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Research Article

Innovative Microbial Nanotechnology Biocidal and fungicidal agents are being Developed and used as Biofertilizers and Biological Preventions

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Abstract

ZnO nanoparticles have been applied to agricultural soil to blend various media, nutrients, and minerals in order to boost soil fertility. ZnO is responsible for supplying the right growth medium for microbial isolates, preserving the food-to-microorganism ratio (F/M ratio), preserving the microbial isolates after they have received the necessary nutrients from a variety of growth media, ensuring the isolates' vitality in an efficient and active manner, and incorporating them into agricultural soil as a liquid biological fertilizer with a marketable value. Comprises a safe and ecologically acceptable population of live active microorganisms. Efficiency and proportion of biofertilizer used in the biological management of illnesses and root rots, as well as resistance to nematodes both during and following treatment. Different percentages from 62%, 65%, and 68% of nematode, bacterial, and fungal examination of a 250-gram soil sample at 25°C before and after treatment (Tomato, Peanut, Orange, Strawberry, and Cucumber plants, as well as when soft and big element estimation in milligrams per square meter of soil (plant banana, efficiency 30.4%, 36.0%, 43.0%, 27.7%, 57.1%, 46.1%, 35.7%. ZnO nanoparticles are utilized in this study as a nano-biofertilizer in the agricultural field to promote higher plant growth and production. They also serve as a vital source of balanced crop nutrition, seed germination, and quality enrichment. Furthermore, food waste and contamination may be reduced significantly by using nanotechnology in post-harvest food processing and packing.

Keywords: *Bio-fertilization, biological control, Biocidal and fungicide, ZnO nanoparticles.*

1. Introduction

These days, research and verification is important to use natural and safe alternatives for the growth of plants and agricultural crops, as well as to increase the fertility of agricultural soil[1]. It is an alternative and instead of using chemical fertilizers and their various toxic damages and severe pollution of the surrounding environment and their negative impact on the fertility of agricultural soils[2,3]. Role of microorganisms is emphasized in promoting the growth of plants and agricultural crops, increasing production and urging their resistance against plant diseases and various pests that may infect plants and agricultural soil and affect the production of agricultural crops[4]. In addition, it leads to a shortage of agricultural crops and the consequent environmental and economic damages, and leads to a decrease in the income of farmers. *Saccharomyces cerevisiae* and lactic acid bacteria are considered a new promising plant growth promoting for different crops[5]. It became in the last few decades a positive alternative to chemical fertilizers safely used for humans, animals and the environment [6]. Due to its cytokine content, yeast treatments were suggested to play a beneficial role in cell division and cell enlargement. Yeast, as a natural stimulator, is characterized by its richness in protein 47%, carbohydrates 33%, nucleic acid 8%, lipids 4%, and different minerals 8% such as Na, Fe, Mg, K, P, S, Zn, Mn, Cu, Si, Cr, Ni, Va and Li in addition to thiamin, riboflavin, pyridoxine, hormones and other growth regulating substances, biotin, B12 and folic acid[7,8]. Earlier reports explained the effect of yeast application on vegetative and fruit growth due to its richness in tryptophan that are considered precursors of IAA (indole acetic acid) and on flower ignition due to its effect on carbohydrate accumulation[9]. Biological control of different plant diseases prevention was focused primarily using bacteria or filamentous fungi[10]. Therefore, application of microorganisms as biocontrol agents acts as a new trend against

different pathogens. Potential use of yeasts and lactobacillus as biocontrol agents of soil-borne fungal plant pathogens and as plant growth promoters were intensively investigated and highlighted the impact of fungal activities of *Rhizoctonia solani* on the strong suppression of diseased sugar beet plants through the secretion of a number of specific proteins[11]. Additionally, bio-organic fertilizers are considered as an important and basic source of the elements needed by plants, large and small, as well as they have a very important role in improving the physical, chemical and biological properties of the soil, and recently the importance of using liquid organic fertilizers has emerged as one of the most important clean alternatives for the nutrients needed by fruit seedlings. This is because it contains some organic acids, such as: humic and fulvic acids, amino acids and other substances. Which is characterized by its cheap price, ease of use, low pollution to the environment and agricultural products, and its contribution to improving the physical, chemical and biological characteristics of the soil, which is positively reflected in the growth and production of various plants, and these substances are absorbed by the roots of the plant and release their ions easily, and move quickly to benefit from them. The plant participates in the physiological processes, which provides the plant with the energy needed to absorb it, especially in the stages of its growth. Wide variety of yeasts have been used extensively for the biological control of post-harvest diseases of fruits and vegetables, against molds of stored grains[12] and to control powdery mildews[13].

