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Improing Yield of Barley Using Bio and Nano Fertilizers under Saline Conditions

Ghada A. Z. Ibrahim and Rehab H. Hegab

Department of Soil Fertility and Microbiology - Desert Research Center, Cairo – Egypt

Abstract

The use of nano-fertilizers is an effective alternative to traditional fertilizers, as it achieves many advantages due to its use in smaller quantities, play an important role in plant nutrition and increase the ability of crops to stress through the use of plant growth-promoting (PGP) and phosphates solubilizing bacteria (PSB). A field experiment was carried out at Ras Sudr Research Station of the Desert Research Center. The experiments were conducted to study the effect of nano phosphozink at **(**50, 100 and 200 ppm) and some phosphate solubilizing bacteria on growth, chemical composition and productivity of Barley in calcareous soil, Treatments were arranged in split plot design with three replicates. The result revealed that, foliar application of Nanophosphozink fertilizer, showed a significantly higher increase of yield parameters of Barley (dry weights of biological yields, straw, grain and plant height) and nutrient contents. Phosphate solubilizing bacteriaas soil drench application (*Brevundimonasolei* and *Acinetobacter baumannii*) a repositive to produce proline, organic acids, phosphatase enzymes, catalease enzyme, peroxidase enzyme. They produced higher yields compared with other treatments. The most effective treatment was 200 ppm of Nano phosphozink with *Acinetobacter baumannii* resulted significant and higher values in this respect compared with other treatments. It could be recommended that Nano phosphozink and the biofertilizer alleviate the hazardous effects of either soil or water salinity, which negatively affect barley seed yield and quality.

Key words: *Acinetobacter baumannii, Brevundimonas olei, Productivity of barely, Nano phosphozink.*

2. Introduction

As the Egyptian people continues to increase, it is necessary to increase land reclamation to close the gap between agriculture production and food demand. There is requiring increasing the cultivated area to the surrounding desert, having mainly calcareous soils. Calcareous soils are soils rich of calcium carbonate, which occur mainly in the arid and semi-arid which contains more than 15% $CaCO_3$. Crop production in such soils is limited due to, the high $CaCO_3$ content and its effect on lowering soil fertility and nutrient availability. The high levels of calcium and magnesium that are associated with carbonates reduce the availability of phosphorus and Molybdenum. In addition, iron, boron, zinc, and manganese deficiencies are common in soils that have a high $CaCO_3$ due to reduced solubility at alkaline pH values. Therefore, it was necessary to study factors that lead to increase water and nutrients holding of these soils such as, fertilization, micronutrient application to raising the productivity of these soils. Thus, it is important to use an alternative technique to get high plant growth and productivity, (Wahba *et al*., 2019).

Barley (*Hordeum vulgare***)** is one of important crops; this plant has several uses as human foods, drink or animal feed. It is also, tolerant of salinity. Salty stress is one of the more environmental factors decrease crop production. Salinity stress do accumulation of proline and H_2O_2 in salinity - sensitive NILs, and a greater improvement in antioxidant enzyme activities in barley (*Hordeum vulgare* L.) (Zhu *et al.*, 2020).

Improving nanotechnology has possibility slow

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soliblization of fertilizers efficiency. The nanotechnology is strategies for possibility agricultural increased, Gupta and Prakash (2020). This technology of eco-friendly is likable necessary in new agricultural practices; due to its function in enhance production of plants, protection with security of environment, biological supportability and steadiness of financial. Making of nano-fertilizers is the most substantial alternative to the traditional fertilizers and pesticides, due to their possibility roles in production of crop, decreasing the utilizing of chemical fertilizers and relieve the reverse impacts in soil, Yaseen *et al*., (2020).

The indirect plant growth-promotion PGPR increase growth of plant by inhibit the plant pathogens or activity's growth and harmful rhizosphere populated microorganisms, this can happen through the lytic enzymes and antibiotics production, competition for nutrients, or resistance systemic against pathogens, Akinrinlola *et al.*, (2018). The number of soil microorganisms in soil inoculated with nano-fertilizer was significantly higher than that inoculated with chemical fertilizer, because it produces large amounts of humic acid during slow release. Humic acid is the main of soil fertility and provides carbon and nitrogen sources for soil microorganisms, VandeVoort and Arai, (2019). There is growing benefits in use of plant growth-promoting rhizobacteria (PGPR) as alternatives or supplements to use of chemicals to enhancement productivity of crops in agriculture. Studies were shown that PGPR have great possibility to increase yields and/or growth of different crops, Akinrinlola*et al*., (2018).

The objective of the present work was to study the possibility of alleviating the harmful effects soil salinity on barley plants growth and yield by folaire application of phosphozink and inoculation with soil drench of Phosphate solubilizing bacteria.

