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SYNTHESIS OF MAGNETIC IRON NANOPARTICLES COATED BY MICRO-NUTRIENTS AND STUDY OF THIER EFFECT ON SALINITY TREATMENT OF IRRIGATION WATER

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Synthetized nanoparticles are believed power factors for agri-fertilizers and evolution boosters. Micro-nutrients (Cu/Mn/Fe/Zn) grafted on iron oxide nanocomposite in agricultural systems, particularly world-wide crop production. Nano-micronutrients are strong candidates for immobilization of agricultural contaminants in soils and water. This article aimed to investigate the influence of nano-micronutrients grafted on iron oxide nanoparticles to reduce the harmful effect of water irrigation salinity through neutralizing sodium and chloride ions to plant. Also, increasing growth, photosynthesis, respiration, and leaf mineral content of wheat, rice and corn maize plants. Iron/micronutrients nanocomposite activated proline synthesis, and increased tolerance to salinity stress. The BET/FT-IR/XRD and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX) are characterizing the nano products. Brunauer-Emmett-Teller (BET) found the average pore diameter at 3.69 and median pore diameter at 30.57. T- Plot/ Langmuir adsorption besides an isotherm, illustrated the thickness of desorbate layers on a non-porous surface of iron oxide. T/MP-plot is applicable to desorbents containing macro pores, mesoporous, and micro pores. This nano size gave the simplicity penetration of nano-micronutrients of leaves and stems of plants. The best pH value of nanocomposite solution was from 6.5 to 7.8 at room temperature. The average dilution of concentrated nanocomposite solution to irrigation water was 1/400 nanofertilizer to irrigation water. The optimal nanocomposite dose was 100 mg/L. The resulted data, in case of wheat, rice and corn maize gave the highest yield at 22.30%, 21.42% and 29.10%, respectively at 100 ppm of nanocomposite with foliar fertilization.

Keywords: nanocomposite, irrigation water, nanofertilizer

INTRODUCTION

A major challenge world-wide in future would is increasing food production and security. Nanotechnology has become a treatment strategy of interest as a sustainable factor in agricultural systems, where it aims to raise efficiency in techniques such as food monitoring and water treatment. Nanoparticles (NPs), such as nano iron-oxides, have been designed to act as adsorbents and desorbents scavengers. Many studies have looked at scavenging ability of nano iron-oxides composite, but few have looked at them in agricultural and food systems.

Nanotechnology gave the ability to synthetize molecules in nanoscale with different new properties and certain functions. This allows the NPs to be used in many application fields. Water is the vital component of life. Water resources are deteriorating continuously due to human activities (Laws, 2000). The water irrigation type is very important for earth ecosystem (Duruibe et al., 2007). The four common methods for water treatment are boiling, filtration, distillation, and chlorination. But for industry, water treatment is depended on pollutant contents found, such as adsorption, membrane separation, activated sludge process are estimated. Dyes are found to be important pollutants in industrial wastewater. Nanomaterials are the best ones to detect, prevent and remove pollutants (Pankaj et al., 2016). In general, they have the power to improve our life and especially for saving health from diseases (Chorawalaa and Mehtab, 2015 and Xiaolei et al., 2015). That is due to the nano-specification nature of nanomolecules such as surface area, catalytic membranes, nanosorbents, bioactive NPs such as iron, titanium oxides and many others (Xu et al., 2012). NPs are released as particles smaller than 100 nm. At this scale, particles had novel size–dependent properties various from their original, many of these searched for using in water treatment (Poedji et al., 2013).

The concentration of heavy metals contamination in water had toxic effects on plants, animals and humans (Chaudhari, 2013). Co-precipitation process is a famous method with reduction yield around 98% (Davis et al., 2008). Magnetic process is the new method to produce magnetite NPs where it is efficient, economic and non–toxic. Lattice structure of Fe_3O_4 metal ion activates the material properties such as surface sorption, photo–induced catalysis etc. Polymer used to protect NPs by protection layer made of charcoal, silica or alumina. These applications required NPs of definite sizes, shapes, surface characteristics, and magnetic properties (Teja and Koh, 2009). Magnetism is a physical nature that is used in water purification by affecting on physical structure of contaminants in water. Adsorption method with magnetic separation has been used prolonged in water treatment (Oliveira et al., 2002).

Purification and recycling processes are needful in industry as well as the municipal wastewater. NPs used in water treatment have good techniques due to high reduction percent yield. Magnetic NPs are used for removal toxic heavy metals such as cations, organic compounds, and microbial contaminants.

The use of iron oxide materials are vital due to high surface area, high adsorption and desorption space. Innovation of nanotechnology in agriculture is confirmed to earn desired high yield of crop productivity (Liu and Lal, 2013 and Farooqui et al., 2016). Literature research is one of the methods to study the effect NPs on plant growth (Huang et al., 2015 and Siddiqi et al., 2016). Many searches investigate that nanomaterials may increase crop yield by raising different physiological processes such as seed germination and photosynthetic activity (Rui et al., 2016). The positive target of NPs on plants are helped with more specific surface area, which gives to their peak solubility and reactivity, and operative interaction with membranes and other cellular components, as also, proteins and lipids (Duran et al., 2017 and Rashad et al., 2021). Fertilization would be the best top for new application applied in future. It reduces soil contamination and improves environmental risks of numerous chemical fertilizers (Bakhtiari et al., 2015).