To get back to a clean agriculture or what is called integrated agriculture to achieve increased production and environmental protection at the same time, and the production of healthy food free of pollutants, and bio-fertilizer is a substance that contains useful microorganisms added to the soil that can supply plants with part of their nutritional needs, or it can be defined as all the additives of biological source, which are called microbial inoculants, which supply plants with their nutritional needs by transforming them from elements of their unprepared forms to their ready-to-absorb forms, in addition to supplying them with stimulating substances for plant growth such as hormones and growth regulators[14]. The conservation agriculture practice is in need of the current agriculture situation and a global force of safe ecology promotes the biofertilizers use with fast pace [15]. In connection to this, little study was conducted under conservation agriculture in different agro-climatic regions or subregion levels. At national and international level agricultural universities, national research stations are continuously working on various aspects of biofertilizer uses in agricultural production systems[15]. Biofertilizers are microbial inoculants or carrier-based preparations containing living or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing and cellulose decomposing microorganisms intended for seed or soil application and designed to improve soil fertility and plant growth by increasing the number and biological activity of beneficial microorganisms in the soil. The objects behind the application of biofertilizer microbial inoculants to seed, soil or compost pit is to increase the number and biological metabolic activity of useful microorganisms that accelerate certain microbial processes to augment the extent of availability of nutrients in the available forms, which can be easily assimilated by plants. The need for the use of biofertilizers has arisen primarily due to two reasons i.e. though chemical fertilizers increase soil fertility, crop productivity and production, but increased/ intensive use of chemical fertilizers has caused serious concern of soil texture, soil fertility and other environmental problems, use of biofertilizer is both economical as well as environment friendly. Therefore, an integrated approach of applying both chemical fertilizers and biofertilizers is the best way of integrated nutrient supply in agriculture. Development of a nation is directly proportional to the amount of food or nutrients available to the population. Growth of the human population creates demand for more food grains. To supply food grains according to the demand, fertilizers are used. A fertilizer is any substance that is used for increasing the productivity of the soil. It promotes soil fertility by adding nutrients in the soil, which helps in plant growth. Fertilizers that are composed of raw chemicals in solid or liquid form manufactured in factories targeting the nutritional requirement of the plants are by definition called a chemical fertilizer. Nitrogen, phosphorus, potassium together called NPK is normally present in these chemical fertilizers along with other nutrients[16].

2. Experimental

2.1 Materials and methods

Soil and banana leaf samples used for experiments were taken from the same location to estimate some elements. The experience of using the microbial solution (biological fertilizer) on the crop of watching live fertilization of the biological fertilizer and its effect on soil and plant (Banana plant and its leaves).

2.2 ZnO nanoparticle synthesis

0.6 M aqueous solution of Zn $(NO_3)_2 \cdot 6H_2O$ and 1 M of NaOH were prepared. After the zinc nitrate hexahydrate was completely dissolved, 1 M NaOH was slowly adding drop by drop for 25 minutes with high magnetic stirring. The process was permitted to continue for 1 hour after the aqueous solution of NaOH was added, and the container was sealed at this temperature for 1 hour. Afterward, the sample was transferred to settle for an overnight period before the resultant liquid was carefully separated. The precipitate was removed after 15 minutes of centrifugation. ZnO NPs were precipitated and rinsed four times with the double distilled water and ethanol before being dried in an air environment at roughly 90° C. Zn $(OH)_2$ was totally oxidized to produce ZnO NPs. The existence of nanoparticles and other functional groups was determined by Fourier transform infrared spectroscopy (FT-IR). The size, shape, optical, and structural properties of the produced ZnO NPs were all measured. An X-ray diffractometer (panalytical) was used to record the X-

ray diffraction (XRD) pattern of manufactured ZnO NPs using Cu-K radiation with a wavelength of (λ = 0:1541 nm) in the scan range of 2theta = 10° –80°. A scanning electron microscope (SEM) with (EDXA, SIRION) for the morphology of the specimen was examined using compositional analysis of generated ZnO NPs.

