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Effect of Mg NPs on A Germination and Some Physiological Parameters for Two Varieties Soft Wheat

A Thesis Submitted in Partial Fulfillment of the Requirements for the
Master's Degree of Science in Biology

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
﴿مَثَلُ الَّذِينَ يُنْفِقُونَ أَمْوَالَهُمْ فِي سَبِيلِ اللَّهِ كَمَثَلِ حَبَّةٍ أُنْبَتَتْ سَبْعَ سَنَابِلَ
فِي كُلِّ سُنْبُلَةٍ مِئَةُ حَبَّةٍ وَاللَّهُ يُضَاعِفُ لِمَنْ يَشَاءُ وَاللَّهُ وَاسِعٌ عَلِيمٌ﴾

صدق الله العلي العظيم

سورة البقرة/الآية (261)

Certificate

I certify, that this thesis entitled " **Effect of Mg Nps on A Germination and Some Physiological Parameters for Two Varieties Soft Wheat**" and examined the student " **Huda Saad Dawas**" , under my supervision in Department of Biology, College of Science University of Al-Muthanna, as a part of the fulfillments of requirements for the degree of Master of Science in Biology/general biology.

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Prof. Dr. Faiq Hassan Ali

Head of Biology Department

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Date : / /2021

Dedication

To those who planted ambition and perseverance in me, and it is time for them to reap the effort that my (**father and mother**) worked on.

To those who supported me and gave me strength my (**dear husband**).

To the bright light in my life my (**brothers and sisters**)

To the brightness of my eyes and my green Sanabel (**Ola and Ali**)

To everyone helped and supported me to do this work

To all of you I dedicate my effort.

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ABSTRACT

The experiment was conducted in a greenhouse at University of Al_Muthanna, department of biology, College of Science during the grown season in 1 \ 12 \ 2020 . The aim was to study the effect of MgO NPs at (0,100, 200 and300) ppm apply at (seed soaking, foliar application, seed soaking and foliar application) on growth and some physiological parameters of *Triticum aestivum* L. varieties Abaa 95 and Rasheed . the project was carried out according to factorial with the completely randomized design (C.R.D) in three replicates. Biosynthesis of magnesium oxide nanoparticles was achieved by a novel, simple green chemistry procedure using: *Allium cepa* (green leaves) extract as a natural reducing agent The biologically synthesized MgO nanoparticles were characterized by UV–Visible spectroscopy, X-ray diffraction (XRD), scanning electron microscopy (SEM) . The results indicates the significant effect of MgO NPs at the lower concentration (100 ppm) when using to (seed soaking and foliar application) in comparsion for the other concentrations the Varity Abaa 95 was more influence than Rasheed on all vegetative growth aspect like (mean of germination(6),speed of germination (12) , length of shoot (66.33 cm) and root length (57.00 cm) , dry weight and fresh weight for both shoot &root) . likewise the physiology parameters , the high result was for Abaa 95 plant like chlorophyll (2.90 mg/g), carbohydrate (44.42 g) , protein (8.81 g) , leaf area (31.25 cm²), membrane stability (6.33%) , weight of 100 plant grain (3.86g) , number of Tillers (3.42) while the lowest result was for Rasheed plant such as chlorophyll (2.49 mg/g), carbohydrate (23.73g) , protein (4.50 g) , leaf area(12.33 cm²) , membrane stability (13.00%) , weight of 100 plant grain(3.28 g) , number of Tillers (2.42) .

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List of Abbreviations

Abbreviations	Terms
T.	<i>Triticum</i>
Mg	Magnesium
NPs	Nanoparticles
Con.	Concentration
Sp.	Species
ppm	Parts per million
chl.	Chlorophyll
SEM	Scanning Electron Microscope
UV	Ultraviolet–Visible spectroscopy
XRD	X-Ray Diffraction
T1	Treatment 1 (seed soaking method)
T2	Treatment 2 (foliar application method)
T3	Treatment 3 (seed soaking +foliar application method)
Nms	Nanomaterials
Nm	nanometers
Faa	Free amino acid
tss	Total soluble solids
Tss	Total suspended particulates
Iaa	Indole acetic acid
Ros	Reactive Oxygen species
C.R.D	Completely Random Design

Chapter One

Introduction

1.Introduction

1.1 Introduction

Agriculture was the backbone of the majority of developed countries. Agriculture was necessary to humanity's life on Earth because, as the world's population grows, new agricultural technologies were expected to fulfill future demands. It also supplies raw materials and food, feeds, and fibers. Cereals and cereal products were an essential starch, calcium, and fiber, in addition to a variety of micronutrients such as vitamin E, some B vitamins, magnesium, and zinc, due to the obligatory fortification of some cereal products (for example, white flour and therefore white bread) and the optional fortification of others (e.g. breakfast cereals) (Jsarotia *et al.*, 2018).Cereals can have a good source of calcium and iron. Cereals and cereal products can also contain a variety of bioactive substances, and there was increasing interest in the possible health benefits that these substances can provide (McKevith, 2004). As a result, wheat has become the world's most important cereal, and it was one of the most important crops in the Poaceae family (Mourad *et al.*, 2019). Wheat was more commonly used for the production of bread than any other grain due to the consistency and quantity of its signature protein known as gluten (Kumar *et al.*, 2011). Also wheat contain the beneficial phytochemicals and dietary fiber components to the human diet, which were particularly abundant in whole-grain substances (Shewry and Hey 2015 ;Czaja *et al.*, 2020) .

Iraq was one of the first areas where wheat bloomed. Despite being one of the countries where the success factors for cultivating this crop were available, its productivity remains low. According to the FAO, the global cultivated area was 763.5 million hectares, and its productivity was estimated to be 739.9 million tons

(FAO, 2017) , The size of the agricultural land in Iraq was 788.5 thousand hectares with a productivity of 2178 thousand tons (ASD, 2018) .

Nanotechnology was an ideal platform for the impending agri-tech revolution due to exclusive physicochemical properties of the nanoparticles (NPs) being used (Lowry *et al.*, 2019). The numerous studies have reported the effects of NPs on seed germination and crops improvement (Mostafavi *et al.*, 2019) enhance the nutrient uptake ability of plants and also for improved growth and disease control in crops (Zaka *et al.* 2016). Nano sized formulations of essential nutrients play an important role in the production of some secondary metabolites in plants (Naderi and Danesh-Shahraki 2013 and Hussain *et al.* 2017) .

Green synthesis concept for making NPs has been booming everywhere. It involves the synthesis and manipulation of nanoparticles by an eco-friendly approach for making the best and safest methods , more efficient and effective (Ravichandran *et al.*, 2016 and Wang and Liu, 2016) . Due to extremely high surface-to-volume ratio and unique crystal morphology, magnesium oxide nanoparticles produced by green approach possess some extraordinary chemical, optical, mechanical, thermal, electronic, magnetic, and adsorptive properties (Dobrucka, 2018) .

Magnesium was used in the present study because at global level, it was the most limiting macronutrient in agriculture. Moreover, it was one of the most important nutrients involved in many enzyme activities and structural stabilization of tissues. Among the macro elements of plants, magnesium (Mg) as the central nucleus of chlorophyll, was responsible for a number of plant yield and as activating enzymatic systems controlling photosynthetic processes, energy transfer and the production of carbohydrates, proteins and lipids .Therefore, the deficiency of this element reduces

the quantitative and qualitative performance of plants (Gerendás and Führs, 2013 and Shinde *et al.*, 2020) .

1.2 The Aim of The Study

1. Using the eco-friend and cheap methods in creating MgO NPs .
2. Improving the germination , physiological parameter and growth , on the other hand , productivity for wheat plant by MgO NPs to increase the product quantity and quality .