Different nanomaterials can be split into macronutrient and micronutrient nanofertilizers. Macronutrient nanofertilizers include one or more macronutrient elements such as N, P, K, Mg, S and Ca, while micronutrient nanofertilizers often contain Fe, Cu, Zn, Mn, and Fe NPs. The practical application of NPs as power growth promoters dependents on particle size, surface charge, and concentration that may change from profitable to phytotoxic (Hossain et al., 2020). Particle size and aggregation characteristics such as a direct connection with the toxicity of NPs raise their efficiency by reducing particle size at fewer concentrations (Angel et al., 2013). Iron is an important micronutrient and has an important role in plant propagation and development of cellular processes, such as chlorophyll biosynthesis, photosynthesis and respiration (Bozorgi, 2012; Alidoust and Isoda, 2013 and Ghasemi, 2014). Iron also engages RNA and respiratory enzymes (Winder and Nishio, 1995). The role of iron as a chelated ion found a varies issues matched to iron as NPs. Zinc (Zn) and copper (Cu), iron oxide NPs are digested in plant slowly as ionic forms. In addition, it has a quickly and fast rest to plant with high biochemical reactions effect. The present study aimed to distinguish the different target and methods proposed to get nano Fe composite with micronutrients. The focus has been on water treatment. Thus, the novelty of this study is utilizing iron oxides NPs coating with micronutrients. Also, nano Fe composite with micro-nutrients possesses high surface area, high pollutant adsorption capacity and have compatibility for functionalization by chemical groups and organic structures.

MATERIALS AND METHODS

1. Materials

Ferrous sulphate x-hydrate (Fe $SO_4 \cdot xH_2O$) and mineral hydroxide were purchased from Merck. All acids used were delivered from Merck manufacture. Inorganic Cu salts as Cu ion source, zinc sulphate, inorganic manganese salt and ferrous sulphate were also purchased from Merck. The alkaline fusion mixture was prepared from the reaction between KOH/NaOH. A co-precipitation method was used in this paper as described by Hasany and Saleem (2012). This method was simple and efficient considering size, structure, and NPs shape (Wu et al., 2011). The preparation efficiency depended on the type of inorganic salts ratios, pH, and etc. Chemical preparations were good techniques because of low cost and high productivity (Maity and Agrawal, 2007). The physical and chemical properties of NPs were changed according to several conditions. To prevent the oxidation and agglomeration of Fe NPs, they were coated with organic or inorganic molecules. A certain weight of inorganic salt was added with 300 ml of de-ionized water in a 500 ml flask. Different concentrations of Cu/Fe/Zn/Mn salts were added in a liquid solution at a certain pH. Then alkali fusion solution and ammonium hydroxide (NH_4OH, 26% of ammonia) were added to raise the pH. Finally, the nanocomposite product was separated by a centrifuge and washed twice with deionized water and ethanol. The obtained MNPs were dried at 100°C for 6 h (Cornell and Schertmann, 1996).

2. Characterization of Nano-micronutrients (NMNs) Grafted on Iron Oxide NPs by Different Instruments

2.1. FT-IR spectra

They were metric in a transmission model on a spectrophotometer (Perkin Elmer Spectrum Version 10.03.09) Spectrum Two Detector LiTa03 that was used for separating the solid and liquid during the preparation of samples.

2.2. Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX)

It was the best spectrum expertise of analysis. High resolution data of surface structure, with nice thickness of spectrum, were made using a highly focused, scanning (primary) electron beam. The primary electrons get in a surface with energy of 0.5–30 kV and breed many low energy secondary electrons. The intensity of these secondary electrons was high putting by the surface topography of samples. Measuring secondary electron intensity was a function of the position of the scanning primary electron beam. The primary electron beam could be focused to a very small spot (<30 nm) and high intensity to topographic features on the outermost surface (< 10 nm) was eaten when using a primary electron beam with an energy of < 1 kV. Hitachi SU8230 Regulus Ultra High-Resolution Field Emission SEM Bruker X-Flash

FQ5060 Annular Quad EDX detector, Bruker X-Flash 6160 EDX detector were used.

2.3. XRD technique

The XRD technique of NMNs grafted on iron oxide NPs was earned using a X-ray diffractometer Schimadzu model: A PAN analytical X-rays diffraction equipment model Xpert PRO with secondary monochromatic, Cu-radiation (λ=1.54A0) at 50k.v.,40 M.A and scanning speed 0.02o/s. The experimental data contained several treatments of NMNs grafted on iron oxide NPs fertilizer. Plants were cut and dry weight of grains was edited (Cottenie et al., 1982). Therefore, this study was conducted to compare the effects of NMNs grafted on iron oxide NPs fertilizer (Foliar) application on crop yield like wheat, rice and corn maize.

2.4. Brunauer-Emmett-Teller (BET)

It is a physical technique that provides quantitative datum on the specific surface area and porosity division of materials. The method was the best for solid matrices from catalyst powders to monolithic materials. The instrument type was BELSORP-mini X - BET surface area, porosimetry and sorption measurement. The specific surface area of the BET sample was determined by the physico-sorption of an inert gas, typically nitrogen, argon, or krypton, on the sample surface. The small gas molecules were attached to surface solid sample and opened a porous structure. After the gaseous monolayer of molecules was formed, the sample was pu into a non-nitrogen atmosphere and heated. This allowed the release of the adsorbed nitrogen gas molecules from the surface of the sample. The released gas molecules could be assumed surface area and porosity of the sample.

2.5. **HPLC method**

It is a sensitive detecting method to use amino acids. This method was good for detection of amino acids such as proline. The amino acid content of samples could be defined by reverse-phase, high-performance liquid chromatography (HPLC). Samples were prepared on cold 100% ethanol; α-aminobutyrate (120 μM, dissolved in distilled water); column: C18-Gemini 5μ110A-250 ×4; HPLC: Beckman Coulter and analysis software was 32 K Software (System Gold HPLC).

2.6. Samples of wheat, rice and corn maize

Ten grams of sample was weighted in porcelain capsules. Samples were dried during 24 h to take off the grains humidity. The sample was burned in an oven under a temperature until the final temperature of 450ºC was ranged, 48 h later (Luis et al., 2012). The resultant ashes were objected to another digestion with some drops of 65% concentrated HNO_3 to support oxidation of the organic matter. This method helps to remove the rest of nitric through evaporation by suitable method. After that, sample was put into the oven and, following the same previous process, white ashes were obtained (González-Weller et al., 2010).

2.7. Analytic process to determine macro, micro and trace elements

Microelements (Mn, Fe, Cu, and Zn) were defined by inductively coupled plasma optical spectrophotometry (ICP) Thermo Scientific ICAP 6300 spectrophotometer. Calibration straights made from model solutions was detected to calculate concentration and the quantification limit for each of the analyzed metal was 0.010 mg/l.