2.3 Characterizations of ZnO nanoparticles

The chemically synthesized ZnO nanomaterials were characterized by UV–vis Spectroscopy (Shimadzu UV-1800) between 200 and 600 nm, the optical absorption of biogenic ZnO nanoparticles was determined. X-ray Diffraction (XRD) (Shimadzu, Kyoto, Japan) in the 2θ range of 1◦ to 80◦, with a step size of 0.0260◦. In addition, transmission electron microscopy (TEM) images (JEOL JEM-1230), scanning electron microscopy (SEM) (FEI Quanta 250 TE scan vega3), and Fourier Transform Infrared (FTIR) spectroscopy (Thermo Scientific Nicolet iS10 FT-IR) were used for surface characterization, and chemical analysis. Thus, the FTIR spectra were directly collected in the range of 4000–400 cm-1 at room temperature, utilizing scans at 4 cm- 1 resolutions using the FTIR spectrometer, model Nicolet iS-10 Thermo Scientific, (USA). Elemental compositions of different sections were analyzed by the Energy Dispersive X-ray (EDX) analysis in order to identify the homogeneity of nanomaterial distribution on the sensor's surfaces. Scanning electron microscopy/energy dispersive X-ray spectroscopy (SEM-EDX) images were recorded using the JEOL JSM-6390LV (TE scan vega3model).

2.4 Preparation of ZnO and microbial solution

1.0 g of ZnO nanoparticles were refined by 10 L deionizing water dispersion and ultrasonication for 30 min and mixing with different microbial types[17].

2.5 The effects of ZnO Nano priming on the soil treatment

ZnO microbial solutions are used for soil treatment by the following method. 4 g of ZnO suspended in 4-liter water containing microbial organisms every time for all of the crops.

2.6 Estimation of biochemical components

The following biochemical constituents were measured in thirty-day-old plants, such as cations, Nematoda, bacterial and fungal analysis of a soil sample of 250 grams at a temperature of 25°C before and after treatment.

2.7 Statistical examination

All the tests were performed in triplicate. The results were shown as mean and efficiency percentage before and after treatment and analyzed through one-way variant analysis.

3. Results and discussion

3.1. Optical studies

The formation of ZnO nanoparticles from zinc acetate was confirmed using UV–vis spectrophotometric analysis. The synthesized ZnO nanoparticles showed absorption peaks of 396 nm in the UV–vis spectrum (Fig. 1A) due to their surface resonance plasmonic property. The absorption behavior of the synthesized nanoparticles was stronger in the UV and visible areas of the spectral range, which may illustrate the advantages in optical applications [18]. According to our observations, the UV spectral range of ZnO nanoparticles is 320–390 nm with a maximum peak at 365 nm[19].

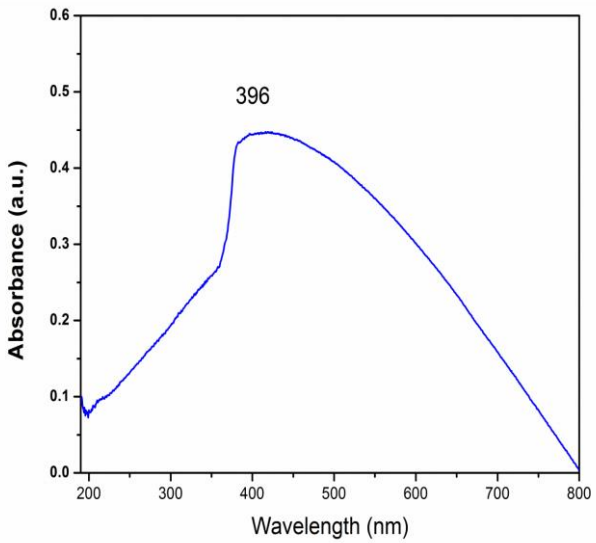


Fig. 1A. UV Vis absorption spectrum.

3.2. Structural studies

The XRD pattern of synthesized ZnO nanoparticles is shown in Fig. 1B. The obtained results showed that the synthesized ZnO nanoparticles had a hexagonal crystalline structure. The presence of planes (100), (002), (101), (102), (1100, (103), (220), (112), (201), (004) and (202) in the XRD pattern also indicates the crystalline nature. No peaks corresponding to impurities were found in the synthesized ZnO nanoparticles, indicating a single phase. The confirmed lattice parameter was 0.323420 nm, according to the results[20]. The Scherer equation was used to calculate the crystallite size of ZnO nanoparticles (from the FWHM of the most extreme peak corresponding to the 101 plane) as follows: D = kλ βcosθ nm Crystallite dimension, Scherer constant, X-ray wavelength, full width half-maximum of the (101) plane, and Bragg diffraction angle are all represented by D, k, λ, β, and θ, respectively. The synthesized ZnO nanoparticles had an average crystalline size of 20- 30 nm. The lattice parameter was calculated as 4.44690 Å.

