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Role of Some Effective Microorganisms in Improving Soil Properties and Productivity of Peanut under North Sinai Conditions

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Abstract: About 77 different microbial isolates (24 *Azotobacter*, 14 *Bacillus*, 9 *Pseudomonas,* 14 Actinomycetes and16 Fungi), isolated from different plant rhizosphere and compost from different localities in Egyptian governorates. The ability of microbial isolates in N_2 fixation, production of phytohormone, phosphate solubilization, antimicrobial (antibacterial and antifungal) and enzyme production) were tested. The most powerful effective isolates were selected and identified being *Azotobacter chroococcum, Bacillus megatherium, Pseudomonas fluorescence, Streptomyces fulvissimus, Aspergillus candidus, Lactobacillus lactis* and *Sacchromyces cerevesiae.* Selected effective microorganism showed high compatibility when mixed together. *Azotobacter chroococcum* recorded the highest values of carbohydrates and microbial gum production. Two filed experiments for Peanut were carried out in El-Sheikh Zowaied experimental station-El-Arish-North Sinai-DRC, Cairo, Egypt. Soil used was sandy received 1% chicken manure as organic matter and supplemented with the half dose of inorganic nitrogen, to evaluate the effect of employment of some effective microorganisms in improving sandy soil properties and productivity of peanut yield. Physical properties of soil (Hydraulic conductivity, Bulk density and aggregation), chemical properties were improved by the product of organic matter decomposition during growth season, microbial gums and root growth promoting substances enhanced soil aggregation process, subsequently soil penetrability resistance decrease. The net result was less cohesion relation to adhesion forces between soil particles. Inoculation of Peanut plant for two seasons with mixture of selected effective microorganisms significantly increased: total microbial counts, CO_2 evolution, PDB, Actinomycetes and. Fungi. Growth parameters of Peanut (shoot length, root length, shoot fresh and dry weight, root fresh and dry weight, chlorophyll content, number of leaves), yield parameters, mineral content (NPK) of Peanut in soil rhizosphere and in plant also, increased by inoculation. The highest effective of soil microorganisms treatment in improving sandy soil (El-Sheikh Zowaied) properties (physical and chemical) and productivity of Peanut plant were by amending soil combined treatment with organic matter , half dose of mineral fertilizers and inoculation with the five selected microbes as seed +soil +foliar, enhancing the highest pod yield Kg/fed of peanut was recorded with triple application of selected effective microorganisms being 832 and 842 Kg/fed at first and second season respectively. Also effect for agriculture production, improving soil properties, increasing soil fertility and reducing environmental pollution.

Key words: Microorganisms, sandy soil, Pea nut, *Bacillus*, *Pseudomonas*, *Streptomyces fulvissium*, *Lactobacillus lactis* and *Sachrromyces cerevisiae*.

INTRODUCTION

Peanut is considered to be one of the most important edible oil crops which due to its high nutritive value of its seeds for human and the produced cake as well as the green leaf hay for livestock, in addition to the importance seed oil for industrial purposes. Increasing of peanut production in order to cover the local consumption and exported out side could be achieved by introducing high productivity varieties and improving the cultural practices and managements as well as chosen the proper planting density- peanut crop has different groups of varieties[1].

Use of soil microorganisms which can either fix atmospheric nitrogen, solubilize phosphate, synthesis of growth promoting substances or by enhancing the decomposition of plant residues to release vital nutrients and increase humic content of soils, will be environmentally begin approach for nutrient management and ecosystem function[2].

Effect of inoculation on soil: Soils are one of the most important resources a farmer has. Soil health is fundamental to profitable and sustainable production and most important resource we use in agriculture. Proper management of the soil is a key to plant health and crop productivity. Soil structure has a strong

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impact on a range of processes influencing crop yield. It refers to the manner and stability with which individual sand, silt, and clay particles are bound together into units called aggregates. Soil aggregation is an important characteristic of soil fertility; the greater the degree of aggregation. Aggregates determine the mechanical and physical properties of soil such as retention and movement of water, aeration, and temperature[3]. Aggregate formation is an important factor controlling germination and root growth[4].Several studies have shown that formation of stable aggregates strongly depends on both the nature and the content of organic matter[5,6,7,8,9]. Unstable aggregates generally have a lower content of organic matter than do stable ones[10]. Plant roots contribute to soil organic material, and thereby to soil aggregate stability, directly through the root material itself[11] and indirectly through stimulation of microbial activity in the rhizosphere[12]. It is generally believed that microbial action on soil aggregation is due to the production of exopolysaccharides (EPS)[13]. This is supported by experimental observations demonstrating that the amendment of soil with microbial EPS results in an increased soil aggregation[7,14].

Andrade *et al*.[15] reported that soil aggregation is a dynamic process in which plants and the soil microbiota play a major role. The influence of microbes on aggregate stability has largely been studied in bulk soil[13,16]. Relatively little attention has been paid to the influence of microorganisms, particularly EPS-producing rhizobacteria, on the aggregation of root-adhering soil (RAS)[11,17]. According to the model of Oades and Waters[18], roots and fungal hyphae contribute to the formation of macroaggregates, whereas formation of meso-and microaggregates involves plant and microbial debris and bacteria. They suggest that bacteria, probably via their EPS production, also contribute to macro aggregate formation. Theoretically, new aggregates can be obtained from either breakdown of larger aggregates or accretion of meso aggregates[19]. Soil fertility and plant nutrition are important components in crop production. In addition to providing basic physical support for plants, productive, fertile soils also supply moisture and air to the roots and act as a reservoir for available plant nutrients. O'hara *et al*.[20] reported that, iron-deficiency specifically limits nodule development in peanut inoculated with *Bradyrhizobium* sp Plants sprayed with iron produced greater numbers of excisable nodules and carried a greater nodule mass than untreated plants. Defreitas and Germida[21] also demonstrated that in low fertility soil, *Pseudomonas* bacterial strains significantly enhanced early plant growth.

Abdel-Ghany *et al*.[22] studied the effect of refuse compost, dry sludge and sheep wastes at $10m^3$/fed in Wadi Sudr, South Sinai, two biofertilizers (Bio1, *Azotobacter chroococcum+Azospirillum lipoferum*) and (Bio2, Bio1 + some micronutrients) and their interaction on barley cvs. CC 89, Giza 123 and Giza 124. Result showed that, importance of bioorganic fertilizers as compared to other treatments, as well as significant relation between N_2 fixing bacteria and other factors such as highest protein content, stable soil aggregates & nitrogen uptake by plants. The highest economical yield i.e., highest protein content, were in the treatment rich in N_2-fixing bacteria. Treatments which decrease the penetrability resistance of soil correlated with higher aerobic cellulose decomposer numbers and yields indicating the need of the barley crop for a stable soil structure. Chaykovskaya[23] reported, that phosphate solubilizing bacteria increased phosphorous accumulation in plants, yield of pea and barely. Amer[24] showed that, the inoculation with the most active strains of *Azotobacter*, *Azospirillum* and *Streptomyces* in a green house experiment increased the soil microbial activities. The used strains as a tri mixture also, exhibited high reduction of disease severity together with an increase of growth and yield of cucumber plants (plant height, root length , fresh and dry weight, number of flowers and fruits, weight of fruits , chlorophyll content and nitrogen percent in fruits. Bandel and Meisinger[25] reported that soil fertility is very important for essential plant nutrients and for soil properties as texture, structure, organic matter, anion and cation retention, cation exchange capacity (CEC), base saturation (BS), and pH (acidity). Leij *et al*.[26] reported that high concentrations of 2,4-diacetylphloroglucinol in the rhizosphere of pea seedlings increased root mass production by more than about 50% in all soil types provided that soil conditions did not limit plant growth. Emine Orhan *et al*.[27] studied effects of plant growth promoting rhizobacteria on yield, growth and nutrient contents in organically growing raspberry The results showed that *Bacillus* treatment stimulated plant growth and resulted in significant yield increase. Inoculation of raspberry plant roots and rhizosphere significantly increased yield (33.9% and 74.9%), cane length (13.6% and 15.0%), number of cluster per cane (25.4% and 28.7%) and number of berries per cane (25.1% and 36.0%) compared with the control, respectively. In addition, N, P, Ca, Fe and Mn contents of the leaves of raspberry increased. Bacterial applications also significantly effected soil total N, available P, K, Ca, Mg, Fe, Mn, Zn contents and pH. The results of this study suggest that *Bacillus* have the potential to increase the yield, growth and nutrition of raspberry plant under organic growing conditions

The objective of this study was to evaluate the effect of employment of some effective soil microorganisms in improving sandy soil (El-Sheikh Zowaied) properties (physical and chemical) and productivity of Peanut plant.