3. Materials and Methods

Particle size distribution

Nano phosphozink kindly obtained from Department of Radiological Research, Polymer Chemistry – National Center for Radiation Research and Technology, Cairo – Egypt. Nano particle size measured using dynamic light scattering (DLS, Malvern Zetasizer Nano-ZS Nano Series). The compound consists of sulphuric acid and Zink sulphate dissolved in glycerol. About 0.1 mg of sample was dispersed in 10 ml of water and sonicated for 30 min with 10 seconds on-off cycle. The samples discrete in water and the size measurements were carried out at 25°C at 90º/173º scattering angle in Central Lab. of Desert Research Center.

Isolation of bacteria used

Acinetobacter baumannii isolated from sample of sandy salt soil (Ras sudr) on Bunt and Rovera agar medium Bunt and Rovira medium (1955). *Brevundimonasolei* isolated from a sample of olive mill wastewater on Ramsay's medium (Ramsay *et al*., 1983), this strain was isolated and identified by (Omar and Ibrahim, under press).

Identification of bacteria

The isolates were identified to molecular level using partial16S rRNA gene sequence technique according to (Berg *et al*., 2002) inSigma Scientific Services Company.

Isolates were identified by dir-ect extraction of genomic DNA. The bacterial 16S rRNA gene sequences wereamplified by PCR using forward and reverse primers:

F (5′ AGA GTTTGA TCC TGG CTC AG-3′)
R (5′ -GGT TACCTT GTT ACG ACTT-3′),

The PCR was performed by using a total volume of 20 µl containing 1× Taq & Go (MP Biomedicals, Eschwege, Germany), 1.5 mM $MgCl_2$, 0.2 mM of each primer and 1 µl of template DNA (95°C, 5 min; 30 cycles of 95 °C, 30 s; 57°C, 30 s; 72°C, 90 s; and elongation at 72°C, 5 min). The PCR product was purified using Gene JET™ PCR Purification Kit (Thermo K0701). The sequencing to the PCR product was performed using ABI 3730xl DNA sequencer using forward and reverse primers (Lane, 1991).The sequences obtained from bacterial isolates were analyzed using (BLAST) tool at the National Centre for Biotechnology Information database (NCBI) Gene Bank database using the Basic Local Alignment Search Tool (BLAST) analysis tools (Altschul *et al*., 1990) to identify the most similar 16S rRNA sequences available in the Gene Bank). *Brevundimonasolei* was identified by Omar and Ibrahim (under press).

Salinity tolerance test of isolated bacteria

The turbidity of isolated bacteria grown on nutrient broth medium after 10 days incubation period at 30^{O} C was measured using a spectrophotometer at 600nm absorption using a Jas.co model 7800 UV/VIS Spectrophotometer (Jenway Model 6105 UV/ Vis spectrophotometer) at varying salt concentrations (3, 6, 9, 12, and 15%) (Jacobs and Gerstein, 1960).

Phosphatase enzyme activity

One enzyme unit of phosphatase was defined as

amount of enzyme that hydrolyzed 1mM of p-nitrophenol hour^{-1}. The sample was determined at Soil, Water and Environmental Research Institute, Agriculture Research Center. Determination free-cell supernatant assayed. After 6 days incubation at 35^{0}C and used 0.5 ml inoculum from both broth cultures individual and control sample (without inoculation) on bacterial broth cultures, then phosphorus was measured for acidic and alkaline phosphatase activity according to Tabatabi and Bremner (1969).

Total phosphorus in bacterial broth cultures

Bunt and Rovera broth medium Rovira medium (1955) was used to determine total phosphorus release by both bacteria, after 10 days incubation at 30^{o}C. Total phosphorus was determined according to Cottenie et al. (1982).

Organic acids: Quantitiy evaluation according to Anil Kumar et al., 2014).

prolin: nutrient broth medium (Jacobs and Gerstein, 1960) with 6% NaCl was used to grown both bacteria individual at 30^{0}C / 7 days. This experiment was conducted according to Bates et al. (1973), in Central Lab. of Desert Research Center.

Growth and Yield characters

A field experiment was carried out at Ras Sudr Research Station of the Desert Research Center, located at 29º 32'28" N and 32º 39'25 " E on barley (Giza 126), November 2020, to study the effect of nano phosphozink and some growth promoting bacteria to increase growth and productivity of Barley in saline calcareous soil. The main chemical and physical characteristics of used soil were carried out according to methods of Pipper (1950) and Page et al. (1982) and the obtained data were recorded in Table 1.