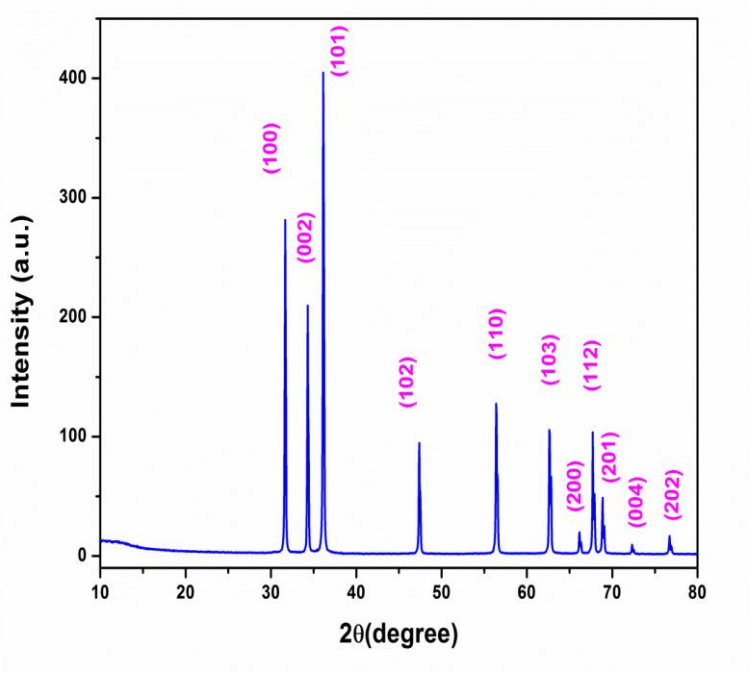


Fig. 1B. XRD pattern of ZnO nanoparticles

3.3. FT-IR studies

The interaction of active metabolites of the synthesized ZnO nanoparticles was studied using the FT-IR spectrum. The synthesized nanoparticles were observed in the range of 400–4000 cm- 1 (Fig. 1C). The large peak at 3359 cm- 1 reflects the presence of vibration of O–H, smaller bond vibration peaks of 2948 cm- 1 which indicates the vibration of C–H. A peak observed at 2185 cm- 1 matched the -C≡C- stretching vibrations. The peak at1732 cm-1 and 1652 cm- 1 corresponded to functional groups C=O and C–O (stretching), while the peak in the range of 1444 cm^{-1} corresponded to the aromatic compound C-C stretching. Zn–O stretching modes resembles the absorption peaks reported at 1120- 400 cm^{-1}.

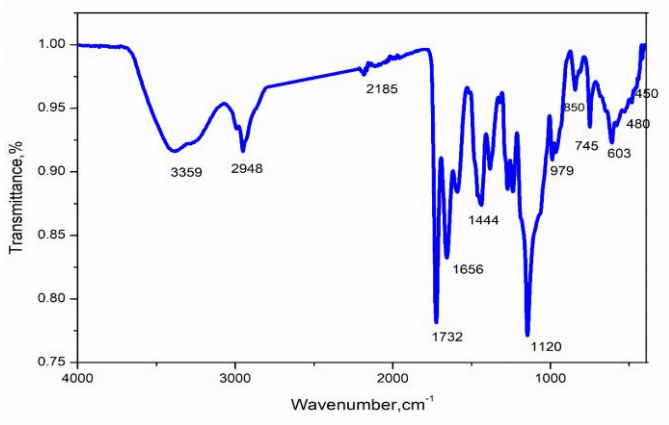
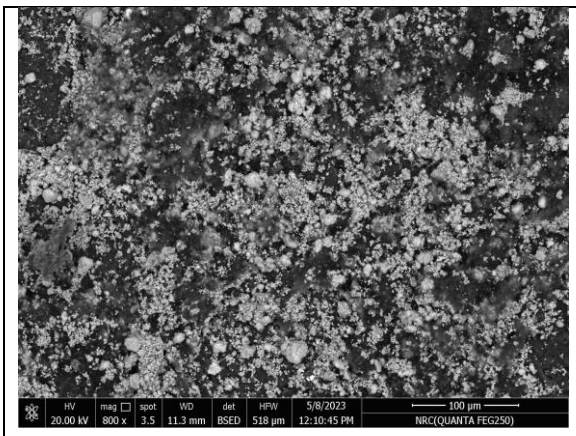