RESULTS AND DISCUSSION

1. Features of Iron/Micronutrients Nanocomposite

1.1. FT-IR spectroscopy of iron/micronutrients nanocomposite

Fig. (1) shows that Fe–O vibration related to the iron oxide NPs gave data at 602 cm^{-1} and 450 cm^{-1}. Two transmission peaks at 2,173 and 2,000 cm^{-1} were referred to the asymmetric C-H stretching and the symmetric C-H stretching, respectively. C–H stretching, in 1401 cm^{-1} were because of C–H bending vibrations (Tamás et al., 2007). The IR band at 3202 cm^{-1} could be showed to the stretching modes of surface H_2O molecules. A variation of intensity in transmission bands indicated to associate differences between the compared structures. Hydroxyl groups formed as asymmetrical structures that had new crosslinking linkage between different NPs formed with each other (Zuzana et al., 2017). IR spectroscopy is a major characterization test of nanoscale materials and gave us the prediction of new compounds forms. The nanocomposite formed with interaction between iron oxide Fe-O with Cu-O/Mn-O/Zn-O in nanoscale may give new broad peaks with high intensity (Habib et al., 2018).

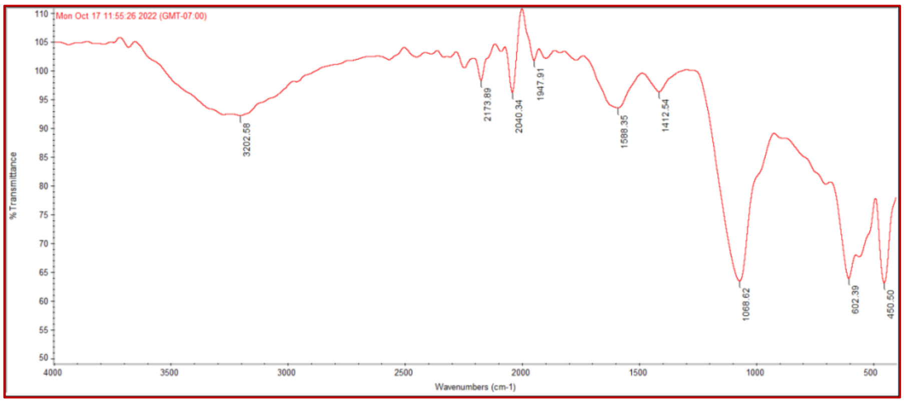

Fig. (1). FT-IR of iron/micronutrients nanocomposite.

1.2. Investigation of BET spectrum of iron/micronutrients nanocomposite

The BET of the powder was found with the average pore diameter at 3.69 and median pore diameter at 30.57 (Fig. 2). A major part of nanocomposite size was less than 10 nm. This is due to the new chemical structure formed. The inorganic salts of manganese, Cu, and Zn had a major role in producing new nanostructure which linked with iron nano core by several hydroxyl groups.

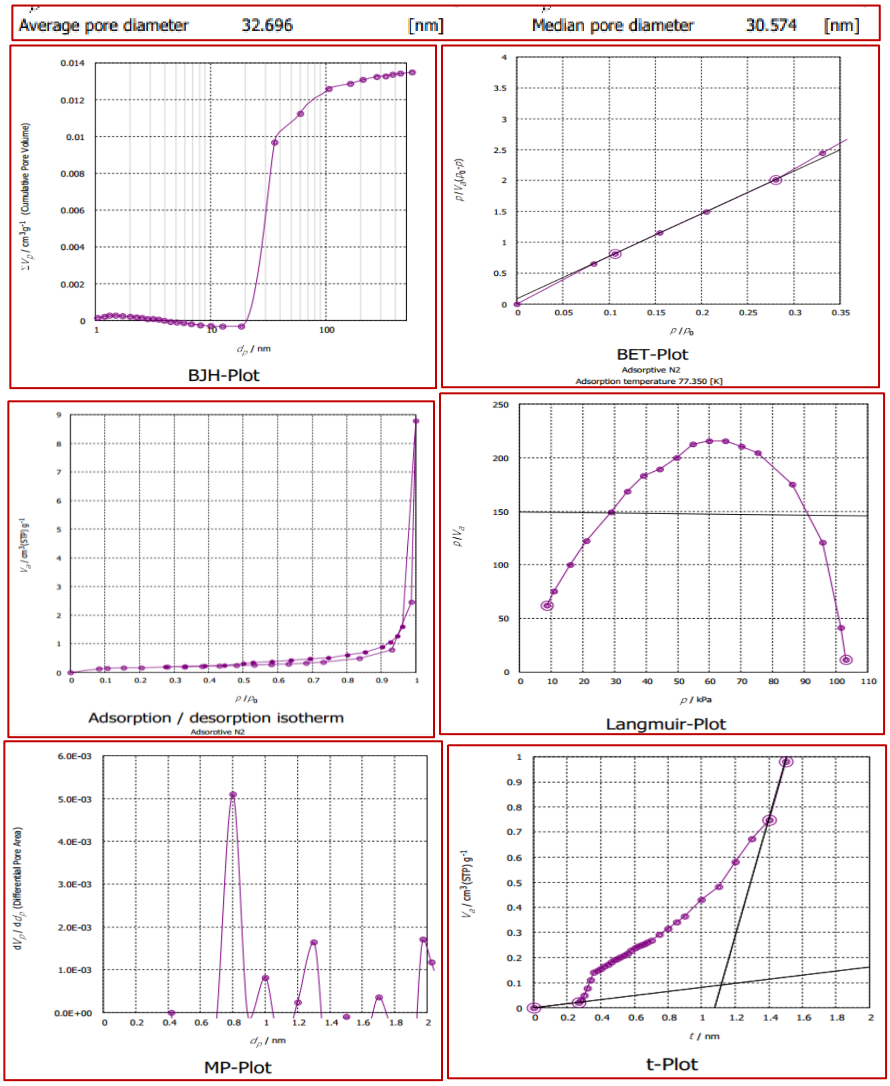

Fig. (2). BET and Langmuir plots data for the obtained nanocomposite.