MATERIALS AND METHODS

Survey of Soil Microorganisms in Egyptian Soils: Seventy seven samples (rhizosphere and soil samples) were collected from different locations in seven governorates of Egypt. These Samples were used for isolation `of *Azotobacter*, Phosphate dissolving bacteria, Actinomycets, Pseudomonas and Fungi isolates. They were grown separately on modified Ashby's medium[28], Bunt and Rovira medium[29], Starch nitrate medium[30], King's medium[31] and Czabek´s Dox agar[32] respectively.

Isolation and Purification of Microbial Isolates: Twenty four *Azotobacter* isolates, fourteen *Bacillus* isolates, nine *Pseudomonas* isolates, sixteen fungal isolates and fourteen Actinomycetes isolates were isolated from soil samples and compost. All isolates were subjected to purification trials by successive streaking on specific media for each isolate.

Isolation and Purification of Lactic Acid Bacteria: Three isolates were taken from Ferm/bam Center Al-Azhar University. All isolates were subjected to purification trials by successive streaking on nutrient Agar medium[33].

Isolation and Purification of Yeast: *Sacchromyces cervisae* were used and grown on Yeast extract malt extract agar medium[34].

Microbial Activity:

Nitrogen Fixation: The purified *microbial* isolates were tested for their N_2 fixation activity according to the Micro Kjeldahl method described by Jackson[35].

Phosphate Dissolving Efficiency: All microbial isolates were tested for phosphate dissolving capability qualitatively by inoculating all isolates on modified Bunt and Rovira medium[29]. Their phosphate dissolving potency was also determined quantitatively according to method adopted by Watanabe and Olsen[36].

Production of Antibiotic: the diameter of the clear zone of inhibition was determined against the particular test organism according to method[37].

Production of Phytohormones: All microbial isolates *were* tested for the promoting activity on plant seedlings by measuring elongation in shoots and roots[38]. Phytohormones were also was also determined quantitatively for selected effective microoranisms using by high performance liquid chromatography (HPLC) according to the modified method of Rizzolo *et al.*[39].

Production of Enzymes:

Proteolytic Assay Technique: The protease enzyme activity was measured by the Gelatine Clearing Zone (GCZ) technique according to Ammar *et al.*[40].

Lipolytic Assay Technique: The lipase enzyme productivity was measured by the Tributyrin clearing zone (TCZ) technique according to Barrow and Feltham[41].

Amylase Assay Technique: The amylase enzyme activity was measured by the clearing zone technique. as described by Barrow and Feltham[41].

Pectinase Assay Technique: The pectinase enzyme activity was measured by the clearing zone technique. as described by Barrow and Feltham[41].

Cellulase Assay Technique: The cellulose enzyme activity was measured by the clearing zone technique. as described by Barrow and Feltham[41].

Determination of Total Carbohydrates: Total carbohydrates content was determined calorimetrically using UV/Visible Spectrophotometer, Unicam UV 300, Thermo Spectronic, USA by Nelson's reagent as reported by Cherry[42].

Determination of Microbial Gum Production: Microbial gums produced by selected isolates were determine using method described by Hamilton[43].

Identification of Selected Microbial Isolates: *Azotobacter* isolates: One (A_{13}) of azotobacters isolates active in N_2 fixation, phosphate solubilization, enzymatic activity, hormonal production and antagonistic activity was subjected to complete identification according to its morphological and physiological characteristics using the methods described in Bergy's Manual[44] and Krig and Holt[45].

Phosphate Dissolving Bacteria: The most active isolates of *Bacillus* (B9) in phosphate solubilization, enzymatic activity, hormonal production and antagonistic activity was subjected to complete identification according to its morphological and physiological characteristics using the methods described in Bergy's manual of Determinative Bacteriology[44,46].

Pseudomonas: The most potent fluorescent pseudomonad isolate (Ps 9) with antagonistic activity, enzyme production, hormone production and phosphate dissolving activity was identified according to the methods described in Bergey's Manual of Determinative Bacteriology[44,46].

Actinomycetes: The most active isolates of Actinomycetes (Act 14) in antagonistic activity was completely identified according to Bergey's Manual of Systematic Bacteriology[47].

Fungi: The most active isolate of *Aspergillus* sp. (F16) in antagonistic activity was completely identified according to Barnet and Hunter[48] and Moubsher[49].

Field Experiments: Two field experiments for peanut were carried out at El-Sheikh Zowaied, El-Arish, North Sinai Governorates Desert Research Center, Cairo, Egypt to study the effect of employment of some effective microorganisms in improving sandy soil properties and productivity. Chicken manure was air dried ground and milled using 2mm sieve to be analyzed for carbon and nitrogen content. Chicken manure was thoroughly mixed with soil before cultivation at the rate of 1%

Mineral Fertilizer: Calcium super-phosphate (containing 15.5% P_2O_5) was added to all treatments at the rate of 200 kg/fed. and mixed with the soil 15 day latter before cultivation, Nitrogen fertilizer (calcium ammonium nitrate 33.3 %N) was added at a rate of 60 kg /fed. in two equal parts after 25 and 45days from sowing. Potassium sulphate (contains 48% K_2O) was added after 25 days of sowing at a rate equal to 40 kg/ fed.. Seeds of Pea nut were washed and immersed for 30 minutes in liquid culture of effective microorganisms (SEM containg Bradyrhizobium for Peanut). Carboxy methyl cellulose 0.5% was used as an adhesive agent. Seeds were then dried at room temperature for two hour. Thus, all treatment used can be summarized as follows: Organic matter added to all treatments,

1-Uninoculated without mineral fertilizer (organic matter).
2-Uninoculated with mineral fertilizer .
3-O.M+Mf+ seed or grain inoculation.
4-O.M+Mf+ soil inoculation.
5-O.M+Mf+ foliar application.
6-O.M+Mf+ seed+ soil.
7-O.M+Mf+ soil+foliar.
8-O.M+Mf+ seed+ soil+ foliar

Sampling and Determinations:

Physical and Chemical Analysis of Soil: Soil sample were mechanically analyzed according to the methods described by Piper[50]. Bulk density, Hydraulic conductivity and aggregation according to Klute[51]. The electrical conductivity (EC) was measured in saturated soil according to method described by Jackson[52].Soluble anions, cations and soil pH were determined in saturated soil according to the method described by Richard[53]. Organic carbon was determined by the rapid titration method and total nitrogen was determined using Micro-Kjeldahl method[54]. Phosphorus was determined according to Troug and Meyer[55]. Potassium being evaluated flame photometrically.

Microbiological Determination: Microbiological analysis of soil included the determination of total microbial counts and phosphate dissolving bacterial counts by plating on modified Bunt and Rovira medium[29] using the decimal plate count technique[56]. The most probable number of *Pseudomonas* was determined after incubating the tubes at 30±2 ˚C for 48 hour on King's B medium[31]. Estimates of number of pseudomonads by MPN technique were calculated using Cochran's table[57]. The most probable number (MPN) of *Azotobacter* was determined after incubating the tubes at 28 ±2˚C for 10 days on modified Ashby's medium[28]. Total fungi counts on Martins agar[58] and total actinomycetes counts on Starch nitrate medium[30].

Parameters of Wheat Plant:

a) Plant height (cm).

b) Fresh weight of both shoots and roots (g/plant).

c) Dry weight of both shoot and roots were recorded after oven drying at 70 ˚C until reaching a constant weight[59].

d) Chlorophyll content was measured by using Minolta chlorophyll meter (SPAD-502) to determine the total chlorophyll in fresh leaves.

f) Yield characteristics (number of leaves, number of tillers, spickles features, weight of 100 grain and grain yield/fed.