Chapter Two

Literature Review

2. Literature Review

2.1 Wheat plant (*Triticum aestivum* L.)

The wheat crop was one of the most important strategic grain crops known and grown by humans because it was the main material in their food and the main source of energy they need, and concedes the predominant cereal crop and a staple food source for more than half of the world's population and was grown on larger area than any other crop and its world trade was greater than for all other crops combined. Also, it was easily stored and transported (FAO, 2014 and FAO, 2017). Wheat was the single most important cereal crop that has been considered as integral component of the food security system of the several nations. It has been described as the 'King of cereals' because of the acreage and high productivity which also occupies a prominent position in the international food grain trade (Patel *et al.*, 2020). Apparently, no economically important diploid wheats were being cultivated as a crop anywhere in the world. Most wheat was grown for human food and about 10 percent was retained for seed and industry (for production of starch, paste, malt, dextrose, gluten). Wheat grain contains all essential nutrients; kernel contains about 12 percent water, including carbohydrates (60-80% mainly as starch), proteins (8-15%) containing adequate amounts of all essential amino acids (except lysine, tryptophan and methionine), fats (1.5-2%), minerals (1.5-2%), vitamins (such as B complex, vitamin E) and 2.2% crude fibers. Wheat was originated in Southwest Asia, Tigris and Euphrates river valley, in the area known as the Fertile Crescent (Shewry and Hey, 2015). Sowing of grains from wild grasses, cultivation and repeated harvesting led to domestication of wheat. Selection of mutant forms with tough ears which remained intact during harvesting, larger grains,

and a tendency for the spikelets to stay on the stalk until harvested was the set-off of modern agriculture (Dubcovsky *et al.*, 1995).

2.1.1 Botanical Description

Wheat was a tall, annual plant with an early variety height from between two and six feet. The plant consists of leaves surrounding a slender stalk which ends at the top of wheat in spikes, or ears, of grain (International Starch Institute). Each spike, ear, of grain consists of spikelets, which encompass the grain of wheat between the lemma and the palea (Valant, 2008). The wheat spike was a determinate inflorescence. It terminates in an apical spikelet placed at a right angle to the plane of the rest of the spikelets. When the spikelets differentiate the number was fixed but adjustment to growth conditions may be made in the number of fertile flowers in a spikelet (Hussain *et al.*, 2016).

The mature wheat plant consists of a central stem from which leaves emerge at opposite side. It was made up of repeating segments, called phytomers, which contain a node, a hollow internode, a leaf and a tiller bud found in the axil of the leaf (Kirby, 2002).

The grains on maturity were variously classified on the basis of color into white, amber and red, the texture being hard or soft. Wheat grains were generally oval shaped, although different wheat have grains that range from almost spherical to long, narrow and flattened shapes. The grain was usually between 5 and 9 mm in length, weighs between 35 and 50 mg and has a crease down one side where it was originally connected to the wheat flower (Setter and Carlton, 2000).

Hard wheat has a physically hard kernel that yields a flour with high gluten and consequently high protein content and this was suitable for producing a western style

loaf of bread and some types of noodles. On the other hand, soft wheat was characterized by a lower protein level and was most suitable for producing cakes and biscuits, which do not require a strong flour. There were also semi-hard wheats having some combination of the above quality characteristics and utilized in unleavened breads such as chapa tis as well as Asian steamed bread and certain noodles (Bushuk and Rasper, 1994).

2.1.2 Classification Of Wheat

The classification of wheat as following below : Singh, G. (2019).

Kingdom: Plantae

Division: Magnoliophyta

Class: Liliopsida

Order: Poales

Family: Poaceae

Subfamily: Pooideae

Tribe: Triticeae

Genus: *Triticum*

Species: *aestivum*

Variety: Abaa 95, Rasheed

2.1.3 Environment

Wheat was an annual grass that grows well in cold temperate regions . There were two main types : winter wheat and spring-planted varieties. Winter wheat germinates in fall and needs to go through a period of cold weather to produce its seed early the following summer. Wheat grown in the field requires at least half of the year to mature , so it produces only one harvest per year . Annual wheat yields range from 10 they in cooler, well-watered (via high rainfall or irrigation), and mostly long-season (8 to 11 mo) growing environments .When wheat was grown in a controlled indoor environment at a constant warm temperature, the phenological development of the crop was faster (Acevedo et al., 2002 and Watson et al., 2018) .

The length of the total growing period (life cycle) of spring wheat (sown in spring) ranges from 100 to 170 days while winter wheat needs about 180 to 300 days to mature. In some exceptional cases, season lengths of more than 300 days have been recorded. Day length and temperature requirements were key factors in cultivar selection. Cultivars can be grouped as winter or spring types according to chilling requirements, winter hardiness and day length sensitivity. Some winter wheat cultivars in early stages of development exhibit a strong resistance to cold temperature, surviving down to -20°C. The resistance was lost in the active growth period in spring, and during the head development and flowering period frost may lead to loss of spikelets, and in extreme circumstances , loss of the whole head (Steduto et al., 2012).

2.1.4 Food Importance

Wheat was a strategic and important cereal crop . It was the main food source of carbohydrates for one-third of the world's population . In addition, its food components values were considered necessary to the human body because its grains contain 63-71% starch, 8-17% protein and water, 2-2.5% cellulose, 1.5-2% fat, 2-3% sugar, and 1.5-2 mineral in addition gluten protein that it was important in baking industry (Breiman and Graur ,1995; Jamali *et al.*, 2000).

The seeds , known as grain, were a primary source of calories for the human race and for animal feed, but in many countries, the straw was also an important product for construction and animal bedding. As a foodstuff for humans, the wheat was distinguished from other cereals by its property of making viscoelastic dough when the ground seeds (flour) were mixed with water. This was because the endosperm of the wheat seed was made up of a matrix of starch grains held together by special groups of proteins known as high and low molecular weight glutenins and low molecular weight gliadins ,which form a complicated elastic mass known as gluten (Snape, 2013) .Gluten proteins were classified into gliadins and glutenins. Gliadins were classified as a-, b-, c- and x-gliadins on the basis of their electrophoretic mobility in A-PAGE (pH 3.1). Glutenin was made up of macropolymers, which were large polymers of high- and low-molecular-weight subunits that were bound together by disulfide bonds. To form the aggregate, these macropolymers spontaneously interact with individual gliadin particles, which were kept together by non-covalent interactions. (Urade *et al.*, 2018).