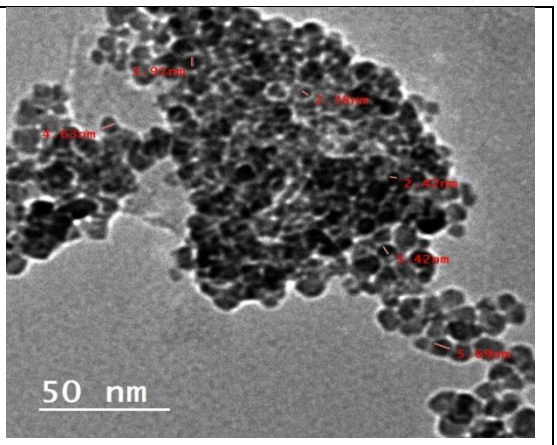
Fig. 1C. FT-IR spectrum of ZnO nanoparticles.

3.4. Surface morphological studies

SEM and TEM analysis has been used to investigate the morphology of synthesized ZnO nanoparticles and is shown in Fig.1D. With an agglomerated micrograph, the shape of green ZnO nanoparticles was clearly observed to be spherical in structure. ZnO nanoparticles have an average particle size of 3-10 nm.



SEM image (I)



TEM image (II)

Fig.1D. (I) SEM and (II) TEM images of synthesized ZnO nanoparticles

Effect of ZnO-NPs / microbial composite on the plant treatment

The rate of treatment with ZnO-NPs / microbial solution was studied. Indeed, there is a direct association between growth rate before and after addition of ZnO-NPs/microbial solution. The positive effect with ZnO-NPs / bacterial addition was detected as it is clear from Table 1, and Figure 2A, the soil efficiency has been significantly increased after treatment with ZnO / microbial solution. The efficiency values of Zn, Mg, Cu, Fe, K, P and N were increased after treatment to 35.7%, 46.1%, 57.1 %, 27.7%, 34.0%, 6.0% and 30.4% respectively.

As it is clear from Table 2 as well as and Figure 2B, soil efficiency was increased after treatment with ZnO / microbial solution. The efficiency values of Zn, Mg, Cu, Fe, K, P and N were increased after treatment to 33.3%, 42.7%, 43.8 %, 50%, 28.3%, 36.7% and 53.6% respectively.

As it is clear from table 3as well as Figure 2C, the soil and leaves pH, E_C and Sp changed after treatment with ZnO / microbial solution. The pH values of soil and leaves changed from 8.95, 8.16 to 8.38, and 8.0 respectively. Ec increased after treatment with ZnO NPs from 3.21 and 1.14 to 4.12 and 1.93 respectively. In Sp values increased from 8.0 and 9.3 to 14 and 11.8 for soil and leaves respectively.

As it is clear from Table 4 as well as Figure 2D, the soil and leaves anions level including the sulphate (SO_4), bicarbonates (HCO_3) and the carbonates (CO_3) were changed after treatment with ZnO / microbial solution. Whereas, the SO_4 concentration values of soil and leaves has been decreased from 8.9 to 4.16 and from 14.3 to 9.6 respectively. HCO_3 increased after treatment with ZnO NPs from 0.65 and 0.43 to 0.68 and 0.72 respectively. In soil, CO_3 values decreased from 3.5 to 2.96 for soil and leaves respectively.

As it is clear from table 5 as well as Figure 2E, the concentration levels of common cations of soil and leaves changed after treatment with ZnO / microbial solution. The K_+ values of soil and leaves changed from 3.2 and 2.0 to 2.1 and1.4 respectively. Na^+ decreased after treatment with ZnO NPs from 11.2 to 2, and from 9.4 to 1.8 respectively. In Mg^{++} values decreased from 7.2 to 3.6, and from to 4.3 to 2.1 for soil and leaves samples, respectively. For Ca^{++} values decreased from 21 to 7.3, and from 18 to 5.6 for the soil and leaves samples, respectively.

As it is clear from table 6, the effect of ZnO / microbial solution on Strawberry plants (250 gm at temperature 25ºC) before and after addition was studied. The efficiency of the soil toward egg and larva changed after treatment with ZnO / microbial solution. The egg values changed from 170 to 53 with percentage of efficiency of 68.8%. Furthermore, larva values changed from 260 to 36 with a percentage of efficiency of 86.1%.