The statistical design of the experiment was split plot design with three replicates, whereas nano fertilizer treatments occupied the main plots and phosphate solubilizing bacteria were arranged in main plots in soil drench application. Nano phosphozink treatments were as follows; 50, 100 and 200 ppm. The addition of nano was (50 ml/L, 100 ml/L and 200 ml/L from nano solution) then prepare (10 L / treatment), while the treatments of sub main were as follows; control (no application), *Brevundimonasolei* and *Acinetobacter baumannii***,** individually. The plot area was 10.5 m^2 (3 long x 3.5 wide). Organic fertilizer at the rate of 20 m^3/ fed was applied to the experimental soil during soil preparation before two weeks sowing. All treatments received phosphate fertilizer as super phosphate **(**15.5% P_2O_5) was added at a rate of 75 kg/feddan for half of recommended dose during seed bed preparation, 100 kg of potassium sulphate (50.0% K_2O) was added at flowering stage, whereas nitrogen fertilizer was applied as ammonium sulfate (20.5% N) at rate of 250 kg/feddan of recommended dose (1/3 of the amount was incorporated in dry soil before sowing, 1/3 was added one month after sowing and the rest was added one week pre flowering stage). Flood irrigation was practiced on the plants. Barely harvest took place on May, 2021.Plant samples including straw and seeds.

Plant parameters at harvesting stage

At maturity, 1 m^2 at the center of each experimental plot was chosen to be harvested for the estimation of biological parameters (biological yields, dry weights of grain, straw and plant height) were determined according to (Black et al., 1965).

NPK and Zn content in barely grains

At maturity, 1 m^2 at the center of each experimental plot was chosen to be harvested for the estimation of biological parameters (biological yields, dry weights of grain, straw and plant height) were determined according to (Black *et al*., 1965). N, P, K and Zn were determined in acid digested solution, which was prepared according to Cottenie et al., (1982). Plant samples were wet digested using H_2O_2 and H_2SO_4 according to procedure described by Nicholson (1984).

Counting of rhizosphere microbial population of Barely plants

Total microbial population was conducted on different media as the following: Ashby's medium (Abd- El – Malek and Ishac, 1968) was used for counting of nitrogen fixers by M.P.N technique and calculated using Cochren's tables, (Cochran, 1950). Total microbial counts were estimated on nutrient agar medium (Jacobs and Gerstein, 1960). For phosphate dissolving bacteria counts Bunt and Rovira medium was used (1955).

Soil dehydrogenase activity (gTPF/g dry soil/24hr.) was analysed using 2, 3, 5-triphenyl tetrazolium chloride (TTC), Casida (1977).

Statistical analyses

The present work data was statistically analyzed and the differences between the means of the treatments were important, as they were more than the least significant differences (L.S.D) at the 5% level by using computer program of Statistix version 9 (Analytical software, 2008).

4. Results and Discussion

Characterization of Nano phosphozink

Pertaining to particle size distribution of nano phosphozink fertilizer is shown in Fig 1. The average data on Particle size distribution indicated that the particle size of nano phosphorus is 19.2 nm.

Identification of bacteria

On the basis of the consensus sequences for the 16S rRNA gene, phylogenetic trees were constructed using sequences from the three bacterial isolates (Fig. 2). Identification of bacterial strains using 16sRNA revealed that the three strains were belonged to the *Acinetobacter baumannii* accession number (NR_117677.1) and *Brevundimonas olei* (MJ15) accession number (NR 117268.1), respectively. *Brevundimonasolei* (MJ15) identified by (Omar and Ibrahim, under press).Nugroho et al. (2020) studied established that the Phosphate solubilizing bacteria (PSB) has ability to convert insoluble form of P to an available form, the mean P dissolved in liquid culture of *A. baumannii*PSB11 after 14 day incubation was (39.3 mg l^{-1}), andstrain SWSI1725 of the genus *Bacillus* showed the strongest ability with a phosphate-solubilizing content of (103.57 mg l^{-1}), respectively.

Salinity tolerance test of isolated bacteria

Figure 3 shows that the salt concentrations used were (3, 6, 9, 12 and 15%) NaCl, both bacteria can growth in salt concentrations, but the growth decrease when the salt increases. The both bacteria were salinity tolerant up to (9% NaCl w/v). Tsubouchi, et al. (2013) determined that the genus *Brevundimonas* growth for salt concentration range was 1 – 4 % (w/v) NaCl. Shete *et al*. (2015) evaluated the strains of Marine *Acinetobacter* spp. which gave high salt tolerance from 8 % to 20 % (w/v).

Phosphatase enzyme activity

According to the findings, both strains were also positive producers for alkaline and acidic phosphatase enzyme. *Brevundimonasolei* yielded 2.1ug P. nitrophenol/1ml/hr, respectively. While *Acinetobacter baumannii* yielded 2.41 ug P. nitrophenol/1ml/hr yielded alkaline, while acidic phosphatase enzyme values were 1.121 ug P. nitrophenol/1ml/hr and 0.971 ug P. nitro nitrophenol/1ml/hr, respectively after incubation for 6 days at 35°C. Margalef et al. (2017) estimated that the place scale data of phosphatase activity ranged between 0.01 and 79 µmol g^{-1} h^{-1}, with a mean of 11.6 ± 0.8 µmol g^{-1} h^{-1} and were divided along the seven continents. Lidbury et al. (2022) estimated that a large fraction of the total phosphorus rally exists in organic form, requiring mineralization to phosphate by enzymes famed as phosphatases before combination into cellular biomolecules. Phosphatases are usualy synthesized in - response - to phosphate depletion, helping with phosphorus earning.