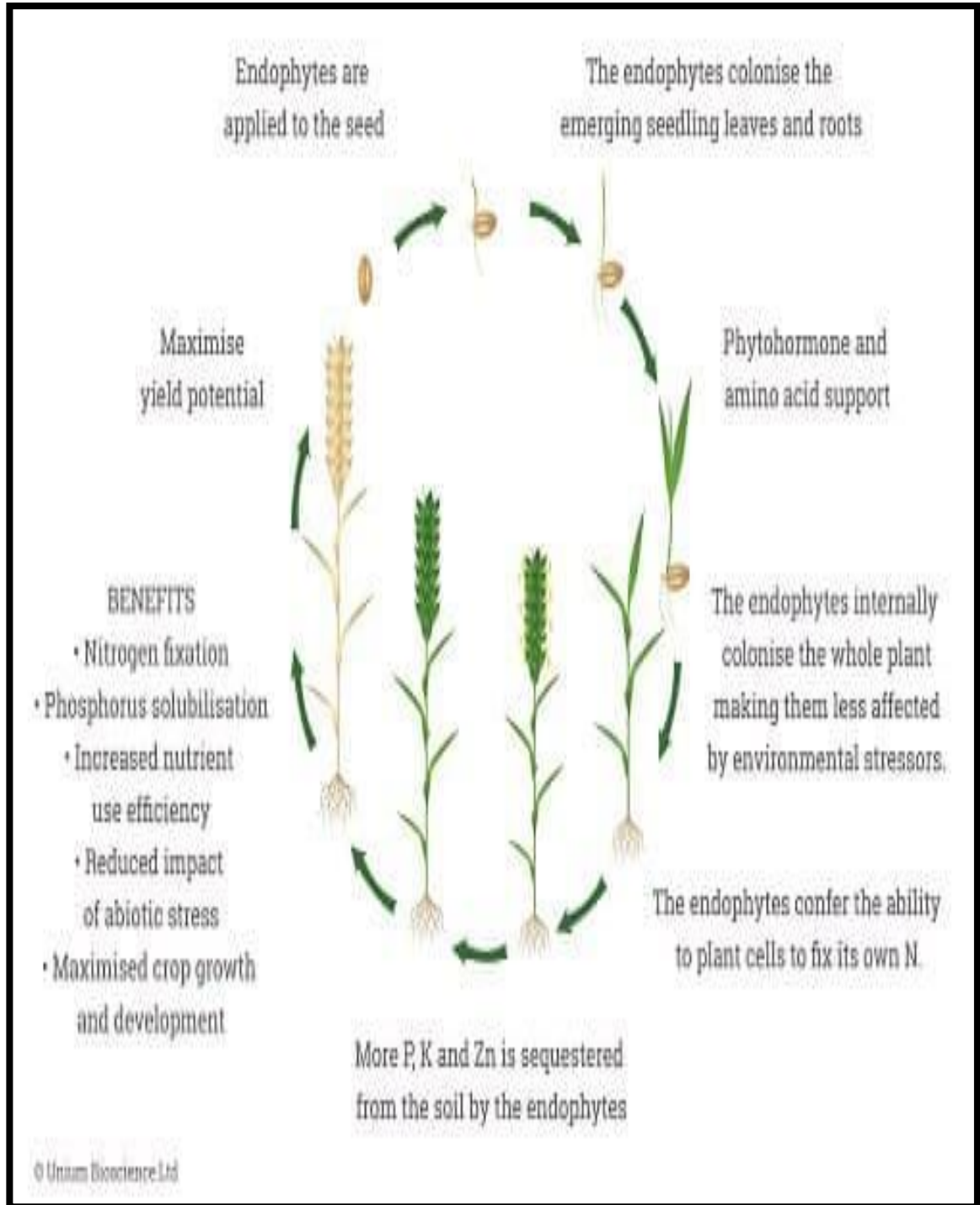


Figure (2-1) growth cycle of wheat plant Miller, T. D. (1992).

2.2 Nanotechnology

The term “nanotechnology” was first defined in 1974 by Norio Taniguchi of the Tokyo Science University as the study of manipulating matter on an atomic and molecular scale (Agrawal and Rathore ,2014). The definition of nanotechnology was based on the prefix “nano” which was from the Greek word meaning “dwarf.” A nanometer was one billionth of a meter. Nanotechnology was a new emerging branch of technology, which has emerged as one of the leading fields of the science having tremendous application in diverse disciplines. As nanomaterials were increasingly becoming part of everyday consumer products , it was imperative to assess their impact on living organisms and on the environment . It was a science that works at the nanoscale and gives various focal points to the diverse fields of science like dentistry, pharmaceuticals and bio-engineering (Leinonen and Kivisaari, 2010 and Mobasser and Firoozi, 2016).

The potential uses and benefits of nanotechnology in agriculture are significant, including producing greater quantities of food with lower cost, energy, and waste. NMs were categorized depending on their size, composition, shape, and origin. The ability to predict the unique properties of NMs increases the value of each classification (Servin and White, 2016 and Jeevanandam *et al.*, 2018,) . Nanoparticles exhibit diverse chemical natures and can be metallic (silver, gold, copper, zinc, etc.), or comprised of metal oxide, silicates, polymers, organics, or carbon (Pal *et al.*, 2019) .There were different methods to synthesize nanoparticles which were as follows (Chemical Reduction, Green Synthesis Method, Sol-Gel Technique) (Kaur, 2017) . In general, top-

down and bottom-up were the two main approaches for nanomaterials synthesis:

- a. Top-down: size reduction from bulk materials.
- b. Bottom-up: material synthesis from atomic level.

In top-to-bottom approach, suitable bulk material was broken down into smaller fine particles by size reduction using various techniques like grinding, milling, sputtering, thermal/laser ablation, etc. while in bottom-to-top approach, NPs were synthesized using chemical and biological methods by self-assembly of atoms to new nuclei, which grow into nanosize particles while the “bottom Traditional methods were used from past many years (Singh and Drexler, 1986).

2.2.1 Green Synthesis Of Nanoparticles

The process of green synthesis was more efficient, simpler, and economical, and can easily be scaled up to perform larger operations ,There were three main concepts for the preparation of nanoparticles in a green synthesis approach which were the choice of the solvent medium (preferably water), an environmentally friendly reducing agent, and a nontoxic material for the stabilization of the nanoparticles (Raveendran, *et al.*, 2003; Hussain *et al.*, 2016) . The use of plant as reducing power for synthesis of nanoparticle because the important compounds in the plant extract were hydroxyl and carbonyl groups which act as reducing agent as well as stabilizing agent. The Biomolecules present in plant extracts act as reducing and capping agents, forming stable nanoparticles. Thus, the properties of the obtained metal nanoparticles, such as biocompatibility and antimicrobial activity, also depend on the properties of the various phytochemicals present in the plant extracts from which they were synthesized. There

were a number of reports on the preparation of MgO NPs via plant-mediated route (Jhansy *et al.*, 2017) . Other studies have been carried out to optimize the extraction of these compounds such as plant drying technique, extraction temperature and the type of extraction's solvent (Mohamad *et al.*, 2014). The advantages of green synthesis of nanoparticles over the physical and chemical methods were: Clean and eco-friendly approach, as toxic chemicals were not used, the active biological component it self act as reducing and capping agent , therefore reduction the overall cost of synthesis process, can be used at large scale production of nanoparticles . External experimental conditions such as high energy and high pressure were not required, which leads to energy saving process (Singh *et al.*, 2016 and Parveen *et al.*, 2016). A metal salt was synthesized with plant extract and the response was completed in minutes to a couple of hours at typical room temperature. This strategy has attracted much more attention amid the most recent decade particularly for magnesium NPs, which were more secure as contrasted with other metallic NPs. Generation of NPs from green techniques can be scaled up effortlessly and they were fiscally smart too (Hussain *et al.*, 2016).

2.2.2 Chemical Features Of Nanoparticles

Nanoparticles were a wide class of materials that include particulate substances having dimension 1–100 nm (Khan 2019). Nanoparticles were designed at nanometer size to provide novel properties. The reason behind the different properties of nanoparticles was increased in the surface area and new quantum effects. The greater surface area and new quantum effects lead to greater chemical reactivity, strength, novel optical, electrical and magnetic behaviors (Umadevi *et al.* 2012). The Physicochemical

characteristics of nanoparticles and engineered nanomaterials including size, shape, chemical composition, physiochemical stability, crystal structure, surface area, surface energy, and surface roughness generally influence the toxic manifestations of these nanomaterials (Gatoo *et al.*, 2014). Different classification methods were applied in the analysis of the Nanoparticles' various chemical and physical properties. These methods include X-ray photoelectron spectroscopy (XPS), SEM, TEM, X-ray diffraction (XRD), particle size analysis, Brunauer–Emmett–Teller (BET) and infrared (IR) (Afolalu *et al.*, 2019).

The magnesium oxide nanoparticles (MgO NPs) were considered high ionic metal oxides, which can have unusual surface areas and have distinct chemical and physical properties due to their small sizes and high density, as they have surface sites for the reaction (Stoimenov, 2002). They were arranged in a large porous structure with an increase in the size of these pores (Klabunde *et al.*, 1996). This leads to an increase in their reactivity that makes them compatible with biological systems, allowing them to be linked with many biological compounds (Yin and Al-Fandi, 2006; Salvador- Morales *et al.*, 2012). The basic functional characteristics wide range Magnesium oxide (MgO) validate, its use as a catalyst, toxic waste remediation agent, an additive in refractory materials, paints, superconductors, refractory materials and superconductive materials (Athar *et al.*, 2012). Nanostructured magnesium oxide has found numerous applications owing to its unique properties, such as large band gap, thermodynamic stability, low dielectric constant, and low refractive index (Mastuli *et al.*, 2012; Shah and Qurashi, 2009).

2.3 Effect Of Nanoparticle On Plant

Nanotechnology, due to their unique physiochemical properties, opens a large scope of novel application in the fields of biotechnology and agricultural industries . Nanoparticles interact with plants causing many morphological and physiological changes, depending on the properties of NPs. Efficacy of NPs was determined by their chemical composition, size, surface covering, reactivity, and most importantly the dose at which they were effective (Siddiqui *et al.*, 2015). Magnesium used as a nanoparticle for its essential to all living cells, where it plays a crucial role in manipulating important biological polyphosphate compound like ATP, DNA and RNA. It was essential as structural components or as enzyme co-factors for plant metabolism. The development of nanoscale particles of Mg may, therefore, help in triggering the metabolic pathways including photosynthesis leading to better growth and higher yield of plants. Magnesium was an alkaline earth metal with its ionic form Mg^{+2} (Rathore and Tarafdar, 2015) .