As it is clear from table 7, the effect of ZnO / microbial solution on cucumber plants (250 gm at temperature 25ºC) before and after addition was studied. The efficiency of the soil toward decreasing egg and larva changed after treatment with ZnO / microbial solution. The egg values changed from 115 to 25 with a percentage of efficiency of 78.2%. Furthermore,

larva values changed from 230 to 36 with a percentage of efficiency of 84.3%. However, for bacteria and fungi the percentage of efficiency for Fusarium, Verticillium and Rhizoctonia after treatment being 62%,63.8% and 65.8% respectively as shown in table (8).

For Tomato plant, the ZnO-microbial solution affect strongly in increasing the efficiency percentage of Nematuda Spiral, Najar Nematuda and Nematuda Root Nodes on Egg and Larva to be 93.3 ,90.3% ,84.5% for Egg and 90.7%,77.7%,90.7% for larva respectively. Moreover, for bacteria and fungi the efficiency percentage being 77.7% (see table 9).

For Peanuts plant, the ZnO-microbial solution affect strongly in increasing the efficiency percentage of Najar Nematuda and Nematuda Root Nodes on Egg and Larva to be 72.8 ,72.5% for Egg and 86.8%,85.0%, for larva respectively. Moreover, for bacteria and fungi the efficiency percentage being 69.2% as shown in table 10.

For Orange trees (table 11), the ZnO-microbial solution effect on increasing the efficiency percentage of Nematuda Root Nodes on Egg and Larva to be 90.8 for Egg and 86.9% for larva respectively. Moreover, for bacteria and fungi the efficiency percentage being 68.9%.

Eventually, real photos (Figure 3A, and B) taken from the fields and farms of Panamas to show the progress of treated plants after the treatment with the nanoparticles of ZnO.

Table (1): Estimation of soft and large elements in soil mg / sq.m. Before and after treatment (Banana plant).

Sample	B	Zn	Mg	Cu	Fc	K	P	N
	mg / sq.m							
Before treatment	-	106	21	3	213	53	48	32
After treatment	85	165	39	7.0	295	93	75	46
Efficiency	-	35.7%	46.1%	57.1%	27.7%	43.0%	36.0%	30.4%

Table (2): Estimate the soft and large elements in the leaf as mg / kg dry plant. Before treatment and after treatment (Banana plant).

Sample	B	Zn	Mg	Cu	K	P	N
	mg / kg						
Before treatment	86	83	11.0	1.8	58	43	19
After treatment	129	145	19.6	3.6	81	68	41
Efficiency	33.3	42.7	43.8	50	28.3	36.7	53.6

Table (3): Results of chemical analysis of soil paste extract before and after treatment (before and after treating banana plants).

Sample	pH		Ec		Sp	
	Before	After	Before	After	Before	After
Soil	8.95	8.38	3.21	4.12	8.0	14
Leave	8.16	8.0	1.14	1.93	9.3	11.8

Table (4): - Anions analysis mg / L before and after treatment (Banana plant).

Sample	SO_4		HCO_3		CO_3	
	mg / L					
	Before	After	Before	After	Before	After
Soil	8.9	14.3	0.65	0.68	3.5	2.96
Leave	4.16	9.6	0.43	0.72	----	-----

Table (5): Table of Cation analysis mg / L before and after treatment (Banana plant).

sample	K		Na		Mg		Ca	
	mg / L							
	Before	After	Before	After	Before	After	Before	After
Soil	3.2	2.1	11.2	9.4	7.2	4.3	21	18
Leave	2.0	1.4	2.3	1.8	3.6	2.1	7.3	5.6

Table (6): Table of Nematode, bacterial and fungal analysis of a soil sample of 250 grams at a temperature of 25°C before and after treatment (Strawberry plant).

		Soil sample 250 grams		Efficiency and percentage	
		Egg	larva	Egg	larva
Before treatment	Nematuda Root Nodes	170	260	68.8%	86.1%
After treatment	Nematuda Root Nodes	53	36		

Table (7): Table of Nematode, bacterial and fungal analysis of a soil sample of 250 grams before and after treatment (cucumber plant).

sample		Soil sample		Efficiency and percentage	
		Egg	larva	Egg	larva
Before treatment	Nematode Root Nodes	115	230	78.2%	84.3%
After treatment	Nematode Root Nodes	25	36		

Table (8): Efficiency changes of *Fusarium, Verticillium and Rhizoctonia* before and after treatment.

sample	Soil sample	Efficiency and percentage		
	Bacteria and fungi	Fu.	Ver.	Rhiz.
Before treatment	*Verticillium* 29% - *Fusarium 36% -Rhizoctonia* 26 %	62 %	63.8%	65.3%
After treatment	*Fusarium* 13% - *Verticillium* 11% *Rhizoctonia* 9 %.			

