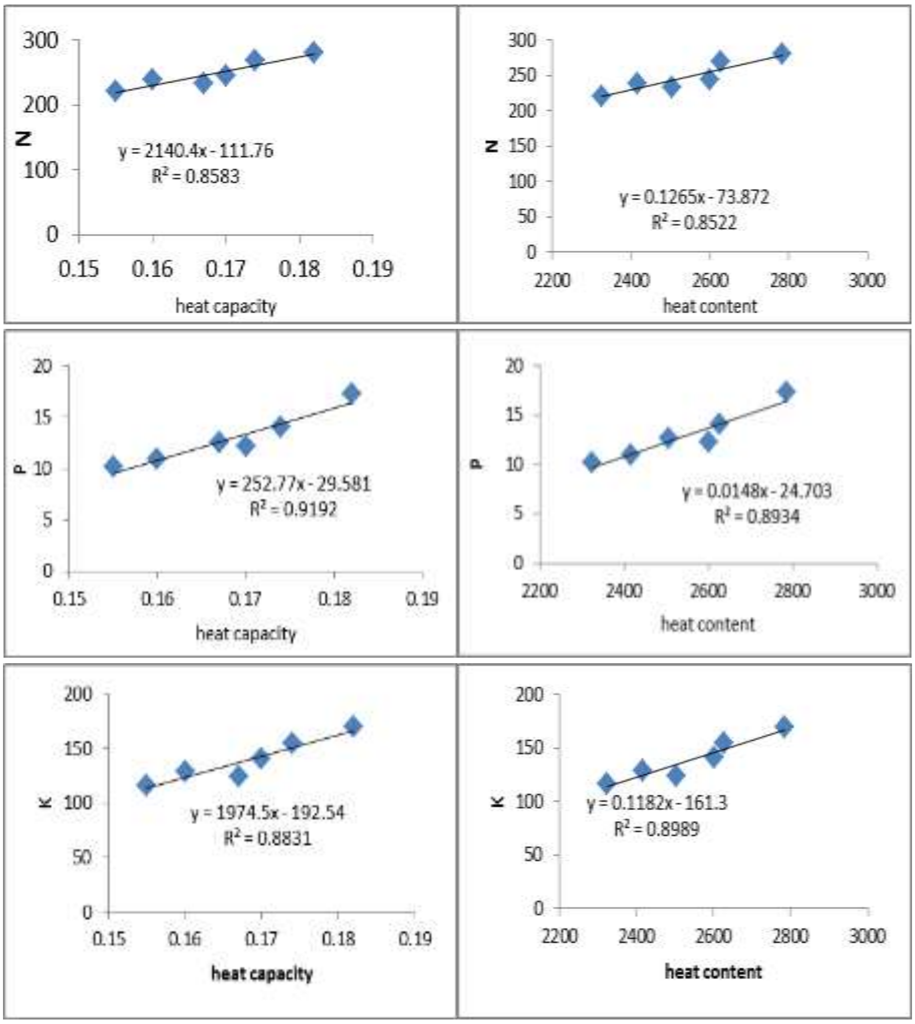
And the multiple regression of the interaction relation was $y= 1.58 + 0.01\ x_1 + 0.04x_2$ where y, x1 and x2 are available moisture, shale and bio, consecutively.

The coefficients of shale and bio declare that available moisture increased by 0.01 % for each of unit shale increasing while, it increased by 0.04 by using bio fertilizers.

NPK affected by soil thermal properties:

Shale concentrations and biofertilizers applications increase soil temperature as soil heat capacity and content which increased NPK available from shale through assist in release its from shale surface **LENN, (1998).Yilvaiaio et al., (2012).** The data shown in Table (2) reveal that available NPK increased by 46, 69 and 26% as to increase soil heat capacity and content. Also fig (2) showed the linear relation between soil thermal characters and NPK available where the values simple correlation were 0.926***, 0.958***, 0.939***, 0.923***, 0.944*** and 0.947*** for NPk with heat capacity and heat content respectively.

Generally, antecede table declare that increasing shale addition increase NPK available.



Fig(3) N,P and K affected by soil heat capacity and content.

Enzymatic activities: enzymatic activities of soil samples are critical index of soil fertility because enzymes play an important role in nutrient cycles **(Dick et. al., (1996),** data in Table (3) showed that the determination of enzymatic activity in rhizosphere area of peanut plants.

Dehydrogenase enzyme: Data in Table 3 showed the determination of enzymatic activities in rhizosphere of peanut. Dehydrogenase activity (DHA) represents the energy transfer, therefore, it is considered as an index of overall microbial activity in the soil. Represented data recorded that shale concentrations combined with biofertilizer application recorded highest values for DHA activity compared with control without biofertilization. This may be due to that *A.chroococcum*, *B.megatherium and B.circulans* played an important role as plant growth promoting rhizobacteria via N_2 fixation and phosphate solubilization (**El-Howeity et al.,2003 ,Muthukumar and Udaiyan2006).** This might led to accumulate available nutrients and stimulate the microorganisms in soil rhizosphere.