2.3.1 Seed Germination

Seed was the basic key to connect two generations of plant life, seeds were the first in contact with soil and/or soil solution. The peculiarity of soils, (e.g., metal enrichment, low Ca to Mg ratio, low nutrient content) can be a factor that modifies the rate of germination (Kranner and Colville, 2011).

Studying the beneficial role of nano- MgO NPs in seed germination and plant growth regulation in *zea maize* accurate by (Jayarambabu *et al.*, 2016) . The possible reason for such beneficial role was the increase in activity of growth hormones, MgO NPs penetrates easily inside the plant cells and causes effects on plant biomass and chlorophyll content. Results clearly demonstrated the greater improvement in biomass shoot-root growth and photosynthetic pigment (chlorophyll) by the application of biologically synthesized MgO nanoparticle at 50 mg.L⁻¹ and 100 mg.L⁻¹ concentrations on 20 days plants.

While (Jhansi *et al.*, 2017) found the smaller size (15 nm) of MgO NPs have enhanced the seed germination and growth parameters as compared with remaining sizes of MgO NPs and control because MgO NPs penetrates into peanut seeds and affecting the seed germination . In addition, this germination found to be high in seeds than germination on selected soil plot MgO NPs (0.5 mg/L stable concentrations) .

2.3.2 Vegetative Growth

Magnesium accelerates the growth of the root system in plants, accelerates the absorption of nutrients from the soil (in particular nitrogen), activates or enhances the activity of enzymes required for some chemical reactions necessary for the proper growth of plants (Cakmak, 2013). Some scientists have developed an approach for green synthesis of magnesium hydroxide nanoparticles and its effectiveness on seed germination and in promoting plant growth in vitro and vivo on *Zea mays* plants at different concentrations has been studied . Mg(OH)₂NPs at 500 ppm showed improved seed germination (100%) and growth. The effect of Mg(OH)₂NPs was analyzed by the

measurement of plants height and chlorophyll (A) fluorescence. The seedlings grown in MS medium supplemented with Mg(OH)2NPs showed significant increase in shoot height (11.96 ± 0.4 cm) and root length (3.92 ± 0.4 cm). Similarly, for in vivo studies, the enhanced shoot height (44.2 ± 1.6 cm) and root length (29.2 ± 1.3 cm) was recorded as compared to plants treated with their bulk counterpart. However, 500 ppm bulk Mg showed comparatively lower shoot height (38 ± 1.5 cm) and root length (21.6 ± 2.3 cm) (Shinde *et al.*, 2020). With the application of both P doses (viz. 0, 13, 26, and 52 mg kg⁻¹) and MgO nanoparticles spray the optical property of MgO nanoparticles was given importance which subsequently increased the different growth parameters of plants like root length, root volume, dry weight of shoot and root when a green house experiments were conducted to evaluate the effect of MgO nanoparticles spray on maize plant (*Zea mays L.*) in three benchmark soils of India which were phosphorus (P) deficient (Adhikari, 2019).

2.3.3 Chlorophyll Contain

Mg has a key role in photosynthesis as it was an essential component of chlorophyll, as it was included in the synthesis of both chlorophyll A and B, the light-absorbing green pigment found in plants. It also helps in the synthesis of amino acids and cell proteins, uptake and migration of P, and causes resistance against biotic and abiotic stress in plants (Ditta and Arshad, 2016). MgO NPs caused an increase in photosynthesis in *Arachis hypogaea* which enhances the ability to absorb and utilize light. However, this NPs stimulated antioxidant systems and hastened the germination and growth of plants (Mageshwari *et al.* 2013). While another study indicated that the effect of combined foliar application of Mg-NPs and Fe-NPs (0.5 g l⁻¹) on the

photosynthetic efficiency of black-eyed pea (*Vigna unguiculata*) was investigated in a field experiment significantly improved photosynthetic efficiency, which ultimately improved growth and yield parameters. Interestingly, their alone application caused a decrease in grain yield (8%) (Delfani *et al.*, 2014). The application of biologically synthesized mgo nanoparticle at 15 Mg L⁻¹ concentration on two week old plants which biologically synthesized nanoparticles were found suitable for plant nutrition more particularly to cluster bean (*Cyamopsis tetragonoloba*) that demonstrate greater improvement in shoot-root growth (18.2 to 49.2%) and chlorophyll photosynthetic pigment (76.1%) (Raliya *et al.*, 2014). Foliar sprayed with MgONPs with other type (CuONPs, ZnONPs, MgHNPs) were found to increase the chlorophyll content when using aproper concentration on *Capsicum* leaves compaer to control ,as well as increasing the plant height and leave growth (Ghidan *et al.*, 2018).

2.3.4 Mineral Elements

Magnesium acts as a transporter for phosphorous within the plant and activates most of the enzymes involved in phosphorous reactions , Necessary for the so-called sodium-potassium pump or what was also known as (K, Na, Mg-pump), which introduces potassium and dismisses sodium from the plant cells to the outside (Senbayram *et al.*, 2015). A biosynthesis process was developed by (Rathore and Tarafdar, 2015) for the synthesis and delivery of magnesium nanoparticles to wheat plants through foliar application. The nanoparticles were characterized, applied to leaf surfaces at optimum concentration (200 ppm) and enter through the stomata, The results revealed that nanoparticles could enhance the solar light absorption (24.9%) of the leaf.

The different beneficial enzyme activities (dehydrogenase, esterase, acid phosphatase, alkaline phosphatase, nitrate reductase) were significantly improved which resulted improvement in native mobilization of nutrients by plants and more uptake of Fe, Cu, Zn, P and Mg. Moreover , significant and positive influence was achieved by foliar nutrition of MgO nanoparticles (50 nm) over the control treatment to macronutrients like nitrogen (N) , phosphorus (P) , potassium (K) , and Mg concentration in whole plant parts of cotton was also increased by 39% (Kanjana, 2020).

2.3.5 Protein And Carbohydrate Contain

The importance of magnesium in protein synthesis in plants is highlighted by its role in activating enzymes and the biosynthesis process of ATP.(Verbruggen and Hermans, 2013) . Once the elemental Mg was taken up by the *Nicotiana tabacum* plants, they were probably bio distributed throughout the whole plant by the vascular network. After the exposure to MgO NPs in the matrix for 30 days, the malondialdehyde, protein , and relative water contents did not differ significantly, indicating that the NPs in the test concentrations had no phytotoxicity or even promoted plant growth (Cai *et al.*, 2018). Results also, showed that the most of both macro and micronutrients content in wheat shoot increased markedly due to spraying wheat plants with 6.72 kg MgSO₄ + 1.68 kg CuSO₄/fed . On the other hand, the highest wheat grains content of protein, N, Mg, Cu and Zn contents (15.45 %, 2.65 %, 0.35 %, 7.90 ppm and 54.40 ppm, respectively) were achieved with spraying wheat plants by 6.72 kg MgSO₄ + 1.68 kg CuSO₄/fed (Abdalla and Ei-sawy, 2015) .

Magnesium (Mg) was the structural component of polysaccharides , who acts as a stimulant for many enzymes important in the metabolism shifts of carbohydrates . In the other hand magnesium plays an important role when present in sufficient quantities to improve sugars in plant or move them to storage parts and it plays an important role in stabilizing the structure of ribosomes on which proteins were built (Farhat, *et al.*, 2016) .

The effect of magnesium and varied nutrition in phloem exudate was studied in bean (*Phaseolus vulgaris* L.) plants , the sucrose export in the phloem exudate was drastically decreased by K deficiency and, particularly, by Mg deficiency, whereas P deficiency either had no effect or stimulated sucrose export. In Mg-deficient plants the rate of sucrose export was decreased to 10–20% of the control plants. There was a close inverse relationship between phloem export and leaf concentration of sucrose (Cakmak, *et al.*, 1994) .

Chapter Three

Materials & Methods

3. Materials and Methods

3.1 laboratory Apparatuses and Equipment:

Below is a table showing Equipment and Apparatuses that have been used in this study .