Statistical Analysis: Data were subjected to an analysis of variance (ANOVA), using a log transformation when necessary. When ANOVA generated a significant F-value ($P < 0.05$), treatment means were compared by Tukey's LSD-test. Experiment was carried out with three replicates per treatment.

RESULTS AND DISCUSSION

About 77 different microbial isolates (24 *Azotobacter*, 14 *Bacillus*, 9 *Pseudomonas*,

14 Actinomycetes and 16 Fungi), isolated from different plant rhizosphere and compost from different localities in Egyptian governorates. The ability of

microbial isolates in N_2 fixation, production of phytohormone, phosphate solubilization, antimicrobial (antibacterial and antifungal) and enzyme production) were tested (Table 1). Selected effective microorganism showed high compatibility when mixed together in a mixed culture (Table 2). Total carbohydrates and microbial gums produced by selected microorganisms were determined (Table 3) and *Azotobacter chroococcum* was highest gums producing .and *Bradyrhizobium* was highest total carbohydrates producing.

Identification of the Most Active Isolates: On the basis of pronounced plant growth promoting, antimicrobial activities, phosphate solubilization and enzyme production of the tested isolates, five efficient isolates that display strong activity towards previous tests were selected and identified .as *Azotobacter chroococcum* Az_{13}, *Bacillus megatherium 9, Pseudomonas fluorescens* 3, *Sterptomyces fulvissium*. Act_{14}. and *Aspergillus candidus* F_{16}, were chosen and used as a mixture with *Lactobacillus lactis* and *Sachrromyces cervisiae*. Their potential as biofertilizer agents to improve productivity of Peanut and improve soil properties was evaluated.

Two field experiments for Peanut plant were carried out in El-Sheikh Zowaied Experimental station-El-Arish-North Sinai-DRC, to evaluate the effect of employment of some effective microorganisms (*Azotobacter*, *Bacillus*, *Pseudomonas,* Actino, Fungi, *Lactobacillus* and yeast) on improving the productivity of Peanut plant and also, improve soil properties .

Soil used was sandy textured amended with 1% chicken manure and supplemented with the half dose of inorganic nitrogen. To evaluate the effects of biofertilization by using the selected effective microorganisms on the growth and yield of Peanut.

Total Microbial Counts: Data presented in Table (4) clearly indicated that, initial total microbial counts in El-Shiekh zowaied, sandy soil were 43 $\times 10^6$ cfu/g soil. Generally, the counts at second season were significantly higher than those of first one. Also, the counts increased gradually through vegetative, flowering then decreased towards harvesting stage of plant growth. All bioorganic treatments significantly increase microbial counts $control_2$ > $control_1$. The highest significant increase was recorded with (soil + seed+ foliar) applications followed in descending order by (soil+ foliar), (soil+ seed); soil; seed applications being 237, 216, 204, 193, 172 and 165×10^6 cfu/g soil for the second season at flowering stage of peanut plant growth, respectively. The enhancement in microbial activity is a good parameter for many soil improvement indices.

CO_2 Evolution: Results in Table (4) show that CO_2 evolution is positively correlated with total microbial counts under different treatments.

Phosphate Dissolving Bacteria (PDB): Application of effective microorganisms as foliar, seed or soil individually or as a mixture significantly increased PDB counts in rhizosphere of Peanut plant during vegetative, flowering growth and decreased towards harvesting stage in first and second season of plant growth. Data presented in Table (4) showed that initial counts of Phosphate dissolving bacteria 25×10^3 cfu/g dry soil. However their counts tended to increase in all treatments rather than $control_2$> $control_1$ by bioorganic treatments, stages and season of plant growth. Counts of PDB increased significantly at flowering if compared with harvesting and vegetative growth stages and at second season if compared with first season of pea nut plant growth. The highest significant counts were recorded with soil + seed +foliar followed in descending order by soil+ foliar, soil + seed, foliar, seed, soil application being 121,111,99,83,80 and 72 $\times 10^2$ cfu/g dry soil at flowering stage and second season of peanut plant growth.

Actinomycetes: Table (4) showed that actinomycetes counts were affected by the different treatments under study, time and stage of plant growth. The initial total actinomycetes count was 8×10^3cfu/g dry soil. With respect to stage and season of pea nut plant growth, the counts tend to increase significantly towards flowering stage then decreased towards harvesting wherease counts were significantly less than vegetative stage of plant growth. Also, counts at second season were significantly higher than those of first season. With respect to bioorganic treatments the least significant increase was recorded with seed inoculation being 17 followed in ascending order by foliar , soil, soil +seed+ foliar being 20,21,21,23,24 $\times 10^3$cfu/g dry soil at flowering stage and second season of wheat plant growth respectively.

Fungi count: The data presented in Table(4) illustrated that the initial count of fungi was 7 $\times 10^3$ cfu/g dry soil. Generally, the counts increased under pea nut growth reaching their maximum counts at flowering stage. However, this trend was affected by the type of biofertilization, stage and season of plant growth. For bio-organic applications, the highest significant increase was recorded with soil+seed+foliar being 20 and the least significant increase being 17×10^2 cfu/g dry soil > control 2 > control1 being 16. 15×10^3cfu/g dry soil at flowering and second season of pea nut plant growth.

Growth of Peanut Plants: Data in Table (5) show that plant height (cm), root length (cm), shoot and root

fresh and dry weights(gm), chlorophyll%, number of tiller and leave/plant increased significantly with bio-organic treatments and affected by stage ,season cultivations and different treatments under study. For plant height the least height recorded at vegetative stage and first season significantly increased toward flowering and harvesting stages of plant growth. Also, plant height significantly increased towards second season of peanut plant growth. Bio-organic treatments affected plant height, the highest significant increase recorded with soil+seed+foliar inoculation and the least one with seed treatment being 39 cm at second season and harvesting stage of peanut plant growth as presented in table(5), respectively. Also, root length affected by different treatment and age of plant growth. The highest significant increase for root length recorded with mixed inoculation (soil + seed + foliar), (soil + foliar); (soil + seed) being 19.6, 17.8 and 17 cm significantly decreased towards foliar, soil, seed inoculation being 15.2, 15.6, 14.8 cm at harvesting stage during second season of pea nut plant growth, respectively (Table 5).

Shoot Fresh and Dry Weights: As presented in Table (5) data showed that bioorganic treatments significantly increased shoot fresh weight from 33.7 to 55.6 and from7.28 to11.5 g/plant for dry weight at harvesting stage and second season of pea nut plant growth. Uninoculated control treatments recorded the lowest shoot fresh and dry weights, control 2 > control 1. Also, shoot fresh or dry weights significantly increased harvesting stage of plant growth. Application of soil + seed + foliar significantly increased shoot fresh and dry weight ≈ 3 folds for fresh weight and 7-8 folds for dry weight if compared with control 1 or control 2.

Root Weights: Concerning peanut root fresh and dry weights Table (5), the lowest was 1.9 g and 0.54 g for $control_1$, respectively. These significantly increased to 8.9 gm and 2.25 g in treatments receiving soil + seed + foliar treatment at harvesting stage and second season of pea nut plant growth for fresh and dry weight, respectively. On the other hand these treatments increased root fresh and dry weights as much as (8.9/3.13, 8.9/3.27) and (2.25/0.88, 2.25/0.93) comparing with $control_1$ and $control_2$ for root fresh and dry weights respectively.

Number of leaves/plant: The effect of treatments, age and stage of pea nut plant growth on number of leaves/plant could be seen from the set of values depicted in Table (6). The number of leaves/plant increased significantly towards harvesting and second season of plant growth. It is clear that $control_2$ recorded higher values than $control_1$. The bio-organic treatments significantly increased number of leaves/plant. The magnitude could be arranged descending as follows, soil + seed + foliar, soil + foliar, seed + soil, soil, foliar, seed inoculation being (41), (39), (36) for leaves/plant at second season respectively.