Nitrogenase activity: increased with biofertilizers application. The highest mean values for nitrogenase enzyme was recorded with the mixed biofertilization treatments and was decreased in control treatment without biofertilization. Many investigators demonstrated the positive effect of dual inoculation with N_2-fixer on N_2-ase activity **(El- Komy, 2005).**

Phosphatase enzyme

Presented data in Table (3) clearly showed that, phosphatase activity recorded significant increase with biofertilization treatments and shale concentrations. inoculation treatment with 20ton /fed shale recorded the highest phosphatase activity being (82.3 mg phenol/g soil/24h), biofertilization treatments increased phosphatase activity by 133.8% compared to control .

Phosphatase enzyme is able to mineralize organic phosphates into inorganic phosphates that provides high phosphate for plant (**George et al., 2002).**

Table 3. Effect of shale concentrations and mixed biofertilizers application on soil enzymatic activities in peanut rhizosphere.

Bioferilization treatments	Shale ton/Fed.	Dehydrogenase	Nitrogenase	Phosphatase
Without biofertilizers	Zero	0.48	0.08	35.2
	10	0.66	0.16	54.1
	20	0.75	0.63	68.4
With Biofertilizers	Zero	0.59	1.0	41.8
	10	0.81	1.29	70.4
	20	1.04	1.46	82.3 `
$LSD_{0.05}$ Bio-fertilizers		0.012	0.036	1.13
$LSD_{0.05}$ Shale		0.015	0.044	1.38
$LSD_{0.05}$ 2 factors		0.021	0.062	1.95

Effect of Bio-fertilization treatments and Shale on peanut production.

Represented data in Table (4) revealed that, effect of peanut yield components by biofertilizers application and shale concentrations where yield parameters of peanut increased with increasing shale applied and bio-fertilizers application.

The superior treatment in this study was Shale at 20 ton/fed with bio-fertilizers which achieved 4.68, 2.76, and 3.76 ton/fed for Hay, Seeds and Pods respectively. The above results agree with obtained results by **Mahrous et al.,(2015)** and **Zaki et al.,(2017)** .

Table (4). Effect of Bio-fertilizers and Shale on peanut production.

Bio	Shale	Hay	Seeds	Pods	Pods	Seeds
treatments	ton/Fed.	Ton/fed			No/plant	
Without Bio	Zero	1.61	0.39	0.89	24	34
	10	2.74	1.86	2.74	33	59
	20	3.95	2.28	3.32	43	79
With Bio	Zero	2.39	0.97	1.43	30	54
	10	3.84	2.21	3.25	43	80
	20	4.68	2.76	3.67	45	87
$LSD_{0.05}$ Bio-fertilizers		0.07	0.06	0.07	0.53	1.25
$LSD_{0.05}$ Shale		0.09	0.07	0.08	0.65	1.53
$LSD_{0.05}$ 2 factors		0.12	0.10	0.11	0.92	2.16

Microbial determinations

A- Total microbial counts: Initial total microbial counts before cultivation in experimental soil was 127×10^5 cfu/gm dry soil. Data in Table 5 showed that the counts tended to increase with all treatments refer to control. Total microbial counts proved an increase with biofertilizer application . Also, interaction treatment between *mixed biofertilization treatments and Shale 20* ton/fed. produced the highest total microbial counts as compared with other techniques and control being (215×10^5 cfu/gm dry soil). These results agreed with **Abd El-Gawad and S.A.Omar(2014).**

B- *Azotobacter* densities:Inoculation with heavy suspension of ***Azotobacter*** led to a rather pronounced increase in densities as recorded The promoting effect due to application of ***A. chroococcum*** not only due to the nitrogen fixation but also to the production of plant growth promoting substances, production of amino acids, organic acids, vitamins and antimicrobial substances as well which increase soil fertility, microbial community and plant growth (**Gupta *et al*.,2015).**

C- Phosphate Dissolving Bacterial counts(PDB) : the initial *PDB* counts in study area were 26×10^2 cfu/gm dry soil. Data recorded in Table 3 proved a marked increase in *PDB* counts in *mixed biofertilization treatments and Shale 20* ton/fed. The promoting effect due to the production of plant growth promoting substances as well which increase soil fertility , microbial communities and plant growth (**Yadav *et al*.,**

2007) These results are in agreement with those obtained by **(Ragab *et. al*., 2006)** and **(Ashrafuzzaman *et. al*., 2009)**, who reported that, inoculation with the plant growth promoting rhizobacteria (***Azotobacter, Azospirillum*, *Bacillus megatherium*, *Rhizobium***) had stimulation effect on the population of rhizosphere microorganisms by increasing their numbers by more than 50% from the initial.