Table(3-1): Apparatus Used in the Experiment and their Companies and Origin

sequence	Apparatuses	Company	Origin
1	Autoclave	Systec	Germany
2	Analytical Balance	Kern	Germany
3	Centerifuge	Universal	China
4	Distill water	LabTech	South Korea
5	Electrical conductivity	meter Europe	Romania
6	Flam photometer	LabTech	South korea
7	Grinder	Silver crest	Germany
8	Hood	LabTech	South Korea
9	Hot plate magnetic stirrer	LabTech	South Korea
10	Mico kjldahal	gerhardt	Germany
11	Muffle furnace	Shin saeng	South Korea
12	Oven	Memmert	Germany

13	PH-meter	Martini	China
14	Refrigerator	Concord	South korea
15	Scanning electron microscope	Vega Tescan	USA
16	Sonitors ultrasonic	Qsonica	Taiwan
17	Soxhlet extractor	Europe union	Romania
19	Specterophotometer	Chromtech	USA
19	UV- spectroscopy	Shimadzu	Japan
20	Vortex mixer	DAIHAN LabTech	South Korea

Table (3-2): Equipment Used in the Experiment and their Companies and Origin

Sequence	Equipment	Company	Origin
1	Cover Slides	Sail brand	China
2	Disposable surgical Gloves	Royal	Malaysia
3	Dust masks	Master guard	China
4	Filter paper	Zelpa	China
5	funnel	Volac	England
6	Glass flasks and beakers	ISO lab	Germany
7	Graduated cylinder	Volac	England
8	Micropipette	Nanolytik	Germany

9	Motar and pestle	ISO lab	Germany
10	Parafilm	Rusco	U.K
11	Petri Dishes	QC lab	China
12	Slides	Sail brand	China
13	Test tube	Afco	Jordan
14	Timer	Junghans	Germany
15	Volumetric flasks	ISO lab	Germany

3.2 Chemicals and Reagents

Table (3-3) shows the chemicals and reagents used in this study

sequence	Chemicals	Structure	Company/origion
1	Magnesium nitrate	$\text{Mg}(\text{NO}_3)_2$	BDH/ England
2	Acetone	$\text{C}_3\text{H}_6\text{O}$	Chemlab/Belgium
3	Phenol crystal	$\text{C}_6\text{H}_6\text{O}$	Isolab/ Germany

4	Sodium hydroxide	NaOH	HMEDIA/ Germany
5	Perchloric acid	HClO ₄	Sdfcl/ India
6	glucose	C ₆ H ₁₂ O ₆	Nice chemicals /India
7	ethanol alcohol 99%	C ₂ H ₅ OH	LINA / Iraq
8	Ammonium molybdate	(NH ₄) ₂ MoO ₄	Laboratory reagent
9	Nitric acid	HNO ₃	AAG chemical

3.3 Preparation of Soil

The soil was selected from the farms located by the banks of Al- Rumaitha river to conduct the study experiments. The surface soil is taken from a depth of 0-30 cm, dried out by an antenna and then passed through a sieve with diameters of 2 mm.

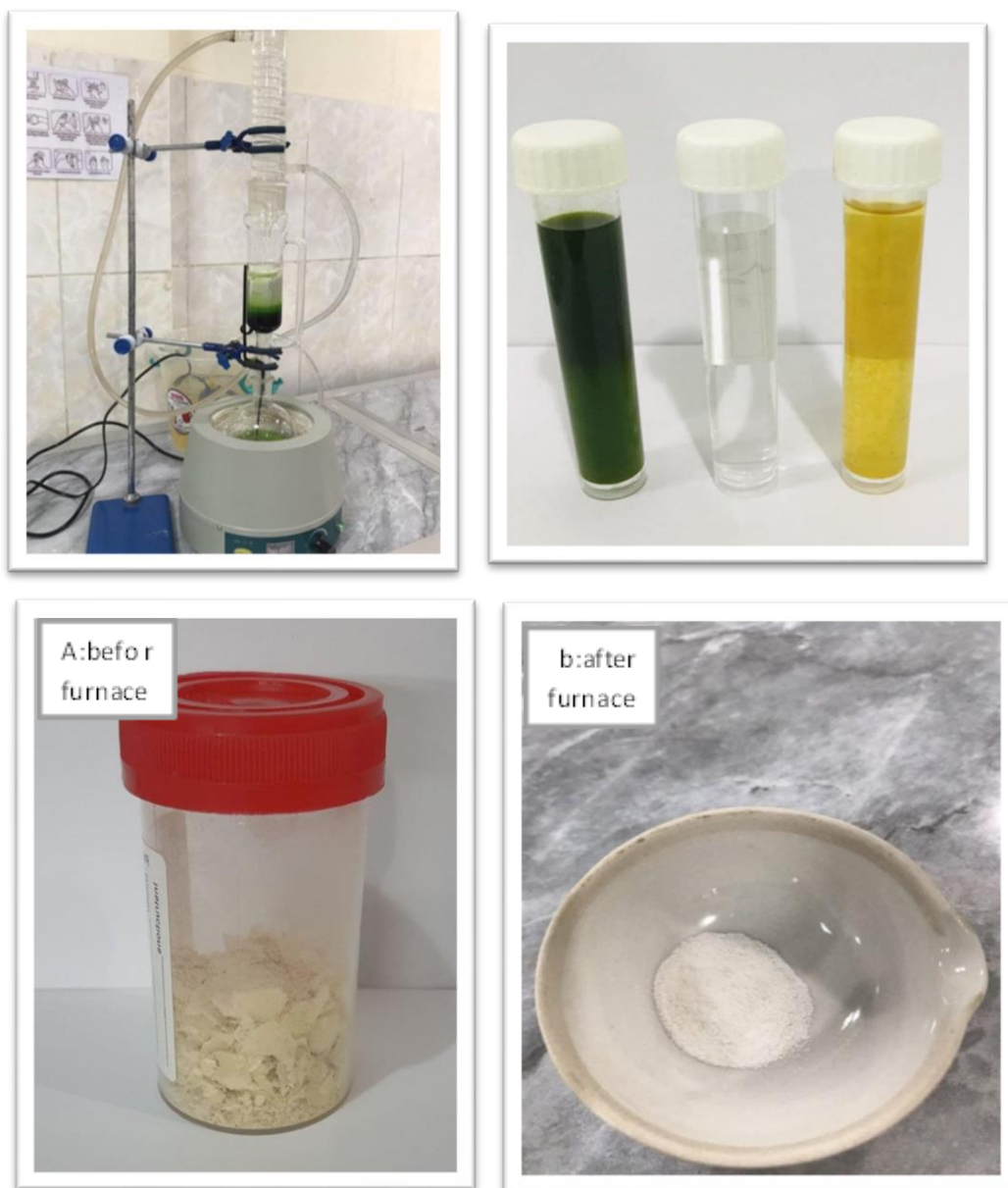
Table (3-4) physical and chemical properties of soil

22.1	Filed capacity	
2	HCO ³⁻ meq/L	
20.58	Total N mg/kg	
29.7	K ⁺	Soluble ion ppm
0.49	P	
85.8	Na ⁺	
422	Mg ⁺⁺	
240	Ca ⁺⁺	
570	CL meq/L	
7.3	PH	
0.4	EC ds/cm	
1.1 %	O.M	
Silty Loam	Texture of soli	Component of soil
18 %	Clay	
68 %	Silt	
14%	Sand	

3.4 Synthesis of MgO Nanoparticles

Allium cepa (green leaves) was used as the source of the reducing agent for green synthesis of MgO nanoparticles. Firstly Prepare an alcoholic extract of the onion plant about (24 gm) dissolve with 240 ml of ethanol. Put them in a soxhlat for 4-5 hours. Then, After drying the sample in oven , add 40 ml of extract mixed with 40 ml of magnesium nitrate together and heat at 60 ° C on a magnetic stirrer . 2M NaOH solution was added drop-wise into the reaction mixture to raise the pH value from (10-12) With PH meter until the color changes to brown or dull yellow (Ali *et al.*, 2020) . The resulting solution is transferred to a centrifuge at 5000 rpm for 20 min to separate the filtrate from the sediments, which will be washed twice to ensure the quality of the sample . The precipitate was placed in muffle furnace at 400°C for 3hr to get MgO nanoparticles. Then, collect the MgO nanoparticles powder as white powder ,the Prepared powders were diagnosed by using X-ray diffraction device

(XRD) and scanning electron microscopy (SEM), and UV–visible spectroscopy (UV) (Alradi, F. H., and Atia, E. A. 2020) .



