



Plant Pathology Journal

ISSN 1812-5387

science
alert

ANSI*net*
an open access publisher
<http://ansinet.com>



Research Article

Effect of NPK Nano-fertilizers and Compost on Soil Fertility and Root Rot Severity of Soybean Plants Caused by *Rhizoctonia solani*

¹Sahar A. El-Sayed, ²Awad A. Algarni and ³Khaled A.H. Shaban

¹Plant Pathology Research Institute, Agriculture Researcher Center, Giza, Egypt

²Department of Biology, College of Arts and Sciences in Baljurashi, Al-Baha University, Saudi Arabia

³Soils Water Research Institute and Environment, Agriculture Researcher Center, Giza, Egypt

Abstract

Background and Objective: Human health is closely related to plants, especially with natural treatments such as; chemical fertilizers and composts as well as nano-particles and their use in a way that reduces the infection of plants with fungal diseases. The present study aimed to study the evaluation between role of nano-fertilizers and compost used on the soil fertility and their use in a way that reduces the infection of plants with fungal diseases. **Materials and Methods:** A field experiment was carried out during the Saumur seasons of 2018 and 2019 at Gelban village. The study was conducted to test the evaluation of foliar application of NPK nano-fertilizers and compost with or without mineral NPK fertilizers on some of the soil properties and soybean productivity. The design of the experiment was a complete randomized block with three replications. **Results:** The soil pH is characterized by slightly to moderately alkaline conditions, where the soil pH values are always around 7.95 to 8.08. The mean values of EC tented to 5.87 to 4.43. The highest of mean values is available in N, P, K, Fe, Mn and Zn contents in soil as affected by compost followed by NPK nano-fertilizers. The increase of plant characters and weight of seeds yield (t/fed) as affected with foliar application NPK nano-fertilizers combined with mineral NPK fertilizers at different rates. The application of compost or nano-NPK fertilizers was significant for Fe concentration in seeds, Mn and Zn concentrations were no significant. **Conclusion:** Application of NPK nano-fertilizers caused a reduction in incidence and severity diseases on plants in greenhouse and field experiments. In field experiments results indicated that the most effective treatment was NPK nano-fertilizers than control.

Key words: Nano-fertilizers, compost, soil properties, severity diseases, alkaline, *Rhizoctonia solani*, soil salinity

Citation: Sahar A. El-Sayed, Awad A. Algarni and Khaled A. H. Shaban, 2020. Effect of NPK nano-fertilizers and compost on soil fertility and root rot severity of soybean plants caused by *Rhizoctonia solani*. Plant Pathol. J., 19: 140-150.

Corresponding Author: Sahar Abbas El-Sayed, Plant Pathology Research Institute, Agriculture Researcher Center, Giza, Egypt

Copyright: © 2020 Sahar A. El-Sayed *et al.* This is an open access article distributed under the terms of the creative commons attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

North West area of Sinai (El-Tina Plain) is a recent reclaimed area bounded by long. 32°20'00"E and 32°33'25"E and lat. 30°57'15"N and 31°04'02"N, to monitor the changes that occurred in land uses over the period between 2000 and 2014 years by using the multi-temporal analysis of satellite imagery and in some characteristics of the soil (soil salinity and ground water level) that hinder or reduce crop productivity¹. Soil salinity is the major soil limitation factor for agricultural production in El-Tina plain region, El-Salam canal project, Egypt². The application of chemical fertilizers in the long time and has tremendously increased crop yields. However, they lead to soil mineral imbalance, destroy the soil structure, soil fertility and general ecosystem, which are serious impediments in the long term. To deal with the situation, it is pertinent to develop smart materials that can release nutrients to targeted areas and contribute to clean environment³. Fertilizer application plays a pivotal role in increasing the agricultural production, however, the excessive usages of fertilizers irreversibly alter the chemical ecology of soil, further reducing the available area for crop production. Indeed, the assistance of nano-technology in plant protection products has exponentially increased, which may assure increased crop yield. Moreover, the major concern in agricultural production is to enable accelerated adaptation of plants to progressive climate change factors, such as; extreme temperatures, water deficiency, salinity, alkalinity and environmental pollution with toxic metals without threatening existing sensitive ecosystems³.

Nano-fertilizers are more advantageous to the conventional fertilizers because they can triple the effectiveness of the nutrients, reduce the requirement of chemical fertilizers, make the crops drought and disease resistant and are less hazardous to the environment. They can easily get absorbed by plants due to their high surface area to volume ratio. The sizes and morphologies of nano-particles are however strong factors that determine the level of bio-accessibility by the plants from the soil⁴. Urban agriculture that makes use of recent nano-technologies has the potential to contribute immensely to food security and healthy nutrition. Although there are associated risks from chemicals which may have emanated from soils, water or air⁵. Nano-fertilizers increase growth parameters (plant height, leaf area and number of leaves per plant) dry matter production, chlorophyll production, rate of the photosynthesis which results more production and translocation of photosynthesis to different parts of the plant as compare with the traditional fertilizers⁶. Nano-NPK fertilizers source significantly enhanced

plant growth parameters i.e., (Plant height (cm), spike length (cm), chlorophyll (SPAD), N, P and K content in leaves) in wheat⁷. Nano-fertilizers facilitate slow and steady release of nutrients and thereby, reduce the loss of nutrients and enhance the nutrient use efficiency⁸.

Compost is an organic matter resource resulted from exploiting wastes through the controlled bioconversion process. Compost amendments in improving physical, chemical and biological properties of soil that depends on the amount and composition⁹. Compost application significantly increased the tolerance against salt stress resulted from improving membrane stability and accumulation of K and proline, on the contrary, decreased Na⁺ content in some crops. Composted organic matter application to soil might have a potential effect on plant growth, yield and quality¹⁰. Application of compost combined with mineral nitrogen in saline soil were increase of available N, P, K, Fe, Zn and Mn content of saline soil and increased N, P, K, Fe, Zn and Mn uptake of straw and grain¹¹.

In fact, most salt-affected soils are deficient in nitrogen (N), phosphorus (P) and potassium (K). Application of compost in such soil enriches the rhizosphere with micro and macro-nutrient elements and counteracts nutrient depletion¹².

Soybean (*Glycine max.* L.) is decline in some areas of Egypt, where it reached to about 7,812 ha in 2016 (Bulletin of Statistical Cost Production and Net Return, 2016). Soybean consumption in Egypt in 2019/2020 was recorded 3.93 million Mt, up over 14%. Soybean (*Glycine max.*(L.) Merr.) is a major source of protein, energy, polyunsaturated fat, fibers and flavones both for humans and livestock¹³. Soybean grain filling duration decreased with increasing salinity and resulted in decreasing final grain weight. In contrast, seed growth rate was significantly reduced under control and mild salinity stresses (3 and 6 dS m⁻¹)¹⁴. Soybean is an important grain legume due to its high protein (35%), oil content (21%) and nitrogen fixing ability (17-127 kg/ha/year). Soybean contains vitamins B1, B2 and B6 as well as flavones are also available in soybean grains¹⁵.