Chlorophyll Content: Data represented in Table (6) showed that chlorophyll content recorded higher increase at flowering and second season than harvesting > vegetative stage of pea nut plant growth. Chlorophyll content affected by bio-organic treatments. These data also clarify the role of biofertilization type in increasing chlorophyll content, whereas the effectiveness order was as follows: soil + seed + foliar (50%)> soil + foliar (40%) > soil + seed (23%) and the least one seed inoculation (13%) at flowering and second season of plant growth. This trend might be attributed to the enhancement of both microorganisms and plant roots in stimulating and producing humic materials which contribute in binding soil separates.

Total Nitrogen Content in Soil: Data represented in Table (7) clearly showed that, total nitrogen content of soil significantly reached their maximal levels at flowering stage of Peanut plants. The mixed application (seed+ soil+ foliar) represented the best treatment compared with the rest of treatments and the control group. The percentage increases over control were 67.8%.

Total Phosphorus Content in Soil: The obtained data from Table (7) indicate that, biofertilizer application increase the total phosphorus than control treatment. On the other hand, data also revealed that biofertilization had a beneficial effect on total phosphorus in soil. Combination of selected effective microorganisms more effective in increasing total p.

Total Potassium in Peanut Rhizosphere: Data in Table 7 demonstrate the total potassium in rhizosphere of Peanut plant as affected by biofertilizer application to seed, soil and foliar. Data showed that total potassium in the rhizosphere significantly increased by addition of mineral fertilizer as recorded in $control_2$ if compared with $control_1$. The highest values were recorded with triple biofertilizer application to both seed, soil and foliar in a mixed treatment being 64.9 and 65.5 during first and second season respectively.

Chemical Characteristics of Plant:

Total Nitrogen Content for Pea Nut Plant: Data reported in Table 7 clearly showed that, inoculation of Peanut plants gave higher records than uninoculated one. However, the highest nitrogen content was recorded with mixed application of selected effective

microorganisms to soil+ seed and foliar. Mixed inoculation significantly increase N content for pea nut> soil + foliar> soil + seed> soil>foliar>seed> control 2 > control 1. The highest significant increase recorded with mixed application of selected effective microorganisms recorded 8.12 and 8.6 at first and second season respectively. The corresponding percentage increase over $control_1$ and $control_2$ were 125 and 59.2 % for $control_1$ and $control_2$at first season and 115and 55.8 for control1 and $control_2$at second season.

Total Phosphorous and Potassium Contents for Pea Nut Plant: Concerning the effect of biofertilizer application on phosphorus and potassium contents data in Table (7) revealed that biofertilizer application to seed, soil and foliar either individually or mixed treatments significantly increase total phosphorous and potassium contents than uninoculated treatments. Mixed inoculation with mixture of selected effective microorganisms and mixed application of mixture to both soil, seed and foliar recorded highest contents of P and K if compared with control or individual application to soil or seed or foliar. The same trend of results was obtained during both seasons.

Effect of Different Types of Treatments on the Morphological Characteristics of Pea Nut Plants: Table (8) shows the effect of different treatments on No. of branch/ plant, No. of pods/ plants, Pod wt. gm/plant , seed weight gm /plant , 100 seed weight, Pod yield Kg/fed, Seed Oil % and Oil Keg/fed. For number of branch/plant as presented in table (8), the highest significant increase recorded with soil + seed + foliar being 10 and the lowest one being 8 as bioorganic treatments = control2 (8) > control1 (7) branch/plant at first and second season.

For number of Pods/plant as presented in Table (8), the highest significant increase recorded with soil + seed + foliar being 12 and the lowest one being 9 as bioorganic treatments > control2 (7,8) > control1 (5) branch/plant at first and second season. As presented in Table (8), the control treatments as Pod wt. g/plant recorded the less significance being 5.9and 8.4 (g) as pod wt. gm/plant for $control_1$ and $control_2$, respectively. For bio-organic treatments the weight of pods g/plant increased significantly in ascending order being 9.8, 10.9,10.4,12.1, 12.6,13.6 gm / plant at first season and 10,11.3,10.9,12.4,13,14 at second season for seed, foliar, soil, soil + foliar and soil + seed + foliar inoculation, respectively. The highest pod yield Kg/fed. was recorded with triple application of selected effective microorganisms being 832 and 842 Kg/fed. at first and second season respectively.

As presented in Table (8), the control treatments as seed wt. gm/plant recorded the less significance being 2.8, 2.8 and 3.9, 4.1 (g) as seed wt. gm/plant for $control_1$ and $control_2$, at first and second season respectively. For bio-organic treatments the weight of seeds gm/plant increased significantly in ascending order being 4.5, 4.9, 4.6, 5.4, 5.6, 6g/plant and 4.7,5.1,4.9,5.6,5.7,6.1 for seed, foliar, soil, soil + foliar and soil + seed + foliar inoculation, at first and second season respectively.

All bio-organic treatments recorded significant increases comparing with control1< $control_2$ being 32, 35.8 and 32.7, 36.2 at first and second season for 100 seed weight as showed in Table (8) respectively. The highest significant increase recorded with seed + soil + foliar and the least one with seed inoculation being 43.6, 37.5 and 43.9, 38.1 g at first and second season respectively.

All bio-organic treatments recorded significant increases comparing with control1< control2 being 30.2, 32.0 and 30.8, 32.0 Oil % at first and second season as showed in Table (8), respectively. The highest significant increase recorded with seed + soil + foliar and the least one with seed inoculation being 39.6, 33.36 and 40.3, 33.4 % at first and second season respectively. The highest mean values of the two growing seasons (Table 9) for Pod yield Kg/fed., Seed oil% and Oil yield Kg/fed recorded with mixed inoculation (Soil+ Seed+ Foliar)being 837, 40 and 144.5 respectively. The corresponding figures for the least one with seed inoculation were 789, 33.4 and 129.3 respectively.

Physical Properties of Soil: The selected and tested soil physical properties include: Bulk density, hydraulic conductivity and soil aggregation

Bulk Density: Table (10) show the measured values of bulk density for the soil samples after each cultivation season for peanut for different applied treatments includes the percentage of decrease relative to the base soil value. From the data it can be concluded the following:

1- General deceasing trend for all treatments relative to the base soil which is indicative to general physical improvement.

2- The second cultivation season for peanut crop indicates greater decrease in values which reflect the radical effect of treatments across the two seasons.

3- General trend of greater changes in bulk density values from the sole treatments which give indication of good interactions among the applied kinds of microbiological strains with the organic base treatment.

Table 1: General Microbial activity for selected effective microorganisms.

	Parameters	Az13	B9	Ps3	Act14	F16
N_2 fixation	T.N (ppm)	114.6	0.0	0.0	0.0	0.0
	Nitrogenase (µlC2H4H-1I-1)	423	0.0	0.0	0.0	0.0
Phosphate solubilization	Qualitative Inhibition zone (cm)	1.2	3.8	0.9	0.5	0.7
	Quntitative Colorimetric (mg P/l)	1.44	4.75	1.1	0.8	1.3
Hormanal activity Quntitative(HPLC)/ Qualitative (bioassay)	Shoot length	13.4	15.2	12.4	9.2	9.3
	Root length	11.81	13.85	11.2	7.12	7.4
	Total Sh+R	25.21	29.05	23.61	16.32	16.7
	% of increase	101.68	66	69.86	69.2	64.5
	IAA	0.17	0.26	0.837	0.183	0.973
	GA_3	3.2	1.37	2.54	4.16	15.46
Enzyme production	Cytokinine	26	12	13.9	16.2	60.7
	Amylase	+++	+	-	+++	+++
	Celluolase	-	++	+	++	+++
	Pectinase	734.71	++	+	+	+
	Protease	+	++	+	+	+
	Lipase	+	++	++	++	++
Antimicrobial activity Antifungal Antibacterial	E. coli	33	28	25	48	55
	S. typhi	29	32	31	31	34
	S. aureus	0	24	32	38	46
	C. albicans	17	30	33	28	39
	B. subtilis	21	23	19	40	41
	F. oxysporum	13	27	29	36	36
	R. solani	15	18	34	29	40
	Alt. solani	0	15	25	32	45

Az: *Azotobacter* sp., B: *Bacillus* sp.; *Pseudomonas* sp., Act: Actinomycetes , F: Fungi

Table 2: Synergistic effect between selected microorganisms Synergestic effect betweem bacterial isolates

Microorganism	B_9	Ps_3	*L. Lactis*
A_{13}	+	+	+
Bradyrhizobium	+	+	+

(b)Synergestic effect betweem Fungi,Actino. Yeast and other bacterial isolates .