Adsorption process can carry on with the pointing of the multilayer covering the new third layer (Rouquerol et al., 1999). The Langmuir adsorption isotherms forecast linear adsorption at low adsorption densities and a maximum surface coverage at higher solute metal concentrations. Langmuir adsorption is vital for monolayer adsorption onto a homogeneous surface when no interaction occurs between adsorbed species (Langmuir, 1918). T-Plot / besides an isotherm, this method requires a so-called thickness function, which terms the thickness of adsorbate layers on a non-porous surface as a function of pressure. The t-plot method attempts to join the adsorption on a material with a model curve which gives the thickness of the adsorbed layer on a surface. A plot is constructed, where the isotherm loading data is plotted versus thickness values obtained through the model. The experimental adsorption curve follows the model; a straight line will be obtained with its intercept through the origin. A sharp vertical deviation will indicate condensation in a type of pore. A gradual slope will indicate adsorption on the wall of a particular pore.

Calculation of area is necessary to get on slope the line section. The total surface area of the material will be represented. The intercept of the line will no longer pass through the origin. T-plot method watched the differences between the isotherm and an ideal adsorption curve. When choosing a thickness model, it is vital for material and adsorbate. Interfering that occur on the t-plot lower than monolayer thickness does not have any physical meaning (Lippens et al., 1965). The method offers adsorption volume division functions as seeker by the Kaganer and Dubinin theories. In addition, when the micro pore analysis is entire, the MP method is the best method for adsorbents including macro and micro pores with self-termination.

1.3. Investigation of the composition of the obtained particles (X–ray diffraction)

Fig. (3) shows that XRD is an effective technique to identify the phase and to confirm the crystal structure of the synthesized iron oxide NPs. The X–ray diffraction pattern of the iron oxide micronutrients nanocomposite synthesized. The XRD peak of 2θ values such as 29.50, 31.00, 33.00, 33.50, 34.00, 34.50, 35.00 36.50, 37.50, 38.00, 56.50 and 59.50 were deducted. From the XRD values, one can conclude that the synthesized iron magnetic NPs lattice structure is face centered and the crystalline nature of the particles found to be cubic which was clearly implied in SEM images. XRD peak represented the iron oxide and copper oxide, zinc oxide, manganese oxide composites in nanoscale. The formed iron oxide/micronutrients nanocomposite crystalline nature is face–centered and structure is cubic. XRD image represented the iron oxide nanocomposite, in which the XRD 2θ peaks values of most of the XRD peaks denoting iron oxide peaks, which showing the crystalline nature of iron oxide. The positions and relative intensities of the reflection peak of magnetite and hematite agreed with the XRD diffraction peaks of iron oxide NPs.

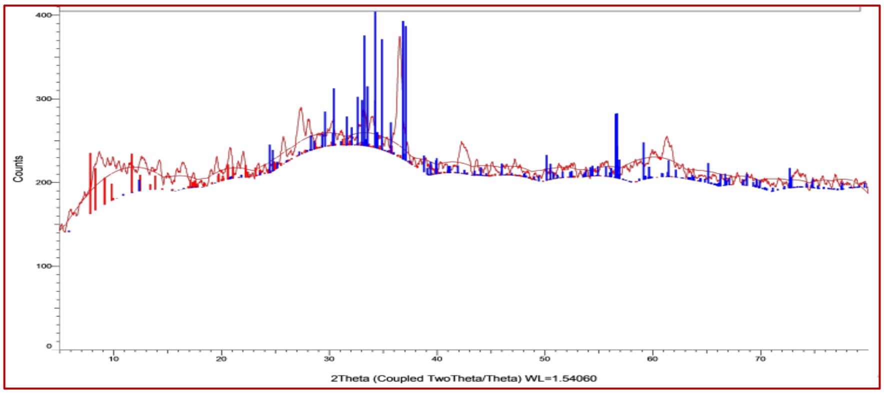

Fig. (3). XRD chart of iron/micronutrients nanocomposite.

1.4. SEM of Fe/micronutrients nanocomposite

Fig. (4) shows that the scanning electron microscope is a device used to find out the outer surface details of a particle. It uses high power electron beams on the surface of the atoms to provide discrete image of topography of the particle with respect to proper scale. SEM showed an effective inorganic salt of iron consisting of nano-pellets with different shapes. The processed SEM images showed the structural appearance of the nanocomposite molecules. The smaller molecules depict the aggregates of unstable molecules whereas the larger ones represent the molecules intact. The nanocomposite appeared to have a three-dimensional shape. Image shows the iron oxide NPs SEM image, the size of the iron oxide NPs surface morphology is spherical in shape and the average size of the particles start from 30 to 35 nm. The iron oxide/micronutrients nanocomposite are shown with the surface morphology of the iron particles and different micronutrients elements. Different micronutrients elements adhered on the surface of the iron NPs. Then the iron oxide, micronutrients nanocomposites shown in elements impregnated inside of the nano iron tetrahedral structure so that the EDAX peaks was dominated (Elias et al., 2010).

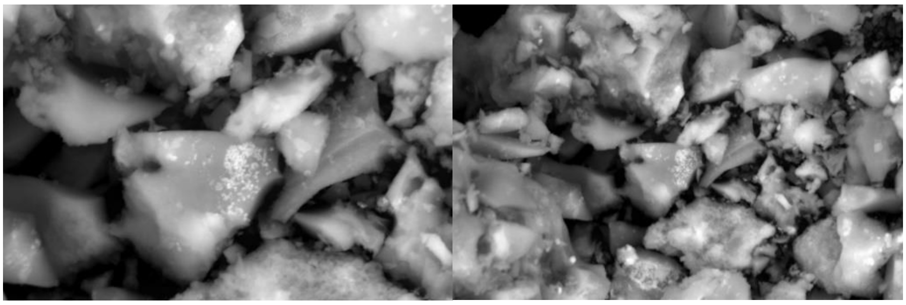

Fig. (4). SEM of iron/micronutrients nanocomposite.