Several pathogens cause seedling diseases including many species of *Pythium* and *Fusarium*, *Rhizoctonia solni*, *Phthophthora sojae*, *Macrophomina phaseolina* and *Mycoleptodiscus terrestris*¹⁶. These pathogens may survive in the soil for years and infect soybean over a wide range of environment conditions. Seedling pathogens may infect individually or in combination¹⁷. Though more than 200 pathogens are known to affect the soybean around the world, only 35 are economically important¹⁸. A number of scientists have conducted studies to understand the effect of silver nano-particles on seed germination and seedling growth of

plants^{19,20}. Effect of silver nano-particles in two varieties of wheat and barley noted increased in germination ratio, stem length and reduced length root as compared to the control are studied²¹. Abou-Zeid and Moustafa²² indicated that low concentration of particles nano-particles increased seed germination and seedling growth of fenugreek plant.

Aim of this study was to determine the effect of foliar application of NPK nano-fertilizers and compost with or without mineral NPK fertilizer different rates on some soil properties and soybean productivity under newly reclaimed soil.

MATERIALS AND METHODS

A field experiment was carried out during the Saumur seasons of 2018 and 2019 at Gelban village. The site lies in the north-west in coast of Sinai, between 32°20'00"E and 32°33'25"E and lat. 30°57'15"N and 31°04'02"N. The study was conducted to test the evaluation of foliar application NPK nano-fertilizers and compost with or without mineral NPK fertilizers on some soil properties and soybean productivity²³. The design of the experiment was a complete randomized block with three replications.

Some physical and chemical properties of the studied soil before planting were determined to the methods described by Cottenie *et al.*²⁴, Page *et al.*²⁵ and Kulte²⁶ shown in Table 1.

Compost analysis was done according to the standard methods as described by Brunner and Wasmer²⁷. Chemical composition of the compost used as shown in Table 2.

All farming processes were carried out before planting. Also, the soils were fertilized by compost as organic fertilizer

at rate of 10 t/fed before 20 days from planting. Super calcium phosphate (15.5% P₂O₅) was applied at rates of 0, 25, 50 and 100 kg/fed during tillage soil.

The soil was irrigated from El-Salam canal (a mixture of (1:1) Nile water and agricultural drainage water).

Soybean (*Glycine max*) was Giza 111 which obtained from Crops Institute Agriculture Research Center, Giza, Egypt. The area of each experimental unit (plot) was 5×10 m which divided into rows with 50 cm.

Soybean seeds inoculation with biofertilizer were prepared from of *Brady rhizobium* just before sowing. Seedling was carried on May 15th, 2018 and May 12th, 2019 for the first and second season, respectively. The plants were thinned to a single plant per hill after 21 days from sowing.

Urea (46% N) was applied at rates (0, 10, 20 and 30 kg N/fed) fertilizer on three equal doses after 21, 42 and 65 days from planting. Potassium sulphate (48% K₂O) was applied at rates (0, 20, 40 and 60 kg K₂O/fed) on two equal doses after 21 and 45 days from planting.

Nano-nitrogen fertilizer 400 ppm N (N), nano-phosphorus fertilizer 600 ppm P (P) and nano-potassium fertilizer 500 ppm K (K) foliar application on soil and plants were conducted early in the morning through applying 200 L/fed of mixture on three period after 21, 45 and 65 days from planting.

Source of pathogens: Virulent isolates of *Rhizoctonia solani* previously isolated from soybean roots were obtained from Legume District Department, Plant Pathology Research, ARC.

Formalin disinfested clay soils was infested with 2% inoculum level of any of *Rhizoctonia solani* grown on autoclaved barley medium in 500 glass bottles. The infested

Table 1: Physical and chemical properties in soil study in Galban North Sinai

Coarse sand (%)	Fin sand (%)	Silt (%)	Clay (%)	Texture	Organic matter (%)	**SAR	CaCO ₃ (%)	
5.88	40.46	23.10	30.56	Sandy clay loam	0.60	17.12	12.85	
Cations (meq L ⁻¹)				Anions (meq L ⁻¹)				
pH (1:2.5)	EC* (dS m ⁻¹)	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	HCO ₃ ⁻	Cl ⁻	SO ⁻⁴
8.14	9.74	11.90	18.30	66.42	0.78	9.40	57.66	30.34
Available macro-nutrients (mg kg ⁻¹)				Available micro-nutrients (mg kg ⁻¹)				
N	P	K		Fe	Mn		Zn	
37.88	4.39	185.00		2.80	1.94		0.55	

*EC: Soil salinity (soil past), **SAR: Sodium adsorption rate

Table 2: Chemical composition of the compost used in the experiment

*EC (dS m ⁻¹)	pH (1:2.5)	Bulk density (g cm ⁻³)	Water holding capacity (%)	Organic matter (%)	Total macro-nutrients (%)			**C/N ratio
(1:5) (Manure: water extr.)	(Manure: water sus.)				N	P	K	
3.76	7.25	0.35	160	37.69	1.83	0.88	2.23	17.80

*EC: Soil salinity (soil past), **Carbon: Nitrogen ratio

soil was distributed in plastic pots (25 cm in diameter) and irrigated one week before sowing the seeds. Ten seeds of soybean of any of the aforementioned treatments were sown in each pot and six pots were used as a particular treatment. Disease incidence was recorded as the percentages of pre and post-emergence damping-off, as well as survived plants 15, 30 and 45 days after sowing, respectively. Also, root-rot severity was assessed 60 days after sowing by using the devised scale (0-5%) according to Salt²⁸ as follows:

$$\text{Root-rot severity (\%)} = \frac{\text{Sum of } nxv}{5N} \times 100$$

Where:

- N : Number of roots in each category
- V : Numerical value of each category
- N : Total number of roots in the samples

Field experiments: The incidence of pre and post-emergence damping-off was determined 15 and 30 days after sowing. Also, the survived plants were counted 45 days after sowing, 10 randomized plants were gently pulled-off, 5 days after irrigation to assess the severity of root-rot as mentioned before.

At harvesting was in 25 September, 2018 and 2019, respectively. The soybean plants were harvested at full maturity, ten plants were randomly taken from each plot to record the average of the following traits: plant length, No. of branches, No. of pods/plant, weight of 100 seeds (g), weight of pods (t/fed) and weight of seeds yield (t/fed).