Table (9): Table of Nematode, bacterial and fungal analysis of a soil sample of 250 grams at a temperature of 25°C before and after treatment (Tomato plant)

sample		Soil sample		Efficiency and percentage	
		Egg	larva	Egg	larva
Before treatment	Nematuda Spiral	209	65	93.3%	90.7%
After treatment	Nematuda Spiral	14	6		
Before treatment	Najar Nematuda	156	36	90.3 %	77.7%
After treatment	Najar Nematuda	15	8		
Before treatment	Nematuda Root Nodes	136	206	84.5 %	90.7%
After treatment	Nematuda Root Nodes	21	19		
Before treatment	Bacteria and fungi	*Rhizoctonia* 36 %		77.7%	
After treatment	Bacteria and fungi	*Rhizoctonia* 8 %			

Table (10): Table of Nematode, bacterial and fungal analysis of a soil sample of 250 grams at a temperature of 25°C before and after treatment (Peanuts plant).

sample		Soil sample		Efficiency and percentage	
		Egg	larva	Egg	larva
Before treatment	Najar Nematuda	140	145	72.8 %	86.8%
After treatment	Najar Nematuda	38	19		
Before treatment	Nematuda Root Nodes	200	100	72.5 %	85.0%
After treatment	Nematuda Root Nodes	55	15		
Before treatment	Bacteria and fungi	*Fusarium 26 %*		69.2%	
After treatment	Bacteria and fungi	*Fusarium 8 %*			

Table (11): Table of Nematode, bacterial and fungal analysis of a soil sample of 250 grams at a temperature of 25°C before and after treatment (Orange trees).

sample		Soil sample		Efficiency and percentage	
		Egg	larva	Egg	larva
Before treatment	Nematuda Root Nodes	230	115	90.8 %	86.9%
After treatment	Nematuda Root Nodes	21	15		
Before treatment	Bacteria and fungi	*Verticillium 29 %*		68.9%	
After treatment	Bacteria and fungi	*Verticillium 9 %*			

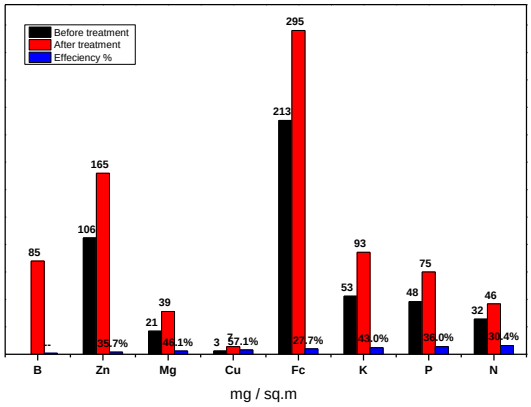


Fig. 2A. Estimation of soft and large elements in soil mg / sq.m. Before and after treatment (Banana plant).

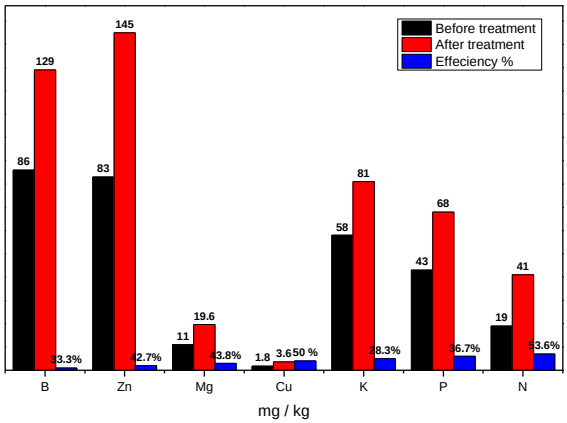


Fig.2B. Percentages of changes of soft and large elements in the leaf as mg / kg dry plant. Before treatment and after treatment (Banana plant).

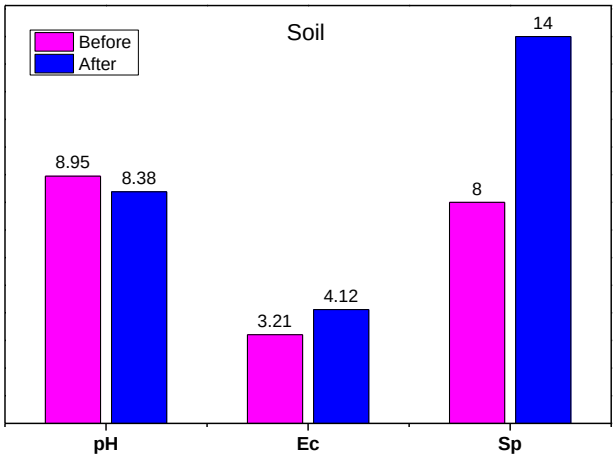


Fig. 2C. Results of chemical analysis of soil paste extract before and after treatment (before and after sample application banana plant).