1.5. Energy dispersive x–ray analysis of iron/micronutrients nanocomposite

Table (1) and Fig. (5) show that EDX is a technique employed for determining analysis of chemical characterization. The peak in the SEM–EDX image and graph of iron/micro-nutrients nanocomposite confirms the presence of iron, copper, zinc and manganese with other metabolic minor elements in plants. This graph had 11 peaks for different elements. The presence of minor elements peaks was due to inorganic salts and alkali used for the synthesis. The presence of micronutrients confirms that these elements were coated on iron oxide NPs. The presence of large amounts of oxygen peak was due to a highly interaction coating linkages between different micronutrients and iron oxide as core particles (Kosasih et al., 2020).

Table (1). Elementary Analysis of iron/micronutrients nanocomposite.

Elements	C	O	Mg	Al	S	Cl	K	Mn	Fe	Cu	Zn
%	5.45	58.58	3.05	0.85	10.76	0.49	2.32	3.37	5.92	4.30	4.90

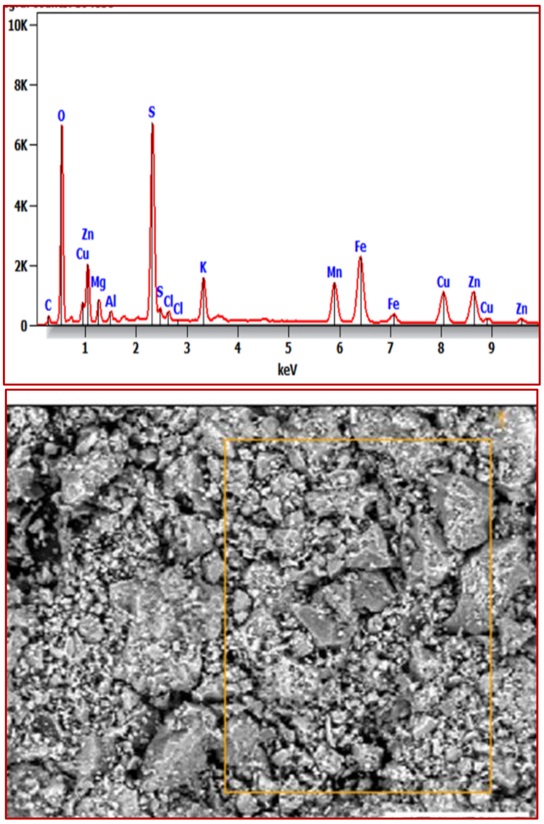

Fig. (5). EDX of iron/micronutrients nanocomposite.

2. Effect of Iron/Micronutrients Nanocomposite on Reducing Salinity of Irrigation Water

Foliar application with Fe coated micronutrients nanocomposite gave notability in prompt the highest degree of pleasure under saline habitat, which rises in growth parameters and dry matter aggregation (Abdel-Fattah, 2014; Shankramma et al., 2016 and Sanati et al., 2018). Fe coated micronutrients nanocomposite increased growth parameters of plant. This enhanced role of Fe coated micronutrients nanocomposite might be ascribed to the role of Fe coated micronutrients nanocomposite in enhancing of Cu/Fe/Zn/Mn uptake which stimulate plant growth rather than the harmful effect of Na and Cl, which inhibit plant growth (sodium and chloride ions separate when salts are dissolved in water). The dissolved sodium and chloride ions, in high concentrations, can displace other mineral nutrients in the soil (Askary et al., 2017). Table (2) shows the chemical analysis of major ions (cations and anions) in irrigation groundwater. The average salinity of irrigation water from five samples taken from wells gave 1700 ppm. According to water standards salinity levels, the salinity value at 1700 ppm, most of crops did not get on high crop productivity and quality. This is due to the harmful effect of sodium and chloride ions on plants. The velocity of sodium ion absorption to plant tissue prevents any nutrients from absorbing inside it. The useful usage of NMNs fertilizer is preventing sodium effect through the nano-metric size of NMNs fertilizer that is absorbed faster than sodium ion. The minor micronutrients in irrigation water did not have any bad effect on plant physiological activities as shown in Table (3).

Table (2). Chemical analyses of major cations and anions in irrigation groundwater.

Items	Ca	Mg (epm/cation)	Na	K	Total cation (epm)	CO_3	HCO_3 (epm /anion)	SO_4	Cl	Total anion (epm)	TDS (ppm)	EC (µs/cm)	pH
Sample 1	6.8	6.6	22.7	0.3	36.5	0.5	3.0	1.2	30.6	35.3	1860	3116	7.9
Sample 2	6.0	6.0	14.3	0.3	26.6	0.9	2.4	4.5	18.7	26.4	1776	2760	7.6
Sample 3	3.4	5.5	11.7	0.2	20.8	0.2	3.0	4.3	13.5	21.0	1400	2127	7.7
Sample 4	5.8	8.1	13.6	0.5	28.1	0.0	3.50	9.4	15.1	28.1	1700	2800	7.6
Sample 5	5.9	5.6	14.1	0.2	25.8	0.9	2.3	4.3	18.2	25.7	1760	2966	7.8
Average	5.5	6.3	15.2	0.3	27.5	0.5	2.8	4.7	19.2	27.3	1700	2753	7.7

Table (3). Chemical analyses of minor metals in irrigation groundwater.