Soil analysis: After harvest, sample of the surface soil layers (0-30 cm) from each plot were taken. Samples were analyzed for EC (in soil past extract), pH (in 1:2.5 soils:water suspension) organic matter, calcium carbonate and available N, P, K, Fe, Mn, Zn and Cu as described by Page *et al.*²⁵, Klute²⁶ and Soltanpour²⁹.

Plant analysis: Both straw and pods were air-dried and oven dried at 70°C for 48 h dry yield of straw. Ether of oven-dried straw or seeds were ground and kept in plastic bags for chemical analysis. A 0.5 g of each oven dried ground plant sample was digested using H₂SO₄⁻⁴, HClO₄ mixture according to the method described by Salt²⁸. The plant content of N, P, K, Fe, Mn and Zn was determined in plant digestion using the methods described by Hojjat²³ and Cottenie *et al.*²⁴. Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 6.25³⁰.

Statistical analysis: The collected data were subjected to statistical analysis using analysis of variance and LSD at 5% level with MSTAT computer program according to Bates *et al.*³¹.

RESULTS AND DISCUSSION

Effect of compost and nano-fertilizers on some soil properties:

Data presented in Table 3 showed that the application of compost and foliar application combined with or without mineral NPK fertilizers on pH soil were decreases slightly. The soil pH minimum was achieved by compost plus

Table 3: pH, EC and available macro and micro-nutrients contents in soil study

Treatments	N+P+K rates (kg/fed)	pH (1:2.5)	EC (dS m ⁻¹)	Available macro-nutrients (mg kg ⁻¹)			Available micro-nutrients (mg kg ⁻¹)		
				N	P	K	Fe	Mn	Zn
Mineral	0+0+0	8.08	7.95	38.52	4.49	188.00	2.89	1.94	0.57
	10+25+20	8.06	6.23	40.13	4.98	193.00	2.97	1.98	0.61
	20+50+40	8.05	4.80	41.65	5.02	195.00	3.02	2.01	0.63
	30+100+60	8.03	4.48	41.95	5.08	198.00	3.08	2.05	0.65
Mean	-	5.87	40.56	4.89	193.50	2.99	2.00	0.62	
Compost	0+0+0	8.02	6.73	39.14	4.85	190.00	2.96	1.98	0.60
	10+25+20	8.01	5.34	41.35	5.07	197.00	3.05	2.10	0.66
	20+50+40	7.97	4.13	42.76	5.13	203.00	3.09	2.16	0.72
	30+100+60	7.95	3.28	44.59	5.24	207.00	3.13	2.25	0.78
Mean	-	4.87	41.96	5.07	199.25	3.06	2.12	0.69	
Nano-NPK	0+0+0	8.04	5.48	38.98	4.80	189.00	2.93	1.95	0.59
	10+25+20	8.02	4.55	40.88	5.05	197.00	2.99	2.07	0.63
	20+50+40	7.98	3.90	41.75	5.11	203.00	3.04	2.12	0.71
	30+100+60	7.96	3.79	43.55	5.19	210.00	3.10	2.22	0.75
Mean	-	-	4.43	41.29	5.04	199.75	3.02	2.09	0.67
LSD 0.05 N rates	-	-	1.23	ns	ns	1.31	Ns	Ns	0.047
LSD 0.05 amendments	-	-	ns	ns	ns	ns	Ns	Ns	0.020
Interaction	-	-	***	***	ns	***	Ns	Ns	***

EC: Electrical conductivity of soil salinity (extract soil pest), ***High significant

NPK mineral fertilizers (30-100-60 kg/fed) followed by NPK nano-fertilizers combined with NPK (30-100-60 kg/fed) compared with other treatments. The soil pH is characterized by slightly to moderately alkaline conditions, where the soil pH values is always around 8.08-7.95. Reductions in soil pH value may be related to the residual organic compound, active of micro-organisms and released organic acids. These results are in agreement by Hymowitz *et al.*³², reported that the applied composts decreased both pH and EC of sandy soil over the growing period of the cultivated plants. The reduction of pH may be attributed to the production of organic acids resulted from the microbial activity. El-Ghamry *et al.*³³ suggested that the used of nano-fertilizers on soil led to improve soil pH reflected product organic mater and biological activity.

Soil salinity EC soil: Results showed the E_c values of studied soils after soybean harvest, data present in Table 3 revealed that the E_c values in the studied soils tend to decrease by increasing the rates of mineral fertilizers plus compost or NPK nano-fertilizers. The mean values of EC tented to 5.87 to 4.43. As well as, the minimum EC values was 3.79 dSm⁻¹ for soil treated with NPK nano-fertilizers combined with 30-100-60 NPK mineral fertilizers than other treatments. These results may be due to the applied compost and nano-fertilizers plus NPK mineral fertilizers led to activity of micro-organism to reduce salinity and simultaneously improve characterization of soil structure (increasing drainable porosity and aggregate stability) and consequently enhanced leaching process through growth of soybean. On the other hand, the application of NPK mineral fertilizers in different rates were significant increasing affect on soil salinity, while the used soil amendments i.e., compost and NPK nano-fertilizers were no significant. The interaction between NPK mineral fertilizers combined with soil amendments application led to significant decrease of soil salinity. These results showed that the efficiency use of all the treatments for soil salinity could be arranged as shown in the following order: compost>Mineral fertilizers>NPK nano-fertilizers> without mineral fertilizers. Diacono and Montemurro³⁴ reported that the application of compost to saline soil led to decrease bulk density and soil EC. Al-Taey *et al.*³⁵ found that the compost decreasing the EC of soil under salinity stress. This may be due to the role of organic matter in soil reconstruction and improved porosity permeability, which leads to leaching the salts.

Available macro-nutrients contents in soil: Results in Table 3 showed the amounts of some available macro-nutrients i.e., N, P and K (mg kg⁻¹) in soil as affected by

all treatments alone or combined with NPK mineral fertilizers different rates were increases by increasing different rates of mineral fertilizers. The highest of mean values available N, P and K contents in soil as affected by compost followed by NPK nano-fertilizers. The application of compost and foliar application of NPK nano fertilizer were no significant for N and P contents in soil, while the NPK mineral fertilizers different rates were significant for K content in soil. The interaction between mineral fertilizers and soil amendments on available N and K content in soil were significant increases with increasing different rates, while the P was no significant. Azarpour *et al.*³⁶ showed that the use of nano-fertilizers causes an increase in nutrients in soil.