Figure(3-1): prepared MgONPs

3.5 Preparation of MgONPs

MgONPs is prepared by dissolving 1gm from MgONPs in later of distilled water to have concentration 1000 ppm, as stock solution. Along with this to reduce mistake

in chemical preparations by using titration law ($N_1 \times V_1 = N_2 \times V_2$), to prepare the studied concentrations (0,100,200 and 300) ppm , also to distilled water stirrer then quantities were placed separately in a 1 liter flask of 1 liter for each treatment (Chemiasof, 2011).

3.6 Plant Cultivation

The experiment was conducted in the agreenhouse of Al-Muthanna University\collage of science , in 1/12/2020, for the wheat plant varieties using two types, *Abaa 95* and *Al-Rasheed*. 20 seeds were planted for each Plant pot, the number of Plant pot is 72, each concentration has 3 replicates. We used three concentrations of MgO NPs which are (0,100,200, and 300) ppm, in three ways (soaking, foliar plant, soaking and foliar plant together). The tests were conducted in 26 /1 / 2021 and the experiment was completed in 18 \ 4 \ 2021.



Figure (3-2):wheat cultivar's

3.7 Preparation of wheat seed

The varieties Abaa 95 and Rasheed were used, and we took them from Al-Najmi Research Station affiliated to the National Project for the Development of Wheat, and we worked on the seed germination process and the germination rate was (96% for Rasheed, 97% for Abaa 95) .

3.8 Sterilization of seeds

The seeds used in the study were sterilized by washing the seeds with distal water to remove the fogging substance, after which they were transferred to a Clorox solution 4% sodium hypochlorite and kept in it for three minutes, then the seeds washed with distilled water 7 times ,and now they become ready to be used.

3.9 Experimental Design and Treatments

The experiment was factorial, with three replicates and a completely randomized design (CRD). For each Wheat cultivar, there were nine treatments plus a control. The treatments were as follows (Ali and Ali, 2019):

T₁=(100+200 and300) ppm MgONPs by seed soaking method .

T₂=(100+200 and300) ppm MgONPs foliar spraying method.

T₃=(100+200 and300) ppm MgONPs seed soaking +foliar spraying method.

3.10 Growth and Physiological Parameter

3.10.1 Germination Experience

The method of seed germination was carried out using two wheat plant varieties, referred to as the first and second varieties. After sterilizing the seeds with a 4 percent chlorox solution to ensure that they were disease-free, Rasheed soaked them for one day in four separate concentrations of the laboratory-prepared oxide magnesium nanoparticles solution: 0, 100, 200, and 300 ppm then, the speed and mean of germination was calculated according to the following equation :

The speed of germination [Maguire, 1962]:

$$W = \Sigma(d \times pd)/k \text{ (days),}$$

W – Pieper's coefficient,

d – day of seeds germination,

pd – number of normally germinating seeds in given day,

k – total number of the normally germinating seeds.

The mean of germination was calculated according to the following equation

[Maguire 1962]:

$$E = \frac{k_1}{t_1} + \frac{k_2}{t_2} + \frac{k_n}{t_n} \text{ (number of germinated seeds/1 day),}$$

E – Maguire coefficient,

k – number of normally seeds germinating in the subsequent observation days,

t – number of days from the day of sowing.

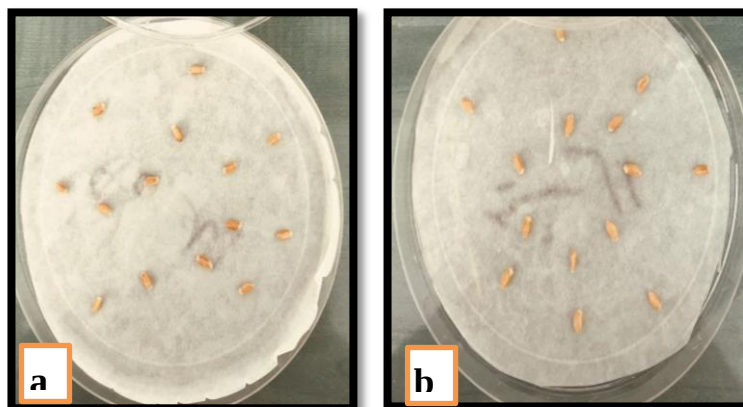


Figure (3-3): a \ Abaa 95 and b\ Rasheed

3.10.2 plant high (cm)

At the 100 percent growth point, ten random plants were collected for each repeater, and the distance from the base of the plant when the soil surface until the end of the spike main branch was calculated, and the rate per plant height was calculated.

3.10.3 Number of Tillers

The number of tillers was calculated at the completion of the flowering stage, as the average number of tillers was extracted by dividing the sum of the tillers for one pot on the number of plants.

3.10.4 Total fresh and dry weight of plant (g)

Roots and shoots were separated from seedlings for the determination of fresh and dry weight. The fresh weight of roots and shoots was measured by sensitive

balance, dried sample using electric oven at 70 C° for 24 h. and dry weights were recorded, according to (Mahajan *et al.*, 2011).

3.10.5 Leaf Area

Cut fresh leave from the top of plant then weight it, after that cut a disc (1cm²) from leave and weight, leaf area is measured according to the following formul :

total leaf area=1cm² × weight of leaf / weight of the disc (Shaheen ,1987) .

3.10.6 Leaf Relative Water Contents

The relative water content of the plant leaves was estimated by cut from the top of plant the third fully expand leave in the afternoon because the plant at this time had reached the true content of the water, the leaf weighed to determine its fresh weight, then leaves placed in distilled water for 12-16 h at room temperature for rehydration the excess water is then removed from the surface of the plant sample using filter paper and directly weighed to detect turgid weight. The leaf cells at the top of their turgid pressure at that time. Dry weight is determined after oven drying the leaf samples at 70 C° for 24h.

RWC is calculated from(Schonfeld *et al.*, 1988) formula as follows:

$$RWC = (FW - DW) / (TW - DW) \times 100$$

FW = fresh weight of a leaf.

DW = dry weight of a leaf.

TW = turgid weight of leaf.

3.10.7 Estimation of Chlorophyll Type and Carotenoid Content

Chlorophyll and carotene contents are evaluated in fresh leaves by the method of (Arnon , 1949) depending on (Mackinney ,1941) a total of 200 mg of fresh tissue from inter venial leaf areas was crushed using a mortar and pestle containing 80% acetone. The optical density (OD) of the solution was recorded at 645 , 663nm for chlorophyll estimation and 452,5 nm for carotenoid estimation using a spectrophotometer (Chrom tech, USA).The following relationships were used to calculate the amount of chlorophyll :

$$\text{Chl.a} = (12.7 (\text{D663}) - 2.69 (\text{D645})) \times V / (1000 \times W) .$$

$$\text{Chl.b} = (22.9 (\text{D645}) - 4.68 (\text{D663})) \times V / (1000 \times W) .$$

$$\text{Chl.(a+b)} = (\text{Chl.a}) + (\text{Chl.b})$$

$$\text{Carotenoids} = 4.2 \times \text{D452.5} - (0.0264 \text{ Chl.a} + 0.426 \text{ Chl.b})$$

D= the optical density reads of chlorophyll extracted at the wavelengths 663 and 645 nm, respectively

V= The final volume of the diluted acetone is (80%).

W= dry weight per gram of extracted vegetable tissue.

3.10.8 Measurement Percentage of Membrane Stability

The membrane stability is determine by taking the uniform leaf discs cut out from randomly chosen plants per replicates which were taken from the middle portion of the fully developed leaf and washed with distilled water to remove surface contamination then transfer this disc to a petri dish containing

5 ml of distilled water. Leave the petri at room temperature 10 °C, for 24 h then measure the conductivity in the solution by electrical conductivity meter ,the same samples are autoclaved at 121 °C for 20 min, and after cooling to 25 °C, the electrical conductivity of the left filter was re-measured and the proportion of the damage index is estimated by the equation of (Bandurska , 1998) as follows:

$$\text{MSI (\%)} = (T_1/T_2) / (C_1/C_2) \times 100$$

Where :C₁ and C₂ Represent the read of the electrical conduction of the control treatment before and after the tissue is killed.