Microorganism	A_{13}	B_9	Ps_3	*L. Lactis*
Fungi	+	+	+	+
Actino	+	+	+	+
Yeast	+	+	+	+

Table 3: Determination of total carbohydrates and microbial gums produced by selected microorganisms.

Parameters	Reducing Sugar (mg/l)	Disaccharide(mg/l)	Polysaccharide (mg/l)	Total carbohydrates (mg/l)	Gums (mg/l)
Azotobacter	310.59	29.67	17.61	357.87	750
Bacillus	103	78	51	232	365
Pseudomonas	89.18	64.37	17.96	171.51	207

Table 3: Continue

Bradyrhizobium	260.25	116.45	11.65	388.44	519
Actinomycetes	0.131	0.064	0.023	0.218	0.08
Fungi	237.6	86.4	6.29	330.29	65
Lactobacillus	293.7	189.86	119.01	601.94	136
Yeast	218.96	43.52	15.41	277.87	92

Table 4: Effect of inoculation with effective microorganisms on microbial determinations of Peanut plant at different stages of growth during two seasons.

Treaments	Total microbial count						CO2 evolution						PDB counts					
	First Season			Second Season			First Season			Second Season			First Season			Second Season		
	I	II	III		II	III	I	II	III	I	II	III	I	II	III	I	II	III
Cont 1	44	91	63	52	118	98	11.6	15.8	14.2	12.3	17.9	15.6	27	41	31	30	41	53
Control 2	51	101	75	62	124	104	14.1	18	16.8	15.5	19.3	17	29	45	35	31	47	59
Seed	61	112	85	79	165	127	15.3	21	19.2	16.9	23.1	21.5	32	56	48	34	60	73
Soil	72	123	96	98	193	138	16.7	22.8	20.7	17.4	24.9	22.1	36	64	49	39	73	83
Foliar	68	118	91	85	172	135	16.1	21.7	20.3	17.2	23.6	21.8	32	60	48	36	69	80
Soil+Seed	76	138	105	113	204	169	18.1	24	22.5	19.3	26	23.9	41	67	53	49	88	99
Soil+Foliar	78	147	113	122	216	188	19.6	24.6	22.9	20.7	27.6	24.6	42	71	54	51	92	111
Soil+Seed+Foliar	80	162	125	127	237	207	20.3	25.3	23.2	21.5	28.4	25.2	46	73	59	53	102	121
L.S.D.at 0.05%	1.36			1.58			0.61			1.41			0.86			0.6		

Treatment	Actinomycetes count											
	First Season			Second Season			First Season			Second Season		
	I	II	III	I	II	III	I	II	III	I	II	III
Cont 1	9	14	13	10	15	14	7	10	9	9	15	12
Control2	9	14	13	11	16	15	8	11	10	11	16	15
Seed	10	16	15	12	19	17	9	13	11	12	17	15
Soil	11	18	16	13	21	19	9	14	12	14	18	16
Foliar	11	17	16	12	20	18	8	13	11	13	17	16
Soil+Seed	13	19	17	14	21	19	10	16	14	15	20	17
Soil+Foliar	13	20	17	15	23	20	10	18	14	17	20	18
Soil+Seed+Foliar	14	21	19	15	24	21	10	19	15	18	20	18
L.S.D.at 0.05%	0.72			1.26			4.1			1.23		

Table 5: Effect of inoculation with effective microorganisms on Plant characteristic of Peanut plant at different stages of growth during two seasons

Treatments	Shoot length						Shoot fresh weight						Shoot dry weight					
	First Season			Second Season			First Season			Second Season			First Season			Second Season		
		II	III		II	III		II	III		II	III		II	III		II	III
Cont 1	17.2	21.6	22.9	18.4	22.3	24.5	22.1	28.7	32.1	23.4	30.1	33.7	4.5	4.9	6.9	4.8	5.1	7.3
Control 2	19.6	23	25.2	20.5	24.8	27	24.8	30.9	34	27	32.4	36.9	5.3	5.8	7.5	5.4	6	7.7
Seed	20.8	26.3	29	22.2	28	30.8	28.3	34.1	39.5	30	34.2	39.3	6.2	6.8	8.2	6.3	7.1	8.6
Soil	23.6	28	32	24.2	29.3	31.7	30.7	38.3	41.7	32.4	40.6	45.1	6.7	7.2	8.9	6.8	7.8	9.5
Foliar	22.9	27.6	31.4	23.6	28	31	29.6	36.1	40.8	31.9	37.1	44.5	6.4	7	8.6	6.5	7.6	8.9
Soil+Seed	24	30.8	34.7	24.9	31	34.8	32.1	39	46.8	34.7	42.1	49.2	7	8	9.2	7.2	8.3	10
Soil+Foliar	25	32	36	26.8	32.6	36.5	32.9	40.8	52.2	35.2	45	51	7.1	8.4	9.8	7.3	8.7	10.9
Soil+Seed+Foliar	28.7	33.7	37.8	29.7	36.5	39	33.8	42	57.1	37.8	48	55.6	7.5	8.8	11.2	7.5	8.9	11.5
L.S.D.at 0.05%	0.76			0.7			0.5			1.135			0.3			0.51		

Treatment	Root length						Root fresh weight						Root dry weight					
	First Season			Second Season			First Season			Second Season			First Season			Second Season		
		II	III		II	III		II	III		II	III		II	III		II	III
Cont 1	10.5	11.3	12.1	10.9	11.3	12.2	1.9	2.5	3	2.07	2.61	3.13	0.54	0.68	0.82	0.57	0.7	0.88
Control 2	11.2	11.9	12.7	11.4	12	13.1	2.09	2.7	3.17	2.13	2.89	3.27	0.58	0.73	0.9	0.59	0.81	0.93
Seed	12.3	13	14.2	12.4	14	14.8	2.34	3.2	3.84	2.5	3.5	4.16	0.68	0.86	1.01	0.72	0.92	1.07
Soil	12.6	13.35	14.85	12.7	14.9	15.6	2.56	3.86	4.1	2.63	3.94	4.73	0.77	1.03	1.18	0.79	1.04	1.3

Table 5: Continue

Foliar	12.5	13.26	14.7	12.5	14.6	15.2	2.41	3.49	4.5	2.43	3.84	4.52	0.72	0.94	1.12	0.76	1.01	1.24
Soil+Seed	13.2	14.11	15.64	13.46	16.4	17	2.67	4.4	6.02	2.69	4.7	6.54	0.83	1.16	1.54	0.9	1.22	1.67
Soil+Foliar	13.5	14.57	16.18	13.7	16.64	17.8	2.7	5.1	7	2.77	5.3	7.3	0.89	1.38	1.77	0.97	1.36	1.85
Soil+Seed+Foliar	13.9	15.6	17.9	13.9	17.5	19.6	2.8	6.2	8.4	2.83	6.4	8.9	0.9	1.6	2.14	0.98	1.65	2.25
L.S.D.at 0.05%	0.47	0.44	0.24	0.12	1.25	1.23												

Table 6: Effect of inoculation with effective microorganisms on Chlorophyll % and number of leaves of Peanut plant at different stages of growth during two seasons.