It is worthy to mention that the relative increases of soil available N, P and K contents in soil after soybean harvest showed gradually increases as follows: Compost>NPK nano-fertilizers>NPK mineral fertilizers>without NPK fertilizers, respectively. El-Ghamry *et al.*³³ raveled that the application of compost led to improving nitrogen fixation of soybean and increase of macronutrients in soil under salinity stress conditions. Khaled *et al.*³⁷ found that the available N, P and K in saline soil were significantly influenced with compost application. From these results could be caused the increase of N, P and K contents in soil were more associated with the treatments of compost and NPK nano-fertilizers, which is possibly due to the active micro-organisms in soil and their biological activity in particular and help build up the micro flora may increased the soil organic matter in soil showed several benefits over chemical fertilizers and improved fertility of saline soils. The nano-fertilizer NPK application led to the obtained highest available nitrogen, phosphorus and potassium content compared with without nano-fertilizer³⁸.

Available micro-nutrients contents in soil: It is evident from data presented in Table 3 which showed the increase of available micro-nutrients contents in soil i.e., Fe, Mn and Zn mg kg⁻¹ soil as affected with compost and NPK nano-fertilizers. This is more related to the residual organic compounds and chemical changes. The micro-nutrients contents in soil after soybean harvest under the studied various treatments were no significant for Fe and Mn, while the Zn was significant increases affect. These results are in agreement by Mousa and Shaban³⁹, who found that effect of compost at different rates on Fe, Mn and Zn contents in soil was no significant.

In general the positive effects of the used compost and nano-NPK fertilizers on available Fe, Mn and Zn could be arranged in the following order:

- Mineral fertilizers>compost>nano-fertilizers for Fe content in soil with or without mineral fertilizers at different rates
- Nano-fertilizers>compost>mineral fertilizers for Mn content in soil with or without mineral fertilizers at different rates
- Compost>nano-fertilizers>mineral fertilizers for Zn content in soil with or without mineral fertilizers at different rates

The increase of micro-nutrients in soil depends on the increase of soil organic matter in surface layers as affected by compost application and foliar application of nano-fertilizers. Thus, it could be concluded that, the more pronounced increase in the available Fe, Mn and Zn contents in saline soils as a result of increasing the applied compost may be attributed to improve soil pH. It is reported⁴⁰ that the application of compost increased significantly of the available Fe, Mn and Zn in the saline soil. The nano-particles (N and P) absorption of fertilizer and enhances the effect of solution by increasing the availability of Fe and Zn, which are involved in the salt tolerance mechanism⁴¹.

Effect of NPK nano-fertilizers and compost on the incidence and root rot severity of soybean plants under greenhouse conditions: Effect of NPK nano-fertilizers and compost on the incidence and root rot severity of soybean plants in soil untested with specific formal species of *Rhizoctonia solani* under greenhouse conditions as shown in Table 4. The obtained data showed that the percentage of pre and post-

emergence damping-off, survival plants and root rot (%) caused by the fungal pathogens, *Rhizoctonia solani*. All treatments significantly reduced the development of root rot diseases under greenhouse condition compared with control. The highest percentage of survival plant in soy bean was resulted in nano-particles.

Effect of NPK nano-fertilizers and compost on the incidence and root rot severity of soybean plants under field condition:

The effect of the used compost and NPK nano-fertilizers with or without NPK mineral fertilizers different rates on soybean productivity as shown in Table 5. The obtained data showed that the decrease pre and post-emergence damping-off on soy bean under field conditions during two successive seasons. The results revealed that application of compost and nano-particles significantly reduced pre and post-emergence damping-off, survival plants and root rot (%) compared to un treated plants (control). In general, the protection degree offered by nano-particles applied at rate of 30+100+60 kg/fed was much higher than untreated control¹⁹⁻²¹.

The incidence of pre and post-emergence damping-off was determined 15 and 30 days after sowing. Also, the survived plants were counted 45 days after sowing , ten randomized plants were gently pulled-off , 5 days after irrigation to assess the severity of root-rot as mentioned before. The incidence of pre and post-emergence damping-off was determined 15 and 30 days after sowing. Also, the survived plants were counted 45 days after sowing, ten

Table 4: Effect of NPK nano-fertilizers and compost on the incidence and root rot severity of soybean plants under greenhouse conditions

Treatments	N+P+K (kg/fed)	Pre-emergence damping-off (%)	Post-emergence damping-off (%)	Survival plant (%)	Root rot (%)
Mineral	0+0+0	3.33	20.00	56.67	61.67
	10+25+20	13.33	13.33	73.34	55.00
	20+50+40	6.66	6.66	87.34	40.67
	30+100+60	3.33	3.33	93.34	30.45
Mean		11.66	10.83	77.67	46.95
Compost	0+0+0	13.33	6.67	80.00	40.67
	10+25+20	6.66	3.33	90.10	23.60
	20+50+40	3.33	3.33	9.34	13.35
	30+100+60	0.00	3.33	96.67	11.11
Mean	5.83	4.17	90.01	22.18	
Nano-NPK	0+0+0	6.66	6.66	87.34	25.12
	10+25+20	3.33	3.33	93.34	16.67
	20+50+40	0.00	0.00	100.00	11.11
	30+100+60	0.00	0.00	100.00	0.00
Mean	2.50	2.50	95.17	13.23	
LSD 0.05% crop (A)		4.91	3.85	6.91	9.47
Treatments (B)		6.12	6.93	9.18	12.85
AXB		8.90	8.34	10.95	14.23

A: Treatments, B: Rates of NPK fertilizers mineral, AXB: Interaction

Table 5: Effect of NPK nano-fertilizers and compost on the incidence and root rot severity of soybean plants under field condition

Treatments	N+P+K rates (kg/fed)	Season 2018				Season 2019			
		Pre (%)	Post (%)	Survival (%)	Root rot (%)	Pre (%)	Post (%)	Survival (%)	Root rot (%)
Mineral	0+0+0	20.00	23.00	57.00	52.17	20.00	20.00	60.00	45.13
	10+25+20	16.67	16.67	66.66	40.21	16.67	10.00	73.33	35.33
	20+50+40	11.11	10.00	78.89	30.00	10.00	10.00	80.00	27.12
	30+100+60	6.67	6.67	86.66	25.55	6.67	10.00	83.33	21.12
Mean		13.61	14.08	72.30	36.98	13.34	12.50	74.16	32.18
Compost	0+0+0	16.67	20.00	63.33	37.12	16.67	16.67	66.66	33.18
	10+25+20	11.11	10.00	78.89	28.22	10.00	10.00	80.00	25.20
	20+50+40	6.67	6.67	86.66	21.11	6.67	10.00	83.33	18.82
	30+100+60	3.33	6.67	90.00	16.66	6.67	3.33	90.00	11.11
Mean		9.45	10.84	79.72	25.78	10.00	10.00	80.00	22.09
Nano-NPK	0+0+0	10.00	10.00	80.00	13.33	10.00	6.67	83.33	11.11
	10+25+20	6.67	3.33	90.00	11.11	6.67	6.67	86.66	10.00
	20+50+40	3.33	3.34	93.33	8.88	3.34	0.00	96.66	7.77
	30+100+60	3.33	0.00	96.67	6.66	3.33	3.33	93.34	4.44
Mean		5.83	4.17	90.00	9.99	5.84	4.17	89.99	8.33
LSD 0.05 (A)		3.91	4.01	6.70	3.41	4.82	5.01	8.47	4.51
LSD 0.05 (B)		5.72	6.96	8.96	5.34	6.34	6.82	11.34	6.77
Interaction AB		7.33	7.90	12.01	6.81	8.21	8.87	12.80	8.01