T₁ and T₂ Represent the read of the electrical conduction of each treatment before and after the tissue was killed respectively.

-The concentration of sodium and potassium ions was also estimated for leachates foliar tissue by flame Photometer.

3.10.9 Total Soluble Protein

The protein was estimated using the following method (Schacterale and Pollak, 1973) which is modified from the method (Lowry *et al.*, 1951) by measuring the visible density at 650 nm using the optical spectrometer.

3.10.10 Estimation of Carbohydrates

Weight of 0.20 g of well-grounded leave and mix with distilled water (10 ml) and then put it in a centrifuge for 15 minutes / 3000 min⁻¹ cycle and aspirate the solution with filter paper, then pull 1 ml of leachate into a new test tube, add

5 ml of phenol at 5% and 5 ml of 80% sulfuric acid after stirring and shaking .The tubes are cooled and then photo resisted after proper dilution along a 488 nm wavelength using a spectro photometer (Al Wahbi and Bassallah, 2003).

3.10.11 Digestion of Plant Sample to Determine Mineral

Grind 0.5 g of the dry plant sample by the method (Alzoubi, *et al.*, 2013) and digest by wet digestion method by adding 5 cm³ of the sulfuric acid H₂SO₄ and HClO₄ as 1:4 and heat the sample using hot plate until the solution color is clear after filtration, the sample is prepaid to estimate the mineral as follows :

1. Measure the concentration of sodium, potassium and calcium in the plant

Sodium, potassium and calcium in the plant using an optical flamephotometer as described by (Richard, 1954).

2. Estimate the concentration of nitrogen

Nitrogen is estimated in the digested plant sample using Micro Kjeldahl as described by (Alzoubi, *et al.*, 2013).

3. Determine the concentration of phosphor

Phosphor determined in the vegetative extract of the plant using spectrophotometer as reported in (Richard, 1954).

4. . Determine the concentration of magnesium

Calcium and magnesium were measured by melting with versenite and using a reagent Eriochrome Black T (EBT) . Then, calcium was subtracted from the sum of calcium and magnesium, as reported in (Richard, 1954) .

3.10.12 Statistical Analysis

The experiments are designed and statistically analyzed using the Completely Randomized Design (CRD) experiment (Antar, 2010). The significant differences in transaction rates are compared using the Duncan's New Multiple Test under 0.05 significance level BY using SAS program .

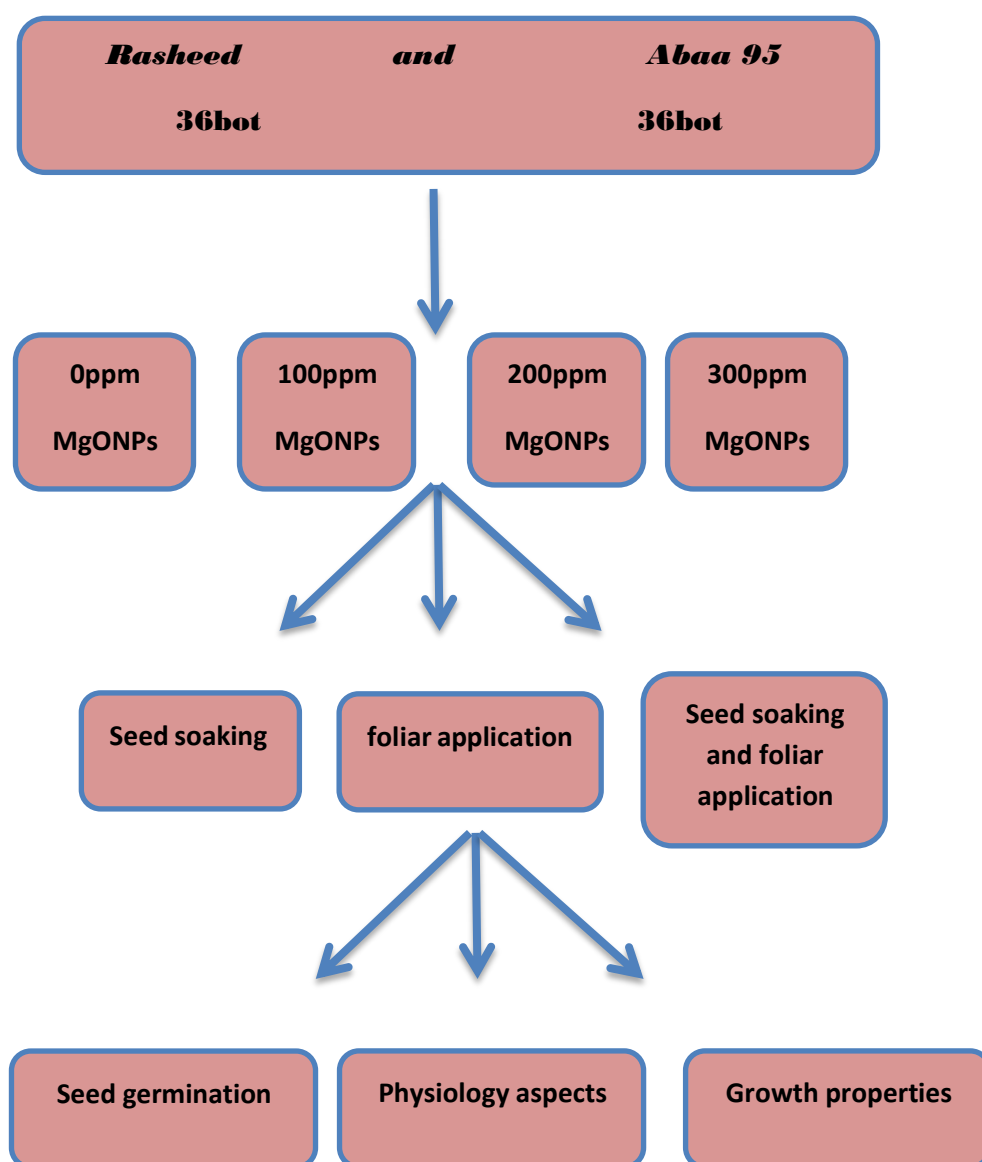


Figure (3-4) Experimental design

Chapter Four

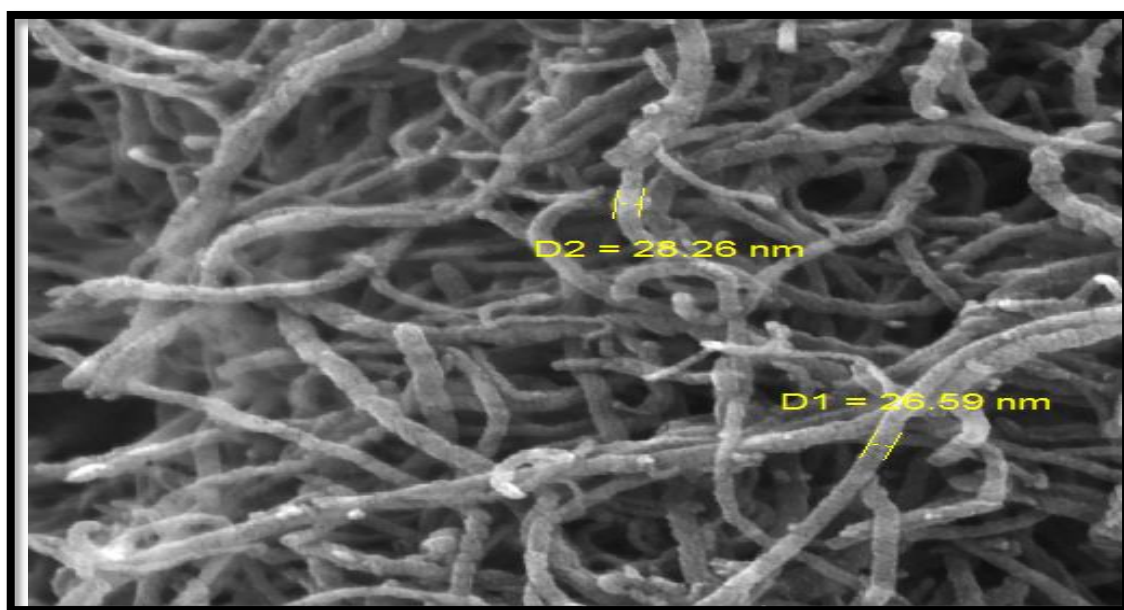
Results & Discussion

4. Results And Discussion

4.1 Nanotechnology Results

4.1.1 SEM analysis

The SEM photograph illustrating in (Fig.4-1) shows the surface morphology of the prepared MgO nanoparticles. The image shows nanowires network and the diameter of these nanowires ranges between (26-28) nm . In comparison to the literature in which the shapes were either spherical or cubic , this study showed the one-dimensional nanoscale (D1) shapes, which were nanowires.