Total phosphorus

Total phosphorus released by *Acinetobacter baumannii* was (5.75%) and for *Brevundimonas olei* was (8.3%). Gupta and Prakash (2020) recorded the highest count of bacterial urease, acid phosphatase and dehydrogenase , enzymes content in the post-harvest status of the soil. Patel et al. (2017) determined the phosphate solubilisation of the strain evaluated on the Pikovskaya agar was (3.5) and quantitative assessment of isolated strain was (27.10 µg/ml) phosphate was releases in NBRIP broth with (1.5%) tricalcium phosphate after 5 days incubation at 37°C.

The pH decreased in Bunt and Rovera broth medium were from (6.8) to (4.47) by *Brevundimonas olei* and to (4.39) by *Acinetobacter baumannii* after incubation for 5 days at 35°C, this mean that some organic acids were produced**.**

Organic acids

Both strains of bacteria used are positive producers of organic acids compared with control. Verma et al. (2015) studied these organic acids help to decrease soil pH values in plant root zone and release unavailable phosphorus. *Brevundimonas* is a PGPB that produces HCN, ammonia, indole-3-acetic acid, and ferric acid. Peix et al. (2009) investigated whether the genus *Acinetobacter* can be employed as a plant-growth stimulating rhizobacteria or as a chemical fertilizer substitute. Two strains of phosphate solubilizing bacteria (PSB) were obtained from the rhizosphere of grasses in Spain and showed a strong ability to solubilize phosphate in vitro, demonstrating their ability to stimulate plant growth.

Prolin

Both strains of bacteria used are positive producers of proline, under saline medium in vitro. The proline produce by *Acinetobacter baumannii* was 9.1 ppm and by *Brevundimonas olei* was 7.4 ppm, this agrees with Qadir et al., (2021), who studied that the *Acinetobacter bouvetii* P1 boosted sunflower by increasing the

production of enzymatic antioxidants such catalases and peroxidase. P1 also increased the production of enzymes as proline. P1 converted phosphate by solubilizing it to organic acids like indole acetic acid, gibberellic acid, and salicylic acid.The generation of phytohormones aided the growth of the host plant.

Growth and Yield characters

Data in Table 2 showed that, foliar application of Nanophosphozink fertilizer showed a significantly higher increase of yield parameters of Barley (dry weights of biological yields, straw, grain and plant height) as compared to control. Phosphate solubilizing bacteria application produced higher yields compared to control. The most effective treatment was 200ppm of Nano phosphozink with *Acinetobacter baumannii* resulted from the values 29.170a, 16.373a, 12.853 aardab/fed. and 68.627a (cm) dry weights for biological yields, grain, shoot and Plant height, respectively. This result may be due to the probable utilization of p in the form of Nano phosphozink as P and Zn released slowly for the entire growth period leading to higher photosynthetic rate and finally more accumulation of biomass yield. Similar trends were reported by Zamin et al. (2011) evaluated that *Acinetobacter* sp. PUCM1022 significantly enhanced of pearl millet seedlings in the shoot height, root length, and root dry weights in pot experiments compared with controls; confirm the plant-growth-promoting potential of these isolates. Kumar and Gera (2013) estimated that the *Brevundimona s*sp. in pot experiments, treatment Bt-cotton seeds with MDB4 increased the plants growth as shown by significant growing in height of plant (68.41 %), weight of dry shoot (58.44 %) and weight of dry root (64.81 %) over untreated control. De La Torre-Ruiz et al. (2016) studied inoculation by the plant growth-promoting bacteria strains (*Azospirillum brasilense, Rhizobium daejeonense, Acinetobacter calcoaceticus* and *Pseudomonas mosselii*) had a significant effect ($p < 0.05$) on plant growth and the sugar content of *Agave Americana*. Hegab et al. (2018a) evaluated that Application of NPK plays a significant increasing crop productivity of peanut and Yield including 1.89, 3.48, 1.46-ton fed-1 and 53.2 % for pod, straw, seeds crop compared to the other materials.