A: Treatments, B: Rates of NPK fertilizers mineral, AXB: Interaction

Table 6: Effect of some nitrogen sources on soybean production under saline soil

Treatments	N+P+K (kg/fed)	Plant height (cm)	No. of branches	No. of pods/plant	Weight of 100 seeds (g)	Weight yield of pods t/fed	Weight of seeds yield (t/fed)
Mineral	0+0+0	48.63	4.52	17.18	10.14	0.293	0.123
	10+25+20	53.41	6.34	32.41	11.63	1.047	0.952
	20+50+40	56.51	6.89	36.58	12.36	1.052	0.982
	30+100+60	59.67	6.91	39.87	13.14	1.180	0.996
Mean		54.56	6.17	31.51	11.82	0.89	0.76
Compost	0+0+0	53.14	5.62	29.41	11.18	0.654	0.463
	10+25+20	58.94	6.79	41.00	13.78	1.147	1.002
	20+50+40	63.14	6.99	45.68	14.14	1.162	1.015
	30+100+60	66.74	7.12	54.23	15.41	1.189	1.028
Mean		60.49	6.63	42.58	13.63	1.04	0.88
Nano-NPK	0+0+0	57.63	6.19	33.41	10.34	1.023	0.951
	10+25+20	59.85	6.85	45.85	12.62	1.189	1.052
	20+50+40	65.41	6.99	52.88	13.66	1.206	1.089
	30+100+60	69.38	7.14	58.63	14.14	1.224	1.175
Mean		63.07	6.79	47.69	12.69	1.16	1.07
LSD 0.05 N rates		0.86	ns	1.96	ns	0.032	0.016
LSD 0.05 amendments		1.22	ns	1.12	ns	0.024	0.012
Interaction		***	**	***	***	***	***

***Very high significant, **High significant

randomized plants were gently pulled-off, 5 days after irrigation to assess the severity of root-rot as mentioned before.

Effect of NPK nano-fertilizers and compost on soybean productivity: The effect of the used compost and NPK nano-fertilizers with or without NPK mineral fertilizers at different rates on soybean productivity is shown in Table 6. The obtained data showed that the increase of plant high (cm), No. of branches/plant, No. of pods/plant, weight of pods yield (t/fed) and weight of seeds yield (t/fed) as affected with foliar application NPK nano-fertilizers combined with mineral NPK

fertilizers different rates, while the increase weight of 100 seeds (g) as affected with compost application combined with mineral NPK fertilizers. The application of compost and foliar application of NPK nano-fertilizers combined with or without mineral NPK fertilizers were significant increase with increasing different rates of mineral NPK fertilizers for plant high (cm), No. of pods/plant, weight of pods yield (t/fed) and weight of seeds yield (t/fed) respectively, while the No. of branches/plant and weight of 100 seeds (g) were no significant.

These results are in agreement by El-Metwally *et al.*⁴² indicated that the nano-fertilizers had a significant effect on

Table 7: Protein, proline and macro-micronutrients concentration in seeds of soybean

Treatments	N+P+K rates (kg/fed)	Protein (%)	Proline (mg/g DW)	Macro-nutrients (%)			Micro-nutrients (mg kg ⁻¹)		
				N	P	K	Fe	Mn	Zn
Mineral	0+0+0	17.81	45.39	2.85	0.25	2.33	52.10	31.69	22.79
	10+25+20	23.69	40.20	3.79	0.31	2.45	55.34	37.65	27.86
	20+50+40	24.06	37.52	3.85	0.36	2.48	58.52	39.85	33.65
	30+100+60	24.81	32.16	3.97	0.41	2.50	60.48	41.52	38.25
Mean		22.59	38.82	3.62	0.33	2.44	56.61	37.68	30.64
Compost	0+0+0	24.25	37.52	3.88	0.32	2.45	55.78	34.69	28.69
	10+25+20	26.75	31.88	4.28	0.38	2.53	65.89	39.52	35.84
	20+50+40	28.94	27.34	4.63	0.44	2.58	74.93	42.18	39.75
	30+100+60	30.56	22.63	4.89	0.48	2.62	79.85	44.37	41.97
Mean		27.63	29.84	4.42	0.41	2.55	69.11	40.19	36.56
Nano-NPK	0+0+0	23.31	39.75	3.73	0.31	2.43	53.69	32.89	27.88
	10+25+20	25.81	35.67	4.13	0.36	2.48	62.87	37.89	34.62
	20+50+40	27.75	30.98	4.44	0.42	2.54	71.55	41.52	37.96
	30+100+60	29.25	24.89	4.68	0.45	2.61	74.63	43.90	40.20
Mean		26.53	32.82	4.25	0.39	2.52	65.69	39.05	35.17
LSD 0.05 N rates		0.66	3.64	0.32	0.02	0.04	2.20	0.86	1.54
LSD 0.05 amendments		1.28	1.85	ns	ns	0.03	0.97	ns	ns
Interaction		***	***	ns	***	***	***	***	***

***Very high significant, **High significant, ns: Not significant

plant height, number of branches, number of pods/plant, pods weight/plant, No. of seed/plant, seed weight/plant, fresh weight of straw/plant, dry weight of straw/plant and 100-green seed weight of peanut. These results may be due to nano-fertilizers enhance ease of use of nutrient to the plants which enhance pigments formation, photosynthesis rate, dry material production and result get better in general growth of the plant indicated increases in grain yields of soybean after applying fertilizer together with nano-materials. Gomaa *et al.*⁴³ revealed that fertilized wheat cultivar Sakha93 soil application of mineral fertilization by NPK with foliar application of nano-fertilizers (NPK) increased yield and its components of the wheat crop, increasing in the pod and seed yields as affected with compost application plus 50% NPK from recommended dose. Shaban *et al.*⁴⁴ suggested that the application of compost combined with N mineral fertilizers were increase of No. of branches/plant, 1000 seeds (g), seeds yield and pod yield (kg/fed), respectively compared with control. These results may be due to the increase in the growth characters by the application compost plus mineral fertilizers, consequently give more ability to convert light energy to chemical energy which could expressed in more yield.