Items	Al	Cd	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	V	Zn
Sample 1	0.108	0.019	ND	0.019	0.201	0.534	0.104	ND	ND	ND	ND	0.011
Sample 2	0.110	0.023	ND	0.014	0.198	0.612	0.230	ND	ND	ND	ND	0.054
Sample 3	0.097	0.021	ND	0.011	0.180	0.548	0.160	ND	ND	ND	ND	0.016
Sample 4	0.140	0.020	ND	0.013	0.220	0.570	0.190	ND	ND	ND	ND	0.032
Sample 5	0.150	0.010	ND	0.020	0.230	0.544	0.110	ND	ND	ND	ND	0.019
Average	0.121	0.018	ND	0.015	0.205	0.561	0.158	ND	ND	ND	ND	0.026

3.3. Effect of iron/micronutrients nanocomposite on reduce salinity of irrigation water

Table (4) shows the average salinity of irrigation water from five samples taken from wells gave 1700 ppm. According to water standards salinity levels, in the salinity value at 1700 ppm, most of crops did not get on high crop productivity and quality. This is due to the harmful effect of sodium and chloride ions on plants. The velocity of sodium ion absorption to plant tissue prevents any nutrients from being absorbed inside it. The useful usage of NMNs fertilizer is to prevent sodium effect through the nano-metric size of NMNs fertilizer that is absorbed faster than sodium ion.

Table (4). The effect of different iron/micronutrients nanocomposite on water salinity.

Fe / micronutrients nanocomposite (ppm)	Average irrigation water salinity before treatment (ppm)	Irrigation water salinity after treatment (ppm)	Reduction %
Control		1500	88.23
25		1250	73.52
75	1700	1100	64.70
100		1000	61.76
150		1050	61.76

4. Effect of Iron/Micronutrients Nanocomposite on Proline Content in Plant

The obtained results showed that diverse concentrations of iron/micronutrients nanocomposite foliar treatment under brackish irrigation condition caused significant increases in the content of proline as compared with controls (Table 5). The results are supported by the findings of Soliman et al. (2015), they stated that iron/micronutrients nanocomposite induce proline synthesis and improve tolerance to abiotic stress. The proline content of plant cells plays a vital role in osmotic under stress so saving structure and cell membranes. Proline stimulates free radical and cellular redox to make stabilization of components of cell (Kaur and Asthir, 2015).

Table (5). Effect of proline on reducing salinity inside plant.

Fe micronutrients nanocomposite (ppm)	Irrigation water salinity before treatment (ppm)	Proline (mg/100 g dry)
control		25.21
25		30.40
75	1700	35.67
100		37.01
150		29.84

5. Effect of Nano-Micronutrient Before and After Addition on Different Plant

Copper (Cu) is one of the most major plant micronutrients. Enzymatic activities in plants, chlorophyll and seed production need the copper ion. Shortage of copper can drive to raise diseases which can give low plant yield. Copper shortage can occur in soils that are sandy and have high organic components. Low copper content is more probably found in cereal grains, such as wheat. Using copper power is amended if the solubility of fertilizer is high and the size of fertilizer particles are small. So that, the preparation of NMNs supports plant to help making micronutrient absorption. Foliar application of Cu can benefit Cu shortage in grains and vegetable plants (Ejaz et al., 2006). Table (3) shows the elevation percentage for Cu in wheat, rice and corn maize. The differences in elevation percentage for all crops before and after the use of nanofertilizers would be in acceptable standard ranges. The elevation percentage differences were 10% in wheat; 12% in rice and 7.6% in corn maize.

Zinc (Zn) is an essential micronutrient for plant life. It is a famous micronutrient in fertilizer systems for plant yield production. A specific enzyme depends mainly on nutrients such as Zn for plant Growth. Carbohydrate, protein, and chlorophyll forming are decreased in zinc-deficient plants. In table 6. Illustrated the elevation percent for zinc in wheat, rice and corn maize. The differences in elevation percent for all crops before use nanofertilizers and after use would in acceptable standard ranges. The elevation percent differences ranged to 12% in wheat; 11% in rice and 8.2% in corn maize. In plants, iron is the major element needed for photosynthesis and chlorophyll synthesis. The obtainable of iron in soils vital for the distribution of plant species and specified quality of crops. Deficient iron get causes delayed growth and chlorosis. It is therefore obligatory for plants to beat the often-restricted obtainable of soil iron mobility increasing. Iron moves a good support in numerous physiological and biochemical ways in plants. Iron component of necessary enzymes such as electron transport chain cytochromes. Iron is one of the element in synthesis of chlorophyll, and it is vital for the maintenance of chloroplast structure and function (Abadía et al., 2011). In Table (6, 7 and 8) Explained that the elevation percent for iron in wheat, rice and corn maize. The differences in elevation percent for all crops before use nanofertilizers and after use would in acceptable standard ranges. The elevation percent differences ranged to 14% in wheat; 13% in rice and 12.7% in corn maize. Manganese (Mn) is one of an important micronutrient and is needed to plants. Iron and manganese deficiency or toxicity is often mistaken. Manganese is a major contributor to various biological systems as including photosynthesis and respiration. Manganese is needed in germination, pollen tube growth, elongation of root cell and resistance to root diseases. Manganese supports in various processes such as photosynthesis process, chlorophyll production, activates enzymes, Enhances starch production, prompts cell division and elongation (Kelley, 1914). Table (6, 7 and 8) show that the elevation percent for manganese in wheat, rice and corn maize. The differences in elevation percent for all crops before use nanofertilizers and after use would in acceptable standard ranges. The elevation percent differences before and after foliar spraying by micronutrients nanocomposite ranged to 9% in wheat; 8% in rice and 10.5% in corn maize. Table (6, 7 and 8) show the elevation difference between two seasons which gave the slightly difference in micronutrients in wheat, rice and corn maize plants.

Table (6). The difference elevation % of nano-absorption on wheat plant.

Element type	**Wheat plant First season**			**Wheat plant Second season**			**Elevation difference %**
	Control before spraying	**After spraying**	**Elevation %**	**Control before spraying**	**After spraying**	**Elevation %**	
Cu	0.43	0.47	10.75	0.52	0.56	13.00	3.75
Zn	2.65	2.87	12.04	2.41	2.70	8.31	3.73
Mn	3.90	4.33	9.40	4.30	4.98	6.61	2.79
Fe	3.19	3.41	14.50	3.40	3.80	8.50	6.00

Table (7). The difference elevation % of nano-absorption on Rice plant.