NPK and Zn content in barely grains

The nutrient content in barely grains during the two sequence seasons, the second season takes the same trend of the first season so we were taking the average values of two seasons for nutrient content. Data in Table 3 showed that Foliar application of Nanophosphozink fertilizer showed a significantly higher increase of N, P, K and Zncontents of barley grains as compared to control. Phosphate solubilizing microbeapplication produced higher yields compared to control. The most effective treatment was 200 ppm of Nano phosphozink with *Acinetobacter baumannii* resulted in the values 266, 0.046, 0.067 and 74.19 N, P, K (%) and Zn (ppm) contents, respectively. The previous facts were assured by the results obtained by Hegab et al. (2018a) studied that The N and P treatment at rate of 100% gave the highest significant value of (2.4, 4.0, 0.2, 0.3, 1.1 and 1.3% for N, P and K content in straw and seeds, respectively. The previous results agreed with those obtained by Zamin et al. (2011), Verma et al. (2015) and Gupta and Prakash (2020).

Soil phosphorus content

The availability of P in calcareous soil at the end of the experiment is presented in Fig. 4. The application of studied treatments increased the available P- Olsen in soil. Nanophosphozink was superior in increasing P- Olsen availability in soil when compared to control. The most effective treatment was 200ppm of N-phosphozink with *Acinetobacter baumannii* resulted the higher concentration of available element in soil than none applied at 0-30 cm soil depth. The inference of this finding is that the P supply from Nano source remains available long time compared with conventional fertilizer. The previous results seem to be supported by those obtained by Hegab et al. (2018b), who studied that the superior treatment Nano 500 with bio N fertilizer highly increased the available nutrients in the studied soil at layer 0-30 cm by (88, 1.73 and 99 mg/kg) for available N, P and K, respectively. Naqqash et al. (2020) reported that the *Brevundimonas* sp. TN37 had the highest phosphate solubilization capability of all the strains. In comparison to non-inoculated controls, *Brevundimonas* sp. TN37 increased growth metrics and nitrogen intake. Based on

the findings of this study, it is possible to conclude that *Brevundimonas* spp. (particularly TN37) have the ability to boost potato development and nitrogen uptake. This is the first time *Brevundimonas* spp. has been identified as an effective PGPR in potato.

Counting of microbialrhizosphere

The results shown there were increased with treatments more than controls by using 50 ppm nano phosphozinc + *Brevundimonas olei* and by using 100 ppm of nano phosphozinc + *Acinetobacter baumannii*. The total microbial counts were increased by using 100 ppm of nano phosphozink + *Acinetobacter baumannii* to (126%) and with 50 ppm Nano + *Brevundimonasolei* to(170.2%) compared with control.Nitrogen fixers' were increased by using 50 ppm of nano phosphozink + *Acinetobacter baumannii* to (199%) and by using 50 ppm of nano phosphozink + *Brevundimonasolei* to (149%) compared with control. Phosphate dissolving bacteria (PDB) increased by using treatment of 50 ppm of nano phosphozink + *Acinetobacter baumannii* to (84%) compared with control. These results agree with Patel *et al.* (2017) studied that *Acinetobacter* strain has potential to act as plant-growth promoting rhizobacteria., and with Chandrima Bhattacharyya et al. (2020) indicated usually different populations of soil bacteria are live rhizospheres of plant., these bacteria are generaly called as plant growth-promoting rhizobacteria (PGPR) and did as substitutes possibility environment-friendly of chemical fertilizers, fixing atmospheric nitrogen, release soil unsolvable phosphates and potassium and by producing different phytohormones to boost the growth of plant.Kibbey and Strevett (2019) studied this experiment was about doing an examination of how nanomaterials affect rhizosphere bacteria, and plant growth. Lettuce seeds were grown in suspensions of 3 different nanoparticles. Two nanomaterials (titanium dioxide nanoparticles and polystyrene-modified nanoshells) caused a significant reduction in plant root and stem growth and the number of rhizosphere bacteria. On the contrary, (nanoshells of sulfate modified –polystyrene) increased the count of rhizosphere bacteria, but had no significant impact on growth.

Dehydrogenase enzyme activity increased to (37%) by using treatment of 100 ppm nano phosphozink + *Acinetobacter baumannii*and using treatment of 50 ppm + *Brevundimonas olei* (TTC) increased to (34%) compared with controls. Meena and Rao (2021) reported that the enzyme activities are indicators of fertility and soil health.

6. Conclusion

Previous results showed that foliar application of Nano phosphozink fertilizer and inoculation with phosphate solubilizing bacteria treatment gave the highest significant yield, and N, P, K, and Zn content of the barley crop. The most effective treatment was 200ppm of N-phosphozink with *Acinetobacter baumannii* resulted the higher concentration of P- o availability in soil than none applied at 0-30 cm soil depth. Also, we can recommend that the application of these amendments may provide a useful way to reduce the adverse effects of salinity stress on barley crop grown in saline soil.