Macro-nutrients concentration in seeds of soybean: Results presented in Table 7 showed that the concentrations of N, P and K in seeds of soybean in all studies were at low and sufficient limits, where it ranged 2.85-4.89% for N; 0.25-0.48% for P and 2.33-2.62% for K for seeds soybean, respectively. The low values of N, P and K concentrations were observed in plant treated with NPK mineral fertilizers, while the highest

values obtained from plants treated with compost plus NPK mineral fertilizers different rates. The application of NPK mineral fertilizers different rates were significant for N, P and K concentrations in seeds with increasing rate, while the application compost and foliar application NPK nano-fertilizers were no significant for N and P concentrations in seeds and K concentration was significant. As well as, the interaction between soil amendments and NPK mineral fertilizers different rates on P and K were significant while the N concentration was no significant. It is also reported³⁵ that the used of nano-fertilizers caused an increase in their efficiency, release of the nutrients and extend the fertilizer effect period. It is found⁴⁵ that the application of nano-fertilizers can improve plant growth and increase of N, P and K nutrient uptake. Iyarin and Aravinda⁴¹ reported that nano-fertilizers consist of N, P, K increase the uptake and utilization of nutrients by grain crops⁴⁶. Janmohammadi *et al.*⁴⁷ found that the nano-fertilizer may be a strategy to improve the nutrient use efficiency of crops and crop productivity. Shaban *et al.*⁴⁸ suggested that the combined compost with mineral 40 kg N/fed led to increase of N, P and K concentration in seeds of peanut. This promoting effect could be related to the supplementary effect of compost which might create favorable soil physical and chemical conditions, which affect the solubility and availability of nutrients and thus uptake of nutritional elements.

Micro-nutrients concentrations in seeds of soybean: The data presented in Table 7 showed that the micro-nutrients concentrations (Fe, Mn and Zn%) in seeds (%) in the seeds recorded the highest values as affected with compost application and nano-fertilizers foliar application combined by

mineral NPK fertilizers than control. The effect of different rates of NPK fertilizers on Fe, Mn and Zn concentrations in seeds soybean were significant, while the application of compost or nano-NPK fertilizers were significant for Fe concentration in seeds and Mn and Zn concentrations were not significant. As well as, the interaction between the application of compost and nano-NPK fertilizers foliar application led to significant increases for Fe, Mn and Zn concentrations in seeds with increasing different rates of NPK mineral fertilizers. These results are in agreement by Jyothi and Hebsur⁸, who suggested that the use of nano-fertilizers to increase crop yield and improve crop productivity by influencing fertilizer nutrient availability in soil and enhanced the uptake by plants. Nano-fertilizer can either provide nutrients for the plant or aid in the transport or absorption of available nutrients resulting in better crop growth. Foliar application of nano-fertilizers combine with mineral fertilizers led to the release and increase uptake nutrient in crops reported by Abdel-Aziz *et al.*⁴⁹. Application of compost led to increases in these micro-nutrients availability might be attributed to several reasons: (1) Releasing of these nutrients through microbial decomposition of organic materials in soil, (2) Reducing the pH of the soil making the nutrients more available and (3) Lowering the redox statuses of iron and manganese leading to reduction of higher Fe³⁺ and Mn⁴⁺ to Fe²⁺ and Mn²⁺ and/or transformation of insoluble chelated forms of micro-nutrients into more soluble ions Mahrous *et al.*⁵⁰.

Protein content in seeds soybean: Data presented in Table 7 revealed that protein content (%) of seeds soybean from all treatments were highest than control. The compost and NPK nano-fertilizers combined with mineral NPK fertilizers significantly increased the protein compared with NPK mineral fertilizers. The interaction between NPK nano-fertilizers and compost combined with NPK mineral fertilizers led to significant increase of protein with increasing mineral NPK fertilizers. Mahrous *et al.*⁵⁰ found that the highest increases in protein content in seeds soybean was recorded for the plants treated with compost compared control. Mabrouk⁵¹ found that organic plus mineral fertilization treatments were more effective in increasing protein in seed contents of peanut plants as compared with the individual mineral. Abdel-Aziz *et al.*⁵² revealed that the foliar application of Nano-fertilizers was increase proteins (%) content in the grain. It is supposed that nano-fertilizers alter gene expression for protein synthesis during grain development. Dhansil *et al.*⁵³ found that the protein content (%) was significantly increased under different level of chemical and nano-fertilizer may be due to greater density in reactive areas which increased the

uptake of nitrogen that eventually led to enhance in leaf moisture percentage, total chlorophyll, crude protein, total carbohydrate and plant nutrients.

Proline (mg g⁻¹ dm) content in seeds soybean: Data presented in Table 7 indicated that the effect of foliar application NPK nano-fertilizers and compost application plus mineral NPK fertilizers different rates were positive effect on decreased the proline contents in seeds because the redact soil salinity compared with control. The foliar application of NPK nano-fertilizers and compost plus mineral NPK fertilizers different rates gave the significant decreased of proline content in seeds soybean compared with NPK mineral fertilizers application different rates. The interaction between NPK nano-fertilizers and compost application were significant increasing proline content in seeds with increasing different rate of mineral fertilizers. These results are in agreement by Yamika *et al.*⁵⁴ indicated that the proline increase content in soybean plant grown under stress condition than that grown under normal conditions. This study recommended that used the nano-fertilizer increased the yield and nutritional property of soybean and releases nutrients slowly, leading to an increase in soil fertility and improved nutrients in the grain.

CONCLUSION

In general, it may be concluded that compost or nano-NPK fertilizers applications decreased soil pH and EC but increased soil organic matter and the contents of N, P, K, Fe, Mn and Zn. The results clearly indicate that the nano-fertilizer increased the yield and nutritional property of soybean. Therefore, this study has established that nano fertilizers releases nutrients slowly, leading to an increase in soil fertility and improved nutrients in the grain.

SIGNIFICANCE STATEMENT

This study suggested that the evaluation of compost and nano-fertilizers on some soil properties. The use of compost and nano-fertilization led to a decrease in infection with root rot in soybeans, which is caused by *Rhizoctonia solani*. Likewise, the numbers of the survival plants increased, so care to use natural alternatives must be carried out to compost and nano-fertilizers to reduce fungal infections and as an alternative to using fungicides. From this result, it could be possible that the use of nano-fertilizers led to decreases the daisies of rot root soybean and increases the available macro-micro-nutrients in soil and plants.