Treatments	Chlorophyll%						Number of leaves					
	First Season			Second Season			First Season			Second Season		
		II	III		II	III		II	III		II	III
Cont 1	23	29.2	25.4	23.7	29.8	25.6	22	25	28	22	26	28
Control2	25.7	31.5	28.5	26.1	31.9	29.4	23	27	31	24	27	31
Seed	27.1	32.3	30	27.8	33.5	30.7	25	29	32	26	30	33
Soil	27.5	35.5	31.6	29	36.3	32.6	26	31	34	27	31	35
Foliar	27.4	34.1	30.8	28	35.9	31.3	25	30	32	26	30	34
Soil+Seed	29	37	34.8	30.2	37.2	36.8	27	31	35	27	31	36
Soil+Foliar	29.6	38.8	37.4	31.5	41.5	39	28	33	37	27	35	38
Soil+Seed+Foliar	30.2	43.2	41.1	32.9	44.9	42.2	29	34	38	30	37	41
L.S.D. at 0.05%	0.54			0.36			1.22			3.15		

Table 7: Effect of inoculation with effective microorganisms on NPK in soil and plant of Peanut plant at different stages of growth during two seasons.

Treatments	N in soil						P in soil						K in soil					
	First Season			Second Season			First Season			Second Season			First Season			Second Season		
		II	III		II	III		II	III		II	III		II	III		II	III
Cont 1	0.02	0.03	0.024	0.027	0.041	0.036	0. 64	0. 92	0. 76	0. 68	0. 95	0. 81	15.1	21.9	17.9	15.7	22.17	18.3
Control2	0.045	0.061	0.052	0.049	0.078	0.067	0. 71	1.2	0. 79	0.73	1.3	0.9	19.4	24.8	21.5	20.1	25.9	22.6
Seed	0.072	0.081	0.074	0.084	0.13	0.092	0. 72	1.5	0.8	0. 76	1.8	0. 93	20.1	26.1	22.7	20.5	26.5	24
Soil	0.096	0.14	0.11	0.1	0.16	0.14	0.73	1.6	0.81	0.79	1.8	0.95	23.9	33.5	26.2	24.1	33.8	27.8
Foliar	0.09	0.12	0.098	0.092	0.154	0.12	0.71	1.3	0.8	0.76	1.6	0.92	21.6	28	24	21.9	28.3	25.2
Soil+Seed	0.127	0.189	0.14	0.134	0.22	0.179	0.75	1.9	0.83	0.8	2.0	0.96	28.3	46.9	37.8	24.5	47.5	38
Soil+Foliar	0.144	0.216	0.178	0.165	0.29	0.21	0.78	1.9	0.82	0.82	1.8	0.95	31.8	51	42.7	32.8	52.7	43.2
Soil+Seed+Foliar	0.235	0.319	0.245	0.27	0.342	0.28	0.79	2.1	0.85	0.84	2.3	0.97	39.5	64.9	53.9	42.9	65.5	54.7
L.S.D.at 0.05%	0.5			0.015			4.6			9.22			4.65			4.78		
Treatment	N in plant						P in plant						K in plant					
	First Season			Second Season			First Season			Second Season			First Season			Second Season		
		II	III		II	III		II	III		II	III		II	III		II	III
Cont 1	2.65	3.61	3.28	3.02	4.01	3.6	0.31	0.41	0.36	0.32	0.34	0.38	1.22	2.02	1.76	1.28	2.08	1.74
Control2	4.1	5.1	4.51	4.31	5.52	4.73	0.35	0.48	0.4	0.36	0.5	0.41	1.46	2.34	2.1	1.47	2.36	2.15
Seed	4.26	5.54	5	4.6	6.38	5.52	0.37	0.52	0.42	0.37	0.55	0.43	1.55	2.42	2.18	1.59	2.47	2.23
Soil	5.15	6.45	5.65	5.37	7.3	6.15	0.4	0.61	0.48	0.42	0.58	0.46	1.83	2.43	2.07	1.9	2.48	2.11
Foliar	4.81	5.9	5.22	5.03	6.92	5.69	0.38	0.57	0.44	0.4	0.6	0.46	1.85	2.46	2.12	1.92	2.47	2.15
Soil+Seed	5.49	7	5.91	6.36	7.83	6.55	0.43	0.66	0.52	0.45	0.71	0.56	2.08	2.52	2.21	2.12	2.53	2.26
Soil+Foliar	5.7	7.6	6.49	6.29	8.31	7.03	0.44	0.72	0.59	0.48	0.77	0.64	2.31	2.72	2.51	2.38	2.82	2.52
Soil+Seed+Foliar	5.86	8.12	6.95	6.18	8.6	7.43	0.47	0.78	0.64	0.52	0.81	0.69	3.42	4.11	3.62	3.44	4.16	3.76
L.S.D.at 0.05%	0.18			0.177			0.089			0.087			0.12			0.115		

Table 8: Effect of inoculation with effective microorganisms on yield of Pea nut plant (first season).

Treatments	Yield Pea nut (First season)							
	No. branch/plant	Pods no. /plant	Pod wt. gm/plant	Seed wt. g/pod	100 seed weight	Pod Yield Kg/F	Seed Oil%	Oil Kg/fed.
Cont1	7	5	5.9	2.8	32	655	30.2	94.9
Cont2	8	7	8.4	3.9	35.8	712	32	113.8
Seed	8	9	9.8	4.5	37.5	783	33.4	126.7
Soil	9	10	10.9	4.9	41.2	810	36.8	163.8
Foliar	8	9	10.4	4.6	39.6	789	35.2	128.4
Soil+Seed	9	11	12.1	5.4	42	824	37.3	138.5
Soil+Foliar	9	11	12.6	5.6	42.3	815	39.1	133.8
Soil+Foliar+Seed	10	12	13.6	6	43.6	832	39.6	142.8
			Yield Pea nut (Second season)					
Control 1	7	5	5.9	2.8	32.7	679	30.8	95.6
Control 2	8	8	8.4	4.1	36.2	754	32	119
Seed	8	9	10.0	4.7	38.1	796	33.4	132
Soil	9	10	11.3	5.1	41.9	827	.37.1	166
Foliar	9	10	10.9	4.9	39.8	795	35.6	133
Soil+Seed	9	11	12.4	5.6	42.2	839	37.7	143
Soil+Foliar	10	11	13	5.7	42.5	827	40.2	139
Soil+Foliar+Seed	10	12	14	6.1	43.9	842	40.3	146

Table 9: Mean Yield of Pea nut at two seasons.

Treatments	Pod yield Kg/fed	%	Seed Oil%	%	Oil yield Kg/fed.	%
Cont1	667	-	30.5	-	95.3	-
Cont2	733	-	32	-	116.6	-
Seed	789	7.7	33.4	4	129.3	10.9
Soil	818	11.7	37	15.6	133.5	14.5
Foliar	792	8.04	35.4	10.6	130.7	12.1
Soil+Seed	831	13.4	37.5	17.2	140.5	20.5
Soil+Foliar	821	12	39.6	23.4	136.4	17
Soil+Foliar+Seed	837	14.2	40	24.5	144.5	23.4

Table 10: Effect of inoculation with effective microorganisms on Soil Bulk density and Hydraulic Conductivity.

Treatment	Bulk density				Hydraulic Conductivity cm/h			
	Peanut 1st season		Peanut 2nd season		Peanut 1st season		Peanut 2nd season	
	R	%	R	%	R	%	R	%
Cont 1	1.63	-1.8	1.55	23.6	-11.9	-6.6	23.6	-11.9
Cont 2	1.63	-1.8	1.54	23.2	-13.4	-9.7	23.2	-13.4
Seed	1.62	-2.4	1.53	22.5	-16	-13.8	22.5	-16
Soil	1.61	-3	1.52	20. 8	-22.4	-17.9	20. 8	-22.4

Table 10: Continue

Foliar	1.62	-2.4	1.52	21.7	-19	-14.2	21.7	-19
Soil+ Seed	1.61	-3	1.51	19.8	-26.1	-20.1	19.8	-26.1
Soil+ Foliar	1.61	-3	1.51	21.2	-20.9	-18.3	21.2	-20.9
Soil+Seed+Foliar	1.60	-3.6	1.50	19.5	-27.2	-24.3	19.5	-27.2
L.S.D at 0.05	0.017		0.017		0.44		0.17	

Initial Bulk density: 1.66, Initial Hydraulic Conductivity: 26.8

Hydraulic Conductivity: Saturated hydraulic conductivity (K) refers to the steady improvement of water through the soil under a head of water. The larger the value of hydruliac conductivity means the faster the movement of water which may be desrible in som soils while not for the others. Table (10) show the hydraulic conductivity values of the experiments conducted in El-Sheikh Zowaied experimental station after cultivating with Peanut with different applications of microbial inoculations. From the table it can be concluded the following:

1- General trend of decreasing Km values with different application under the two cultivated crops which means movement of water through soil.
2- The greater decrease values are contributed to the high dose of inoculation, by means of soil + seed + foliar > soil +seed or soil+ foliar. This could be ascribed by complement utilization of organic base treatment by different ways as soil & seed treatments utilize directly from the soil, while the foliar application utilize indirectly from the soil through enhancing plant growth.
3- The effect of complement treatments also include root growth enhancement. So, their exudates which could impede the water movement due to their viscous nature.
4- The second growth season show greater decrease in K values than the first one which render to residual effect of treatments.