Element type	**Rice plant First season**			**Rice plant Second season**			**Elevation difference %**
	Control before spraying	**After spraying**	**Elevation %**	**Control before spraying**	**After spraying**	**Elevation %**	
Cu	0.22	0.28	3.66	0.25	0.33	3.12	0.54
Zn	1.09	1.18	12.11	1.20	1.40	6.00	6.11
Mn	1.10	1.22	9.16	1.19	1.32	9.15	0.01
Fe	0.80	0.86	13.33	0.95	1.40	2.11	11.22

Table (8). The difference elevation % of nano-absorption on corn maize plant.

Element type	Corn maize plant First season			Corn maize plant Second season			Elevation difference %
	Control before spraying	After spraying	Elevation %	Control before spraying	After spraying	Elevation %	
Cu	0.31	0.35	7.60	0.42	0.55	3.23	4.37
Zn	2.21	2.47	8.20	2.07	2.56	4.22	3.98
Mn	0.49	0.53	12.25	0.57	0.70	4.38	7.87
Fe	2.71	2.92	12.90	2.80	2.98	15.55	2.64

3.6. Effect of Iron/Micronutrients Nanocomposite on Plant Characterization

The roots length increased with the increase in the concentration of micronutrients nanocomposite with respect to control by 10.25%, 11.20% and 77.46% for wheat, rice and corn maize, respectively at 100 mg/L. Table (9) shows that the length of stems of wheat, rice and corn maize increased with increasing the concentration of micronutrients nanocomposite by 5.80%, 7.45% and 65.85%, respectively compared to control at 100 mg/L. However, the variation occurred in length of leaves increased by 15.20%, 13.78% and 72.00%, respectively. The big effectiveness of nanocomposite appeared in corn maize plant. It is perhaps due to the nature of corn maize plant where it needs large amounts of fertigation content. The novelty of the chemical structure of NMNs fertilizer gave the nutrients need certain ranges and more flexibility and suitability (Rane et al., 2015). Tables (9, 10 and 11) show the slight difference in collected data between the two seasons in wheat, rice and corn maize. This might be the useful effect of NMNs on the physiological activities of plant such as length of roots, stem leaf.

7. Effect of Iron Micronutrients Nanocomposite on Crop Yields

Table (12) shows the relation between synthetized nanocomposite with micronutrients and wheat, rice and corn maize yields under salinity of irrigation water at 1700 ppm. Different nanocomposite concentrations from 25 ppm to 150 ppm would be used with foliar application to wheat, rice and corn maize fertilization. The results in case of wheat gave the highest yield (22.30%) at 100 ppm of nanocomposite with foliar fertilization. For rice, the largest crop productivity was shown at 100 ppm of foliar nanocomposite which gave 21.42%. The highest value of corn maize yield was 29.10%, which appeared at 100 ppm nanocomposite concentration. The best nanocomposite concentration was 100 ppm. The raising of irrigation did not contribute with harmful effect on productivity, this might be the physiochemical interaction occurred between NPs of synthetized nanocomposite with elements in water irrigation and chelating them in the nanomaterials chemical skeleton, preventing the bad effect of large content of sodium and chloride ions in water.

Table (9). Comparison of crop plant lengths treated by synthetized nanocomposite (Wheat Plant).

Crop parameter	Wheat plant First season			Wheat plant Second season			Difference between seasons
	Before treatment (cm)	After treatment (cm)	Length %	Before treatment (cm)	After treatment (cm)	Length %	Length %
Length of root (dose/ 100 ppm)	75.00	82.30	10.25	72.00	81.20	7.82	2.43
Length of stem (dose/ 100 ppm)	95.00	111.37	5.80	92.00	108.00	2.55	3.25
Length of leaf (dose/ 100 ppm)	30.00	31.97	15.20	32.00	36.00	8.00	7.20

Table (10). Comparison of rice plant lengths treated by synthetized nanocomposite.

Crop parameter	Rice plant First season			Rice plant Second season			Difference between seasons
	Before treatment (cm)	After treatment (cm)	Length %	Before treatment (cm)	After treatment (cm)	Length %	Length %
Length of root (dose/ 100 ppm)	40.00	43.57	11.20	42.00	46.21	9.97	1.23
Length of stem (dose/ 100 ppm)	85.00	96.40	7.45	83.00	88.03	16.50	9.05
Length of leaf (dose/ 100 ppm)	65.00	69.71	13.78	68.00	73.65	12.03	1.75

Table (11). Comparison of corn maize plant lengths treated by synthetized nanocomposite.

Crop parameter	Corn maize First season			Corn maize Second season			Difference between seasons
	Before treatment (cm)	After treatment (cm)	Length %	Before treatment (cm)	After treatment (cm)	Length %	Length %
Length of root (dose/ 100 ppm)	110	142	3.43	115	139	4.79	1.36
Length of stem (dose/ 100 ppm)	270	410	1.92	265	423	1.67	0.25
Length of leaf (dose/ 100 ppm)	90	125	2.57	95	134	2.43	0.14

Table (12). Effect of iron/micronutrients nanocomposite on plant productivity**.**

Fe micronutrients nanocomposite (ppm)	**Average irrigation water salinity (ppm)**	**Wheat yield average (ton /faddan)**	**Wheat yield after treatment (ton /faddan)**	**Wheat yield %**
25			3.10	15.20
75	1700	2.70	3.14	16.40
100			3.30	22.30
150			3.23	19.87
Fe micronutrients nanocomposite (ppm)	**Average irrigation water salinity (ppm)**	**Rice yield average (ton /faddan)**	**Rice yield after treatment (ton /faddan)**	**Rice yield %**
25		4.50	5.21	15.77
75	1700		5.39	19.80
100			5.46	21.42
150			5.44	21.00
Fe micronutrients nanocomposite (ppm)	**Average irrigation water salinity (ppm)**	**Corn maize yield average (ton /faddan)**	**Corn maize yield after treatment (ton /faddan)**	**Corn maize Yield %**
25			4.21	20.50
75	1700	3.50	4.39	25.47
100			4.51	29.10
150			4.50	28.76