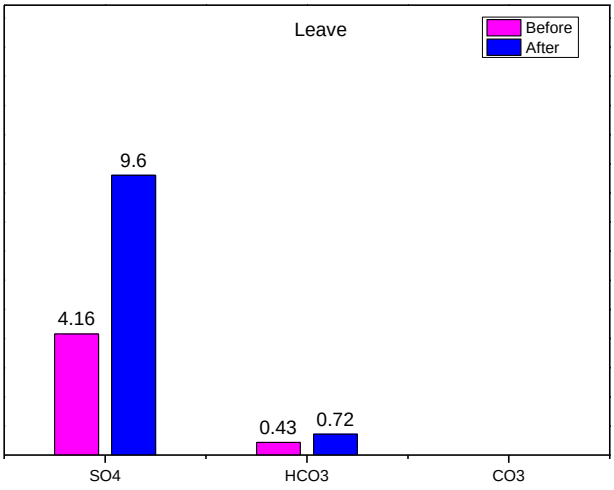


Fig. 2D. Anions analysis (mg /L) before and after treatment (Banana plant).

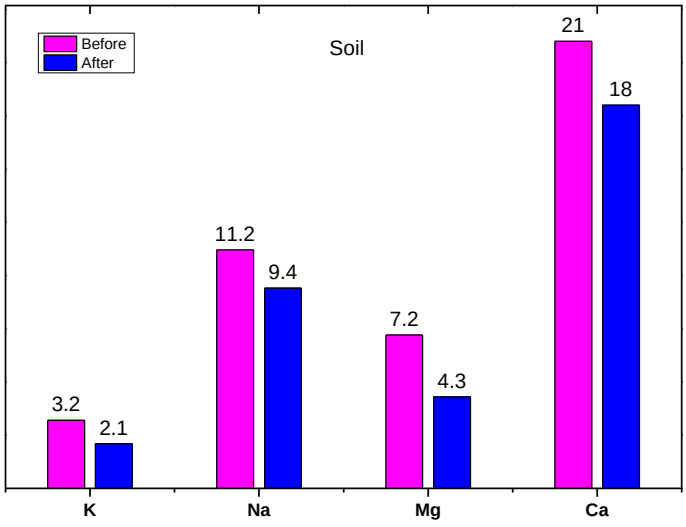


Fig. 2E. Cation analysis (mg /L) before and after treatment (Banana plant).

Fig. 3A: Images of Banana plant after treatment with ZnO nanoparticles/ microbial solution in the beginning of the growth.

Fig. 3B: Images of Banana plant after treatment with ZnO nanoparticles/ microbial solution after complete growth.

Conclusion

There is an urgent need to improve the awareness and use of bio fertilizer. It is crucial to play in ensuring bio fertilizers technology is fully adopted as the first choice in our quest to address soil fertility challenges. Inoculation with microorganisms helps in improving water status of plants thus proves favorable to protect crops in arid soils also. Therefore, integrated application of bio fertilizers along with chemical fertilizers in a sustained way can meet the nutrient needs of plants besides maintaining the soil health and environmental safety. Therefore, synthesis of ZnO nanoparticles and full characterization by XRD, IR, SEM and TEM images has been achieved then mixed with microorganisms in water of plant soil. From the study before and after treatment, ZnO – microbial solutions protect the crops, increase the product of soil, and maintain the soil health and environmental safety. So, it was recommended for being used in the future.

Author Contributions Statement

M. Y. A. H. performed all experimental work. G. M. A reviewed the manuscript. H. M. M. reviewed the manuscript. A. A. A supervised the thesis, wrote and revised the manuscript.

Data Availability Statement

Data are available upon request from the corresponding author of this article.

Author declaration

The experiments conducted here are complied with relevant institutional, national, and international guidelines and legislation. All samples are collected with full permission.

Permission to collect plants

These plant varieties of crops, vegetables and fruits were collected with the permissions and under the supervision of the Agricultural Engineer in Agricultural Extension, Agricultural Administration, and Directorate of Agriculture in Minya Governorate, Egypt.

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