Dry Stable Aggregates: Table (11) shows the four measured dry stable aggregates in the two seasons with different treatments. From the table it can be concluded the following:

1- 1.00-0.84 mm Aggregate: This size considers as the limit of erodible aggregates by wind, so the grater the amount of this size is the greater soil surface stability as well. The data indicate slight, but gradual increase in this size by increasing treatments complementary. i.e., from sole to triple treatments. Increases are more sensible in the second season than first one.

2- 0.84- 0.50mm Aggregate: The same trends in the former aggregate size have been achieved with this size, but with greater increasing values. This size is responsible for the easy uptake water with root system, so its increase is effective in the active growth of plants as a whole.

3- 0.50-0.25 mm Aggregate: The minimum increasing values are contributed with this size of aggregates with the same trends.

4-<0.25mm Aggregates: This size is responsible for reserving soil water near the wilting point WP, So increasing its value by any portion will participate in avoiding plant from dryness threaten. Similar trends are noticed for the values in this size but higher than former one but less than the first two size i.e., 1-0.84 and 0.84-0.5mm.

From the aforementioned discussion it can be concluded that the complement treatments are more effective than double or sole ones which could be described by enhancing the plant growth by different ways.

Chemical Analysis of the Experimental Soil: The data of soil chemical analysis are presented in Tables (12) and (13) soil after Peanut cultivation during two seasons for each crop. The pH value range of soil samples showed slight differences between treatments. pH for Peanut first and second season recorded 6.8 to 7.51 and initial pH before cultivation 7.88.

Also, electrical conductivity differed from season to other ranged between 0.34-1.29 for peanut compared with initial 1.63. Control 2 recorded highest chloride contents being 5.32 compared with triple inoculation treatment recorded the lowest chloride content being 1.02

The soil content for some mineral was presented in Table (12). Such as, sodium cations detected in soil sample showed high level with control 1 treatment being 1.14.

Treatment with triple inoculation recorded the highest concentration of potassium being 4.32, however the lowest concentration was determined in soil treated with control1 being 1.47. The lowest calcium content was determined in soil sample treated with triple application being 0.1. It is clear from Table (13) that soil sample of wheat not detected any amount of for carbonates. Sulphate content in soil samples ranged between 5.63 for two seasons.

Table 11: Effect of inoculation with effective microorganisms on dry stable aggregates

Treatments	Dry Stable aggregates1.0-0.84		0.84-0.5	
	Peanut 1st season	Peanut 2nd season	Peanut 1st season	Peanut 2nd season
Cont 1	0.46	0.5	0.71	0.78
Cont 2	0.48	0.51	0.73	0.8
Seed	0.48	0.51	0.73	0.83
Soil	0.49	0.54	0.77	0.86
Foliar	0.48	0.52	0.74	0.83
Soil+ Seed	0.49	0.55	0.77	0.87
Soil+ Foliar	0.49	0.56	0.77	0.87
Soil+Seed+Foliar	0.53	0.58	0.81	0.89
Treatments	Dry Stable aggregates 0.5-0.25		<0.25	
	Peanut 1st season	Peanut 2nd season	Peanut 1st season	Peanut 2nd season
Cont 1	76.3	77.06	22.53	21.66
Cont 2	76.5	77.08	22.29	21.61
Seed	76.54	77.12	22.25	21.54
Soil	76.82	77.15	21.92	78.55
Foliar	76.53	77.14	22.25	21.51
Soil+ Seed	76.86	77.19	21.88	21.39
Soil+ Foliar	76.85	77.2	21.87	21.37
Soil+Seed+Foliar	76.94	77.24	21.72	21.29

Table 12: Chemical analysis of the experimental soil.

pH	E.C.	Cation				anion				Microelement			
		Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^-	HCO_3^{--}	Cl^-	SO_4^{--}	Fe	Mn	Zn	Cu
7.88	1.63	1.5	3.58	8.72	2.49	-	4.37	5.53	6.41	0.61	0.91	0.32	0.24

Table 13: Chemical analysis after Peanut cultivation (first season).

Treatment	pH	E.C.	Cation				anion				Microelement			
			Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^-	HCO_3^{--}	Cl^-	SO_4^{--}	Fe	Mn	Zn	Cu
1	7.23	1.57	0.92	2.96	8.38	3.44	-	5.05	4.89	5.76	0.68	0.93	0.35	0.27
2	7	1.99	1.06	5.74	7.52	5.68	-	6.55	4.32	8.51	0.71	0.93	0.36	0.28
3	7.3	1.22	0.62	2.28	5.5	2.8	-	3.24	4.57	4.2	0.71	0.93	0.36	0.28
4	6.8	1.01	0.3	3.81	4.62	2.28	-	2.8	3.75	3.42	0.74	0.95	0.38	0.29
5	7.5	0.89	0.32	3.85	2.5	2.21	-	2.3	3.72	2.88	0.71	0.94	0.36	0.28
6	7.35	0.82	0.28	3.77	1.86	2.3	-	1.87	2.2	4.13	0.74	0.94	0.37	0.3
7	7.21	0.65	0.14	3.05	0.91	1.42	-	1.69	2.73	2.08	0.74	0.94	0.36	0.29
8	7.34	0.63	0.14	4.32	0.34	1.5	-	1.62	2.25	2.43	0.74	0.95	0.38	0.31

Table 13: Continue

Peanut cultivation (second season)														
1	7.51	1.08	0.79	1.47	4.9	3.64	-	4.3	2.7	3.8	0.75	0.98	0.41	0.29
2	7.12	0.75	0.52	2.88	1.5	2.8	-	3.9	2.2	1.4	0.77	0.98	0.41	0.3
3	7.38	0.7	0.43	2.62	1.25	2.7	-	3.1	1.9	2.0	0.77	0.99	0.42	0.31
4	6.94	0.68	0.39	2.71	1.1	2.6	-	2.4	1.6	2.8	0.79	1.01	0.44	0.32
5	7.31	0.68	0.38	2.65	1.2	2.57	-	2.3	1.7	2.8	0.77	1.00	0.43	0.3
6	7.48	0.63	0.37	2.68	0.55	2.7	-	2.7	1.9	1.7	0.8	1.03	0.46	0.34
7	7.29	0.54	0.31	259	0.4	2.1	-	2.5	1.3	1.6	0.8	1.02	0.45	0.33
8	7.06	0.41	0.29	2.42	0.23	1.15	-	1.5	1.48	1.12	0.82	1.03	0.46	0.35