REFERENCES

1. Yossif, T.M.H. and G.M. Ebied, 2016. Monitor of changes of land uses and soil characteristics at North West area of Sinai using satellite imagery, Egypt. *Egypt. J. Soil Sci.*, 56: 56-487.
2. Nawar, S., 2009. Mapping units of some soil of El-Salm canal basin using Geographic Information Systems (GIS). M.Sc. Thesis, Faculty of Agriculture, Suez Canal University, Egypt.
3. Kabiri, S., F. Degryse, D.N.H. Tran, R.C. da Silva, M.J. McLaughlin and D. Losic, 2017. Graphene oxide: A new carrier for slow release of plant micronutrients. *ACS Appl. Mater. Interfaces*, 9: 43325-43335.
4. Elemike, E., I. Uzoh, D. Onwudiwe and O. Babalola, 2019. The role of nanotechnology in the fortification of plant nutrients and improvement of crop production. *Applied Sci.*, Vol. 9, No. 3. 10.3390/app9030499
5. Xiong, T.T., C. Dumat, V. Dappe, H. Vezin and E. Schreck *et al*, 2017. Copper oxide nanoparticle foliar uptake, phytotoxicity and consequences for sustainable urban agriculture *Environ. Sci. Technol.*, 51: 5242-5251.
6. Singh, M.D., C. Gautam, O.P. Patidar, H.M. Meena, G. Prakasha and Vishwajith, 2017. Nano fertilizers is a new way to increase nutrients use efficiency in crop production. *Int. J. Agric. Sci.*, 9: 3831-3833.
7. Aljutheri, H.W., K.H. Habeeb, F. Jawad, K. Altaee, D.K. Al-Taey and A.R.M. Al Tawaha, 2018. Effect of foliar application of different sources of nano-fertilizers on growth and yield of wheat. *Biosc. Res.*, 15: 3988-3997.
8. Jyothi, T.V. and N.S. Hebsur, 2017. Effect of nanofertilizers on growth and yield of selected cereals-A review *Agric. Rev.*, 38: 112-120.
9. Chitravadivu, C., V. Balakrishnan, J. Manikandan, T. Elavazhagan and S. Jayakumar, 2009. Application of food waste compost on soil microbial population in groundnut cultivated soil, India. *Middle-East J. Scient. Res.*, 4: 90-93.
10. El Sabagh, A., M.S. Islam, A. Ueda, H. Saneoka and C. Barutcular, 2015. Increasing reproductive stage tolerance to salinity stress in soybean. *Int. J. Agric. Crop Sci.*, 8: 738-745.
11. Taha, M., A. Salama, M. El-Seedy, I. El-Akhdar, M.S. Islam, C. Barutcular and A. El Sabagh, 2016. Potential impact of compost tea on soil microbial properties and performance of radish plant under sandy soil conditions-greenhouse experiments. *Aust. J. Basic Applied Sci.*, 10: 158-165.
12. Zaki, S.S., 2016. Effect of compost and nitrogen fertilization on yield and nutrients uptake of rice crop under saline soil. *Mod. Chem. Applic.*, Vol. 4, No. 2. 10.4172/2329-6798.1000183
13. Lakhdar, A., C. Hafsi, M. Rabhi, A. Debez and F. Montemurro *et al*, 2008. Application of municipal solid waste compost reduces the negative effects of saline water in *Hordeum maritimum* L. *Bioresour. Technol.*, 99: 7160-7167.
14. Safina, S.A., F.Y.M. Hanaa, I. Abdel-Wahab Eman and M.A.M. Ibrahim, 2018. Seed yield and its quality of some soybean varieties as affected by humic acid. *Acad. J. Agric. Res.*, 6: 194-213.
15. Ghassemi-Golezani, K., M. Taifeh-Noori, S. Oustan and M. Moghaddam, 2009. Response of soybean cultivars to salinity stress. *J. Food Agric. Environ.*, 7: 401-404.
16. Messina, M.J., 1997. Soybean Foods: Their Role in Disease Prevention and Treatment. In: *Soybeans: Chemistry, Technology and Utilization*, Liu, K.S. (Ed.). Chapman and Hall, New York, USA., pp: 442-466.
17. Grau, C.R., A.E. Dorrance, J. Bond and J.S. Russin, 2004. Fungal Diseases. In: *Soybeans: Improvement, Production and Uses*, Boerma, H.R. and J.E. Specht (Eds.), American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, Madison, Wisconsin, USA., pp: 679-763.
18. Ellis, M.L., 2011. The soybean seedling disease complex: *Pythium* spp. and *Fusarium graminearum* and their management through host resistance. Ph.D. Thesis, The Ohio State University, USA.
19. Hartman, G.L., 2015. Worldwide Importance of Soybean Pathogens and Pests. In: *Compendium of Soybean Diseases and Pests*, Hartman, G.L., J.C. Rupe, E.J. Sikora, L.L. Domier, J.A. Davis and K.L. Steffey (Eds.), APS Press, St. Paul Minnesota, USA., pp: 4-5.
20. Lee, W.M., Y.J. An, H. Yoon and H.S. Kweon, 2008. Toxicity and bioavailability of copper nano-particles to the terrestrial plants mung bean (*Phaseolus radiatus*) and wheat (*Triticum aestivum*): Plant agar test for water-insoluble nano-particles. *Environ. Toxicol. Chem.*, 27: 1915-1921.
21. Yang, L. and D.J. Watts, 2005. Particle surface characteristics may play an important role in phytotoxicity of alumina nano-particles. *Toxicol. Lett.*, 158: 122-132.
22. Abou-Zeid, H.M. and Y. Moustafa, 2014. Physiological and cytogenetic responses of wheat and barley to silver nanopriming treatment. *Int. J. Applied Biol. Pharm. Technol.*, 5: 265-278.
23. Hojjat, S.S., 2015. Impact of silver nano-particles on germinated fenugreek seed. *Int. J. Agric. Crop Sci.*, 8: 627-630.
24. Cottenie, A., M. Verloo, L. Kiekens, G. Velgh and R. Camerlynck, 1982. *Chemical Analysis of Plant and Soils*. Laboratory of Analytical and Agrochemistry, State University of Ghent, Belgium, pp: 100-129.
25. Page, A.L., R.H. Miller and D.R. Keeny, 1982. *Methods of Soil Analysis. Part 2-Chemical and Microbiological Properties*. 2nd Edn., American Society of Agronomy, Madison, Wisconsin, USA.
26. Klute, A., 1986. *Methods of Soil Analysis, Part 1. Physical and Mineralogical Methods*. 2nd Edn., ASA and SSSA., Madison, WI.