7. References

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تحسين انتاجية الشعير باستخدام التسميد الحيوي والنانوي تحت ظروف الأرض الملحية

غادة أمين زكى إبراهيم ورحاب حلمى حجاب
قسم خصوبة وميكروبيولوجيا الأراضى-مركز بحوث الصحراء

كما هو معروف فإن مشكلة الاراضى المصريه تكمن في انها اراضى قلوية مما يسبب عدم قدرة النباتات على الاستفادة من العناصر الغذائية كالفوسفور والذى يوجد فى صور غير قابلة لامتصاص النبات خاصة تحت ظروف الملوحه فى هذه الدراسة نحاول الاسهام في حل هذه المشكله عن طريق استخدام التسميد الحيوي بسلالتين من البكتيريا المحفزه لنمو النبات والميسره للفوسفور، مع استخدام مركب كيميائي نانومتري (نانو فوسفوزنك) والذى بدوره يسهم بإمداد نبات الشعير باحتياجاته من الفوسفور بشكل ايسر وابسط من الاسمدة الكيميائية التقليدية والتى ثبتت اضرارها العديدة على الانسان والبيئة فضلا عن ارتفاع اثمانها وعدم استفادة النبات من غالبيتة الكمية المضافة فى التسميد نظرا لفقدها من خلال التربة. اثبتت التجارب ان استخدام تركيز 50 و 100 جزء فى المليون مع كل بكتيريا على حده يعطى نتائج مرتفعه فى القياسات النباتية نظرا لانه سهل وسريع الامتصاص ويستهلك النبات منه معظم الكمية المضافه عن غيره من الاسمدة الكيميائية. وقد وجدنا بالتجربة ان كل من السلالتين البكتيريتين المستخدمتان *Brevundimonasolei* و*Acinetobacterbaumannii* لهما القدرة على انتاج احماض عضوية وبذلك يكون لهما القدره على التقليل من قلوية التربه فى منطقة الريزوسفير وكذلك لهما القدرة على انتاج انزيمات الفوسفاتيز التى تحرر الفوسفات من المادة العضوية (والتى تم اضافتها مع تجهيز الارض فى بداية التجربه)، كما ان للسلالتين القدرة على النمو فى مدى من املاح كلوريد الصوديوم مما يسهل نموه في اراضى راس سدر الملحيه محل الدراسة. وكانت افضل تركيزات لانتاج المحصول وقيم النيتروجين والفوسفور والبوتاسيوم والزنك في النباتوالتربة عند 200 جزء فى المليون مع بكتيريا*Acinetobacterbaumannii*
هذا ما استطعنا دراسته فى هذا البحث ولكن لابد من مواصلة الدراسات والابحاث على تلك المواد النانوميترية بشكل عام لمعرفة مدى تأثيراتها السلبية على الانسان ومدى ترسبها بالتربة وفى النبات وتأثير ذلك على الكائنات الحية الدقيقة وعلى البيئة بشكل عام.

TABLE 1. Some physical and chemical properties of the studied soil and the chemical analysis of irrigation water

Depth cm	pH	E.C dS/m	OM	$CaCO_3$	Particle size distributes			C.E.C $emol_c kg^{-1}$	Texture
					Sand	Silt	Clay		
			%			%			
0-30	7.73	8.56	2.28	26.9	81.2	8.57	10.23	5.81	L.S
30-60	7.96	7.35	1.73	27.4	80.08	10.59	9.33	6.65	L.S

Soluble cations and anions in soil ($mmol_c L^{-1}$)

	Na^+	K^+	Ca^{+2}	Mg^{+2}	HCO_3^-	Cl^-	SO_4^{2-}
0-30	47.1	8.9	24.4	5.2	8.1	51.3	26.2
30-60	41.2	12.7	15.8	3.8	3.5	46.5	23.5

Available nutrients in soil ($mg\ kg^{-1}$)

	N	P	K	Fe	Mn	Zn	Cu
0-30	36.8	5.19	48.5	4.26	2.18	1.25	0.57
30-60	21.5	3.84	52.3	4.64	2.23	1.31	0.66

E.C, pH, soluble cations and anions of irrigation water ($mmol_c L^{-1}$)

	pH	EC	Na^+	K^+	Ca^{+2}	Mg^{+2}	HCO_3^-	Cl^-	SO_4^{2-}
	7.94	7.85	46.9	2.62	20.5	8.48	6.3	47.5	24.7