CONCLUSION

In this paper, the synthetized micronutrients nanocomposite had a good role for irrigation water treatments. The enhanced role of Fe coated micronutrients nanocomposite might be ascribed to the role of Fe coated micronutrients nanocomposite in enhancing Cu, Fe, Zn and Mn uptake which stimulate plant growth rather than the harmful effect of Na and Cl which inhibit plant growth (Sodium and chloride ions separate when salts are dissolved in water). The dissolved sodium and chloride ions, in high concentrations, can displace other mineral nutrients in the soil. Iron micronutrients nanocomposite induced proline synthesis, and improved tolerance to abiotic stress. The novel methodology of synthetized nanocomposite was complex. The BET of the powder was found the average pore diameter at 3.69 and median pore diameter at 30.57. The major part of nanocomposite size was found less than 10 nm. The inorganic salts of manganese, copper, and zinc had a major role to produce new nanostructure which link with iron nano core by several hydroxyls groups. The nanocomposite formed with interaction between iron oxide Fe-O and Cu-O/Mn-O/Zn-O in nanoscale may give new broad peaks with high intensity.

Iron oxide NPs SEM image shows that iron oxide NPs surface morphology is spherical in shape and the average size of the particles start from 30 to 35 nm. The Langmuir adsorption is applicable for monolayer adsorption onto a homogeneous surface when no interaction occurs between adsorbed species. The big challenge for achievement high desorption percent of NMNs grafted on iron oxide was how to use nanoparticles in plant fertilization treatment. This nano size gave the simplicity penetration of NMNs of leaves and stems plants. The best pH value of nanocomposite solution was from 6.5 to 7.8 at room temperature. The average dilution of concentrated nanocomposite solution to irrigation water was 1/400 nanofertilizer / irrigation water. The optimal nanocomposite dose was 100 mg/L. The results in case of wheat gave the highest yield (22.30%) at 100 ppm of nanocomposite with foliar fertilization. For rice, the largest crop productivity was shown at 100 ppm of foliar nanocomposite which gave 21.42%. The highest value of corn maize yield was 29.10% which appeared at 100 ppm nanocomposite concentration.

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تخليق مركبات الحديد النانومغناطيسية المطعمة بالمغذيات الصغرى ودراسة تأثيرها على معالجة ملوحة مياه الري

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يهدف البحث في المقام الأول إلى زيادة وتعميق مفهوم التنمية المستدامة والذي يعتمد على ربط وحدة المياه ووحدة التربة ووحدة النبات. وفي هذا السياق استطاع البحث المساهمة في معالجة جزيئية وخفض التأثير الضار لملوحة مياه الري وفي نفس الوقت إمداد النبات بالتغدية المطلوبة من العناصر الصغرى في صورة جديدة نانوية القياس وذات كفاءة عالية انتاجيًا وعضويًا. يتناول البحث إنتاج مركب محلي التصنيع والإنتاج من مواد كيميائية محلية الصنع في صورة مقياس نانوي جديد من أيونات الحديد المغناطيسي والمحمل عليه عناصر التغذية النباتية الصغرى (الحديد/المنجنيز/النحاس/الزنك). تعتمد التقنية الجديدة على استحداث مجاميع وظيفية هيدروكسيلية متعددة الترابط بالأيونات الموجبة لعناصر التغذية النباتية. أوضحت القياسات التحليلية للمركب النانوي الجديد أن القياس المتري للعديد من أيونات النانو في حدود ١٠ نانومتر. وقد تم عمل العديد من القياسات بأجهزة التحليل الدقيقة للوصول إلى التعرف على خصائص وخواص المركب النانوي الجديد لضمان جودة وأمان تطبيقية. أظهرت النتائج من خلال التجارب الحقلية الواسعة النطاق العديد من النجاحات المرتبطة بمعالجة تأثيرات الملوحة لمياه الري وكذلك معالجة النقص في تغذية النبات من العناصر الصغرى. يهدف البحث في أولوياته إلى المساهمة في زيادة قدرة النبات على تحمل الإجهاد الملحي لوحدة المياه والتربة والحصول على أفضل إنتاجية للمحصول. وقد أعطت النتائج مؤشرات كبيرة على قدرة النبات على إنتاج الحمض الأميني البرولين لزيادة قوة النبات على تحمل ملوحة المياه. وقياسًا على البعد الآخر فهو تقليل التكلفة الرهيبة في استخدام السماد التقليدي كمًا وكيفًا. وقد أثبتت نتائج البحث أهمية استخدام التسميد النانوي الجديد والذي يوفر مالا يقل عن ٤٠-٥٠٪ من التكلفة للأسمدة التقليدية وزيادة الإنتاجية لبعض المحاصيل بنسبة تتراوح ما بين ٢٠-٤٠٪ علاوة على البعد البيئي والملوثات. استطاعت جزيئات النانو المغناطيسية في زيادة امتصاص النبات لعناصر التغذية الصغرى طبقًا لاحتياج النبات الفعلى مما انعكس على معدلات الإنتاجية. ومن أهم أهداف البحث هو توضيح العلاقة بين خفض التأثرات الضارة لأيونات الصوديوم أو الكلوريد السالب في مياه الري وقدرة المواد المغذية النانوية على زيادة الإنتاج الزراعي نظرًا لسرعة نفاذية المواد نانوية الجديدة على اختراق أنسجة النبات أسرع وأسهل. وقد أعطت النتائج لمحصول القمح زيادة في الإنتاجية بنسبة ٢٢.٣٠٪ لاستخدام السماد النانوي للعناصر الصغرى الورقي بطريقة الرش بتركيز يصل إلى ١٠٠ جزء في المليون كأفضل جرعة تغذية. أما بخصوص محصول الأرز فقد زادت الإنتاجية بنسبة ٢١.٤٢٪ عند نفس تركيز السماد النانوي الجديد. وزادت معدلات الإنتاجية لمحصول الذرة الصفراء إلى ٢٩.١٠٪ عند نفس المعاملات السابقة.