Table (5) Microbial determination as affected by shale concentration and biofertilization.

Bio treatments	Shale ton/Fed.	Total microbial counts ($\times10^5$cfu/g dry soil)	*Azotobacter* densities ($\times10^3$cells/g dry soil)	*PDB* counts ($\times10^3$cellsdry soil)
Without bio	Zero	127	39	26
	10	162	52	49
	20	179	54	51
With bio	Zero	152	44	38
	10	195	86	64
	20	215	93	66
$LSD_{0.05}$ Bio-fertilizers		1.95	1.40	0.95
$LSD_{0.05}$ Shale		2.39	1.72	1.16
$LSD_{0.05}$ 2 factors		3.38	2.43	1.64

CONCLUSION:

Biofertilization treatments were mixture of *Azotobacter chroococcum, Bacillus megatherium* and *Bacillus circulans*. The yield parameters of peanut increase with increasing shale applied and bio-fertilizers application. The superior treatment in this study was Shale at 20ton/fed with bio-fertilizers which achieved 4.68, 2.76, and 3.76 ton/fed for Hay, Seeds and Pods respectively. The increasing shale addition resulted in increasing soil heat capacity, heat content, soil bulk density and available moisture by 9.7, 11.87, 3.7 and 14.5% respectively. While, add bio fertilizers resulted in increase the antecedent properties for the last same sequence by 7.8, 7.74, 1.8 and 1.26%. Mean time the superiority increase was achieved by interaction and the values of percent increasing 17.4, 19.7, 6.2 and 16.35% respectively. Increase heat capacity and heat content increase availability of NPK by 46, 69 and 26% respectively. Microbial determinations and soil enzymatic activity were also stimulated by biofertilization and shale concentrations. Thus, we can conclude that, biofertilizers applications and shale concentrations at 20ton/fed was recommended

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تأثير التسميد الحيوي وخصائص التربة الحرارية على تيسير بعض العناصر الغذائية في الرواسب الطبيعية لنبات الفول السوداني

امال السيد احمد* ، مجدى حسن زكي**

* قسم خصوبة وميكروبيولوجيا الاراضى ** قسم كيمياء وطبيعة الاراضى

مركز بحوث الصحراء

اجريت تجربة حقلية بتربة الخطارة الرملية (الطرف الشمالي لمحافظة الشرقية) لتقييم تأثير الخواص الحرارية للتربة والأسمدة الحيوية على توافر بعض العناصر الغذائية من الطفلة كرسوبيات طبيعية لنبات الفول السوداني. كانت معاملات التسميد الحيوي خليط من Azotobacter chroococcum وBacillus megatherium و Bacillus Circulans. أوضحت النتائج أن معاملات محصول الفول السوداني تزداد مع زيادة استخدام الطفلة واستخدام الأسمدة الحيوية.

كانت المعاملة المتفوقة في هذه الدراسة هي الطفلة عند 20 طن / فدان بالأسمدة الحيوية والتي حققت 4.68 و 2.76 و 3.76 طن / فدان للقش والبذور والقرون على التوالي. أدت زيادة إضافة الطفلة إلى زيادة السعة الحرارية للتربة والمحتوى الحراري والكثافة الظاهرية للتربة والرطوبة المتاحة بنسبة 9.7 و 11.87 و 3.7 و 14.5٪ على التوالي. بينما أدت معاملات التسميد الحيوي إلى زيادة الخصائص السابقة لنفس التسلسل الأخير بنسبة 7.8 و 7.74 و 1.8 و 1.26٪. متوسط الوقت تم تحقيق زيادة التفوق بالتفاعل وزادت قيم النسبة المئوية 17.4 و 19.7 و 6.2 و 16.35٪ على التوالي. تؤدي زيادة السعة الحرارية والمحتوى الحراري إلى زيادة توافر NPK بنسبة 46 و 69 و 26٪ على التوالي. تأثرت النتائج الميكروبية ايجابيا بتركيز الطفلة واستخدام السماد الحيوي. أظهرت البيانات التي تم الحصول عليها أن استخدام الطفلة والسماد الحيوي حفز المجتمعات الميكروبية في منطقة جذور الفول السوداني. كما تم زيادة الأنشطة الأنزيمية استجابة للعلاجات المختلفة. يمكننا أن نستنتج أن تركيز الطفلة 20 طن / فدان يحسن السعة الحرارية والمحتوى الحراري ، ويحسن نمو الفول السوداني ، والمحصول ، ويحفز المجتمع الميكروبي والنشاط الأنزيمي.