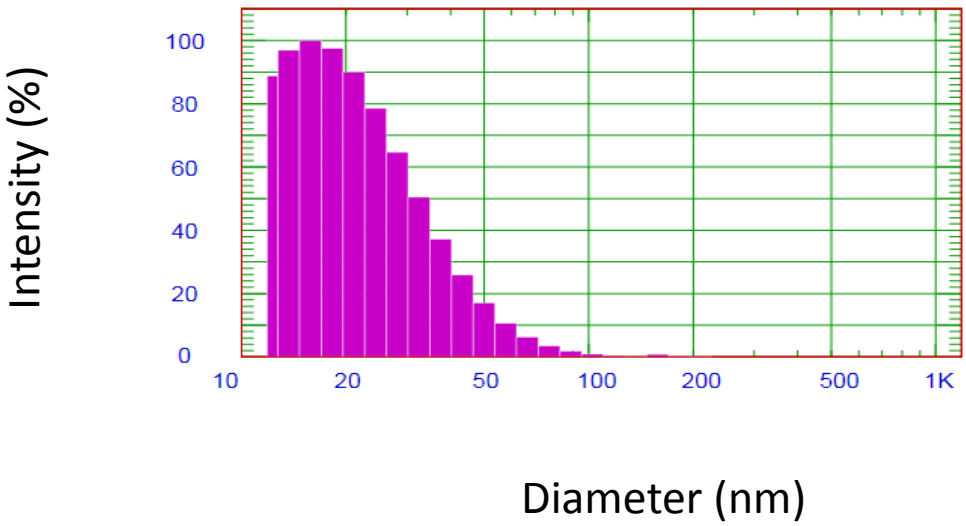

Fig. 1. Particle size distribution (in nm) of Nano phosphozink fertilizers

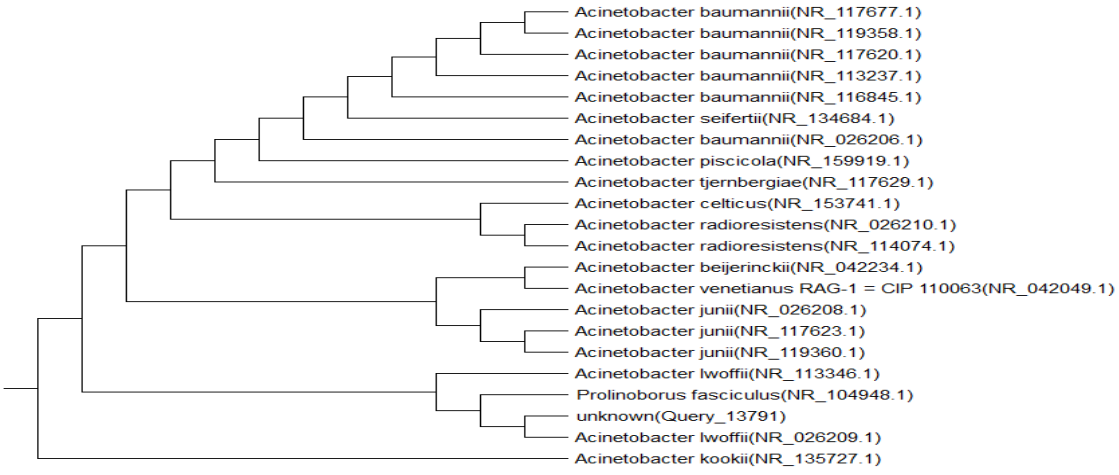

Fig. 2. The identify tree based on the 16S rRNA sequences of *Acinetobacter baumannii*with related 16S rRNA sequences found in Gen Bank database

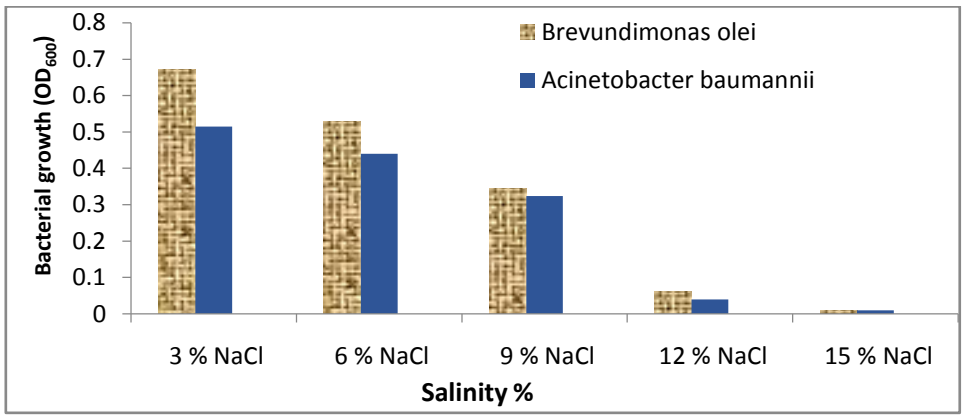

Fig. 3. Bacterial growth on salt medium with different NaCl concentrations

TABLE 2. Growthand yield parameters of barley in the field

Treatments		Total weight (ardab/fed.)	Grain weight (ardab/fed.)	Straw weight (ardab/fed.)	Length (Cm)
Control	Water only	18.657j	10.603l	8.053i	62.727l
	Brevundimonasolei	20.830i	11.510k	9.320g	63.340k
	Acinetobacter baumannii	21.870h	12.297j	9.570f	64.253j
50ppm N-phosphozink	without	21.773h	12.683i	9.093h	64.660i
	Brevundimonasolei	22.940g	12.860h	10.080e	65.677h
	Acinetobacter baumannii	25.113f	13.480g	11.630d	65.980g
100ppm N-phosphozink	without	25.630e	14.083f	11.540d	66.187f
	Brevundimonasolei	26.993d	14.447e	12.547b	66.693e
	Acinetobacter baumannii	27.770c	14.923d	12.793a	67.060d
200ppm N-phosphozink	without	27.340cd	15.513c	11.830c	67.407c
	Brevundimonasolei	28.617[b]	16.080[b]	12.537[b]	67.913[b]
	Acinetobacter baumannii	29.170a	16.373a	12.853a	68.627a
LSD (0.05)		0.4855	0.3314	0.1806	0.1478