Discussion: Application of biofertilizer is considered today to limit the use of mineral fertilizers and supports an effective tool for desert development under less polluted environments, decreasing agricultural costs, maximizing crop yield due to providing them with an available nutritive elements and growth promoting substances[24,60]. In the present study, different changes in the growth and proliferation of the microbial counts in peanut rhizosphere during all stages of plant growth was determined. On the basis of pronounced plant growth promoting, antimicrobial activities, phosphate solubilization and enzyme production of the tested isolates, five efficient isolates that display strong activity towards previous tests were selected and identified as *Azotobacter chroococcum* Az_{13}, *Bacillus megatherium 9, Pseudomonas fluorescens* 3, *Sterptomyces fulvissium*. Act_{14}. And *Aspergillus candidus* F_{16},were chosen and used as a mixture with *Lactobacillus lactis* and *Sacharromyces cerevisiae.* Their potential as biofertilizer agents to improve productivity of peanut and improve soil properties. Data showed also that total microbial counts as well as *A. chroococcum*, actinomycete, fungi *and Bacillus* population increased over a relatively long period of time during plant growth reaching the maximum values at second sampling period (flowering stage) then slightly decreased at the harvesting. This may be due to the shortage of biological nitrogen during the maturing stage of plant growth. In this respect similar conclusion were recorded by Nelson[61]; Ishac *et al*.[62]; Visser and Dennis,[63]; Kumar *et al*.[64,65]. on the other hand addition of selected effective microorganisms to soil significantly stimulated the population densities of all microbial counts and more prominently by treatment with mixture of the five biofertilizer agents as seed ,soil and foliar . This was carried out to improve sandy soil properties by modifying its texture and water holding capacity. Also, organic matter influences the solubility of certain soil minerals and makes them more readily available for plants and microbial growth and increases the soil buffering capacity. In addition, organic matter also serves as a source of energy for the growth and proliferation of microorganisms and provides them with certain essential nutrients required for their growth and activity. *Bradyrhizobium, Streptomyces* sp., *B. megatherium, P. fluorescence and A. candidus* isolated from rhizosphere of different plants and selected as biofertilizer agent possess many desirable properties, as well as they have potential for the biological control of plant pathogens. Besides the ability of *Bradyrhizobium* to fix nitrogen, all three species are able to produce the growth hormone IAA and other phytohormones, and all exhibited seedling growth promoting activities, as demonstrated in this investigation. Therefore, the response of Peanut to inoculation with the five biofertilizer agents in combined treatment to seed, foliar and soil as triple, tri or single inoculation was evaluated in two field experiments.

Several investigators reported that, providing soil with an organic matter having a wide C/N ratio, resulted in a marked increase in densities of microorganisms especially those having the capability to fix atmospheric nitrogen, accompanied by appreciable gain in soil nitrogen through N_2 -fixation process[66,67,68].

The mechanism used by microbes to stimulate plant growth include biofertilization (increasing the supply of mineral nutrients to the plant). Biological control (elimination of the plant enemies including microbial pathogens, and insects) and direct plant growth promotion (e.g. by delivering plant growth hormones to plants)[69].

Plant growth yield parameter (shoot length, root length, fresh and dry weights ,chlorophyll content, and number of leaves) were determined. In addition to the percent of nitrogen as affected by inoculation with selected effective microorganisms as a mixture were also determined. All these parameters were evaluated at different stages of peanut growth i.e., germination, flowering and harvesting stages. The highest significant increase by amending soil with organic matter, half dose of mineral fertilizers and inoculation with selected microbes as seed+soil +foliar. From the present results,

it has been found that seed bacterization with selected effective microorganisms, gave higher values. However, the percentage increase over uninoculated treatment for the previous parameters of plant growth were higher at soil>seed>foliar due to the response of peanut plant to biofertilization grown in the low fertile sandy soil. Many investigators showed that, asymbiotic nitrogen-fixing bacterium (*Azotobacter chroococcum*) were used to increase the nitrogen content of wheat straw. A 13% increase in N content occurred following bacterial inoculation. Nitrogen addition to the residual straw was 8.35-8.55 mg N/g of straw consumed. Seed inoculation with *A. chroococcum* at 1.5 kg/ha increased the yields from 1.53 to 1.71 t in 1979-80 and from 1.72 to 1.81 t in 1980-81. Applied N and/or seed inoculation increased the plant N content, grain protein content and soil N content at harvest[70].

Pati *et al*.[71]; Rabie *et al*.[72] and Arafa *et al*.[73] reported that, wheat inoculation with diazotrophs (*Azotobacter chroococcum*) increased germination, seedling growth, root growth, shoot length and crop yield. they elucidated that, inoculation with *Azotobacter chroococcum* increased plant height, shoot and root DW, total number of tillers, number of productive tillers, number and weight of speckles, grain yield/plant and grain P content.

The stimulating effect observed is due to inoculation with selected effective microorganisms on the peanut plants crop and microbial communities and activities in the rhizosphere can be explained by the capability of such microorganisms to produce growth promoting substances and nitrogen fixation which improve the plant growth and grain yield[62,74,75].

The plant growth promoting ability of biofertilizer agents isolated from rhizosphere has been reported[73,76,77,78]. The beneficial effects of antagonistic biocontrol microorganisms. Including *Azotobacter* sp., *Streptomyces* and *Cheatomium*, on tomato have been reported[79,80,81,82].

Several investigators used biofertilizers to improve soil properties to the most convenient ones for the growth of different plants and their rhizospheric microorganisms, and they also indicated that, rhizobacteria can produce plant growth promoting substances[83,84]. Similar results were obtained by Kundu and Sharma[85] and Arafa *et al*.[73] they stated that, the plant growth hormones and N_2- fixation generally increased by inoculation of wheat and sunflowers with bacteria isolated from the rhizosphere.

Data reported that hydraulic conductivity and bulk density decreases with addition of chicken manure and biofertilizer application to soil, seed and foliar. For hydraulic conductivity, this trend of decreasing soil (K) may be rendered to several reasons, (1) the soil became under cultivation.

(2) formation of small aggregates as a result of organic manure and biofertilizer application.

(3) subsequntely large pores declined against the increasing of medium, small and very small pores, (4) the root growth through the soil profile and its root hairs combined with soil separates which caused slowing in water flow, (5) the attraction and to some extent the expansion of the organic materials led to hold water and reduce its movement into the soil, and(6) the migration of fine sand from the soil surface to underneath can be contributed in partial blocking of drainble pores. These concomitant with those obtained by El-Dawwey[86], El-Sersawy[87], Abd El-Hamid *et al*.[88], Khalil[89] and Mohamed and Awad[90], where they concluded that increasing of cultivation period caused a marked decrease in soil hydraulic conductivity. In addition, by using different soil amendements such as FYM sludge, sheep dung, bentonite and town refuse, the K of light textured soil decreased Soil bulk density significantly decreased with addition of organic matter, mineral fertilizers and selected effective microorganisms this can be attributed to the low specific gravity of organic materials and the role of organic products in enhancing soil aggregation which increase the apparent soil volume and consequently decrease bulk density this results in agreement with many workers[91,92,93]. The general improve in plant growth include healthy and active root system which imply an efficient sole in improving the physical properties of soil as well both root and microbioal exudates which contains several organic compounds accumulated with those resulted from organic manure decomposition play together an enhancement role of physical properties especially with sandy soil such as the soil of experimental site. The main target of bioorganic farming technique is to improve the whole soil properties. Relatively, the improving of biological properties (like microbial counts) is easier than chemical, while both are easier compared with physical properties. So that, improving of physical properties of soil include automatically the improvement of biological and chemical properties as well. In this work, physical properties of the experimental soil were measured before cultivation and after each season of cultivation for peanut.

For soil aggregation, the product of organic matter decomposition during growth season, microbial gums and root growth promoting substances enhanced soil aggregation process, subsequently soil penetrability resistance decrease. The net result was less cohesion relation to adhesion forces between soil particles. Abd El-Ghany *et al*.[22] studied the effect of composted garbage, dry sludge and sheep wastes on some physical properties of the sandy calcareous soil and found that manturing of Wadi Sudr soil south Sinai Egypt produced favorable conditions for the formation of dry stable aggregates. They found that additions of theses wastes increased the dry stable aggregates and their effectiveness can be arranged as follows: composted garbage = sheep wastes > sludge.

Application of a mixed culture of selected effective microorganisms active in fixing N_2, producing plant growth promoting substances, antimicrobial activity and enzyme production resistant to adverse conditions is prevailing in desertic soil environments. So, we recommend to use a mixture of selected effective microorganisms active in nitrogen fixation, hormonal production, phosphate solubilization, antibiotic production and enzyme production in cultivation of plants under desert soil conditions. Artificial inoculation with selected effective microorganisms cause enhancing effect for agriculture production process improving soil properties.

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