27. Brunner, P.H. and H.R. Wasmer, 1978. Methods of analysis of sewage sludge solid wastes and compost. WHO International Reference Center for Wastes Disposal, Duldorf, Switzerland.
28. Salt, G.A., 1982. Factors Affecting Resistance to Root Rot Diseases. In: Faba Bean Improvement, Hawtin, G. and C. Webb (Eds.), IARDA, Aleppo, Syria, pp: 260-270.
29. Soltanpour, P.N., 1985. Use of ammonium bicarbonate DTPA soil test to evaluate elemental availability and toxicity. *Commun. Soil Sci. Plant Anal.*, 16: 323-338.
30. Chapman, H.D. and P.F. Pratt, 1961. *Methods of Analysis for Soils, Plants and Waters*. University of California, USA., pp: 1-309.
31. Bates, L.S., R.P. Waldren and I.D. Teare, 1973. Rapid determination of free proline for water-stress studies. *Plant Soil*, 39: 205-207.
32. Homowitz, T., F.I. Collins, J. Panczner and W.M. Walker, 1972. Relationship between the content of oil, protein and sugar in soybean seed. *Agron. J.*, 64: 613-616.
33. El-Ghamry, A.M., A.A. Mosa, T.A. Alshaal and H.R. El-Ramady, 2018. Nanofertilizers vs. Biofertilizers: New insights. *Environ. Biodiv. Soil Secur.*, 2: 51-72.
34. Diacono, M. and F. Montemurro, 2015. Effectiveness of organic wastes as fertilizers and amendments in salt-affected soils. *Agriculture*, 5: 221-230.
35. Al-Taey, D.K.A., S.S.M. Alazawi, M.J.H. Al-Shareefi and A. Al-Tawaha, 2018. Effect of saline water, NPK and organic fertilizers on soil properties and growth, antioxidant enzymes in leaves and yield of lettuce (*Lactuca sativavar. Parris Island*). *Res. Crops*, 19: 441-449.
36. Azarpour, E., J. Asghari, H.R. Bozorgi and G. Kamalpour, 2013. Foliar spraying of *Ascophyllum nodosum* extract, methanol and iron fertilizers on fresh flower cover yield of saffron plant (*Crocus sativus* L.). *Int. J. Agric. Crop Sci.*, 5: 1854-1862.
37. Khaled, A.S., G.A.E. Mona and M.K. Zeinab, 2012. Effect of soil amendments on soil fertility and sesame crop productivity under newly reclaimed soil conditions. *J. Applied Sci. Res.*, 8: 1568-1575.
38. Hayyaw, W.A.A. and M.N.A. Qusay, 2019. Impact of fustigation of nano NPK fertilizers, nutrient use efficiency and distribution in soil of potato (*Solanum tuberosum* L.). *Plant Arch.*, 19: 1087-1096.
39. Mousa, W.M.E. and K.A. Shaban, 2017. Influence of irrigation rates, bio-fertilizer and compost on forage yield, quality and seed production of Egyptian clover variety (Fahl) under saline soil conditions. *Egypt. J. Applied Sci.*, 32: 51-74.
40. Rashad, F.M., H.H. Kesba, W.D. Saleh and M.A. Moselhy, 2011. Impact of rice straw composts on microbial population, plant growth, nutrient uptake and root-knot nematode under greenhouse conditions. *Afr. J. Agric. Res.*, 6: 1188-1203.
41. Iyarin, E.T.M. and B.N.K. Aravinda, 2019. Foliar application of nanofertilizers in agricultural crops-A review. *J. Farm Sci.*, 32: 239-249.
42. El-Metwally, I.M., D.M.R. Abo-Basha and M.E. Abd El-Aziz, 2018. Response of peanut plants to different foliar applications of nano-iron, manganese and zinc under sandy soil conditions. *Middle East J. Applied Sci.*, 8: 474-482.
43. Gomaa, M.A., F.I. Radwan, E.E. Kandil and M.A.F. Al-Msari, 2018. Response of some Egyptian and Iraqi wheat cultivars to mineral and nanofertilization. *Egypt. Acad. J. Biol. Sci.*, 9: 19-26.
44. Shaban, K.A., A.M. Helmy and A.H. Abd El-Rhman, 2008. Nutrients uptake and yield quality of soybean as affected by bio and organic nitrogen fertilizers. *Zagazig J. Agric. Res.*, 35: 343-362.
45. Gomez, K.A. and A.A. Gomez 1989. *Statistics for Agriculture Research*. 2nd Edn., John Willey and Sons, New York, USA.
46. Guo, J.H., 2015. Synchrotron radiation, soft-X-ray spectroscopy and nanomaterials *Int. J. Nanotechnol.*, 1: 193-225.
47. Janmohammadi, M., A. Seifi, M. Pasandi and N. Sabaghnia, 2017. The impact of organic manure and nano-inorganic fertilizers on the growth, yield and oil content of sunflowers under well-watered conditions. *Biologija*, 62: 227-241.
48. Shaban, K.A., S.M. El-Khadrawy and R.M. El-Shal, 2014. Influence of humic acid, compost and mineral-N on nutrients availability, yield quality and chemical compositions of peanut in sandy soil. *Minufiya J. Agric. Res.*, 39: 1149-1162.
49. Abdel-Aziz, H.M.M., M.N. Hasaneen and A.M. Omer, 2016. Nano chitosan-NPK fertilizer enhances the growth and productivity of wheat plants grown in sandy soil. *Spanish J. Agric. Res.*, Vol. 14. 10.5424/sjar/2016141-8205
50. Mahrous, M., S. Abd El-Azeem and M. Ahmed, 2019. Effect of applying some soil amendments and distance between drains on quality and productivity of soybean grown under saline conditions. *J. Soil Sci. Agric. Eng.*, 7: 937-946.
51. Mabrouk, S.S., 2002. Response of some peanut cultivars to bio and organo-mineral fertilization. *Zagazig J. Agric. Res.*, 29: 2071-2083.
52. Abdel-Aziz, H., M.N. Hasaneen and A. Omer, 2018. Effect of foliar application of nano chitosan NPK fertilizer on the chemical composition of wheat grains. *Egypt. J. Bot.*, 58: 87-95.
53. Dhansil, A., N.M. Zalawadia, B.S. Prajapat and K. Yadav, 2018. Effect of nano phosphatic fertilizer on nutrient content and uptake by pearl millet (*Pennisetum glaucum* L.) crop. *Int. J. Curr. Microbiol. Applied Sci.*, 7: 2327-2337.
54. Yamika, W.S.D., N. Aini, A. Setiawan and R.D. Purwaningrahayu, 2018. Effect of gypsum and cow manure on yield, proline content and K/Na ratio of soybean genotypes under saline conditions. *J. Degrad. Min. Land Manage.*, 5: 1047-1053.