TABLE 3. NPK content in barely grains

Treatments		N (%)	P (%)	K (%)	Zn (ppm)
Control	Water only	1.95l	0.36g	0.40g	4.59h
	Brevundimonasolei	2.07k	0.38f	0.47f	29.72g
	Acinetobacter baumannii	2.15j	0.39e	0.52e	31.42g
50ppm N-phosphozink	without	2.19i	0.44d	0.52e	32.62fg
	Brevundimonasolei	2.24h	0.44c	0.55d	33.10fg
	Acinetobacter baumannii	2.29g	0.45c	0.56d	35.52f
100ppm N-phosphozink	without	2.34f	0.45bc	0.56d	39.15e
	Brevundimonasolei	2.44e	0.45bc	0.56d	40.60de
	Acinetobacter baumannii	2.51d	0.45bc	0.56d	43.26d
200ppm N-phosphozink	without	2.55c	0.45ab	0.62c	58.96c
	Brevundimonasolei	2.61b	0.46a	0.67b	66.70b
	Acinetobacterbaumannii	2.66 a	0.46a	0.67a	74.19a
LSD (0.05)		0.0390	0.00613	0.0142	3.4853

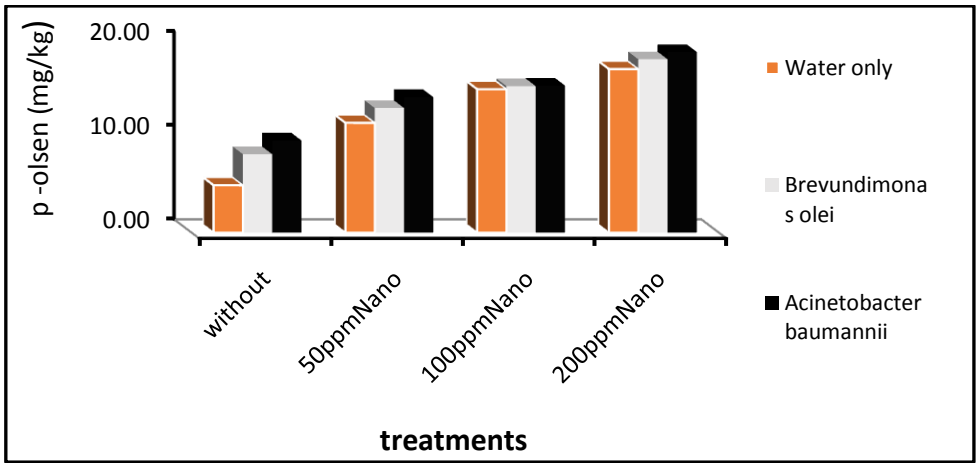

Fig. 4. Soil phosphorus content

TABLE 4. Rhizosphere microbial counts

Treatments		Total count (10^4CFU/gm dry soil)	Nitrogen fixers (MPN/gm dry soil)	PDB counts (CFU/gm dry soil)	Dehydrogenase (enzyme µg TPF/g dry soil/24h)
	Water only	31	$29*10^3$	$6*10^3$	5
Control	***Brevundimonasolei***	50	$60*10^3$	$20*10^3$	16
	Acinetobacter baumannii	62	$69*10^3$	$18*10^3$	22
50ppm	**Nano only**	47	$145*10^2$	$55*10^2$	20
Nano-	**Nano+ *Brevundimonasolei***	127	$150*10^3$	$42*10^3$	35
phospho-zink	**Nano+ *Acinetobacterbaumannii***	71	$200*10^3$	$85*10^3$	25
100ppm	Nano only	117	$180*10^2$	$51*10^2$	29
Nano-	**Nano+ *Brevundimonasolei***	59	$290*10^2$	$84*10^2$	18
phospho-zink	**Nano+ *Acinetobacter baumannii***	142	$104*10^3$	$56*10^2$	38
200ppm	**Nano only**	115	$198*10^2$	$45*10^3$	35
Nano-	**Nano+ *Brevundimonasolei***	114	$125*10^3$	$74*10^2$	33
phospho-zink	**Nano+ *Acinetobacter baumannii***	110	$97*10^3$	$84*10^2$	29