(Fig.4-1): SEM image of the prepared MgO nanoparticle

4.1.2 UV analysis

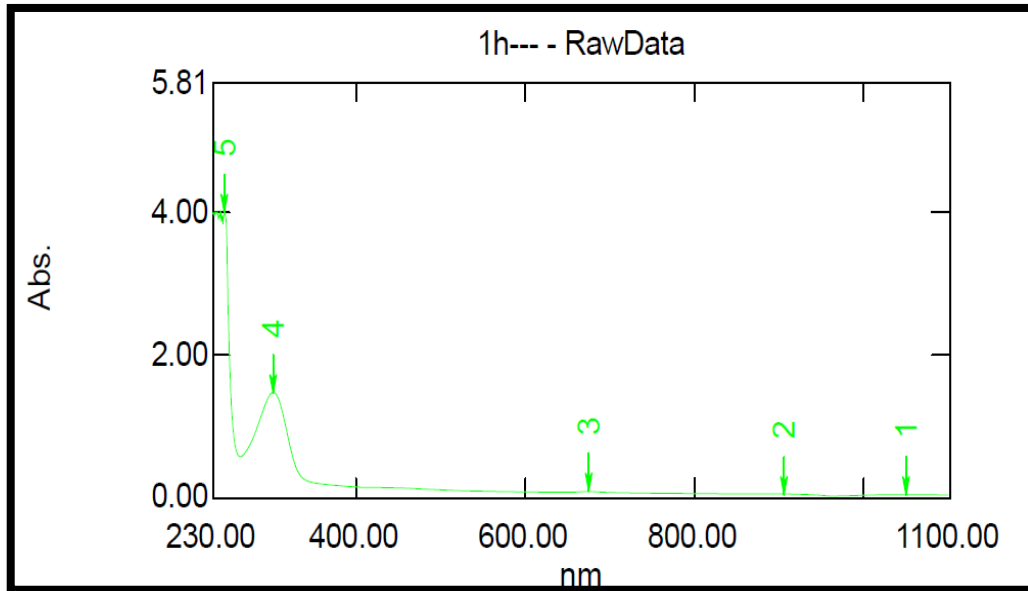
The UV-Vis spectroscopy of the prepared MgO was studied within a range of wavelength numbers ranging from (200 - 1100) nm . Where the spectrum showed an absorption band at (301.5) nm which is related to electronic transitions .

The energy gap for MgO nanoparticles is calculated through the following equation:

$$E_g = \frac{1240}{\lambda} \text{ e.v}$$

Where E_g =Energy gab , e.v = electron volt

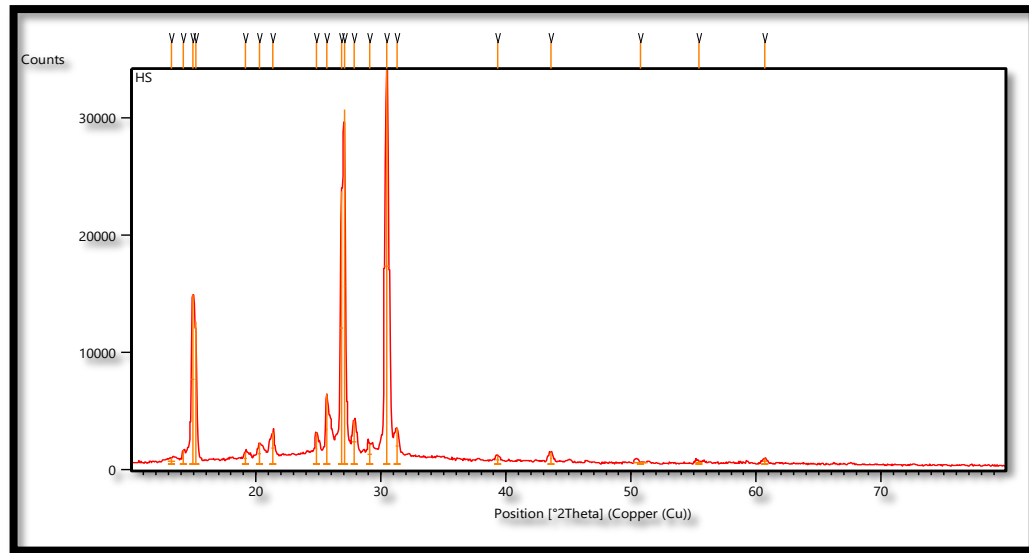
Whereas, the measured energy gap (E_g) = 4.112 e.v



(Fig.4-2): UV analysis

4.1.3 XRD analysis

The particle size and properties of the synthesized MgO nanoparticles were determined using powder XRD (figer .4-3) . The diffraction signals can not be indexed to cubic mgo and hexagonal Mg(OH)₂ crystallites which are in good agreement with standard JCPDS card 78-430 and 07-0239 respectively (Mageshwari , Sathyamoorthy , 2012 ; Dhal *et al.*,2015) This means that the prepared sample has shown a new crystallite phase .



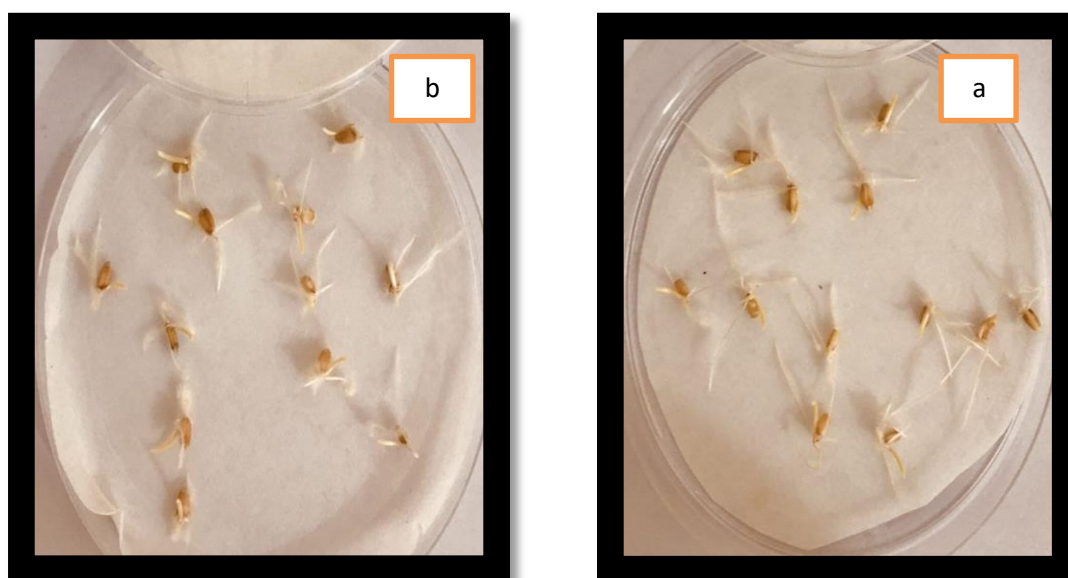
agri-inputs. Indeed, the assistance of nanotechnology in plant protection products has exponentially increased, which may assure increased crop yield. Moreover, the major concern in agricultural production is to enable accelerated adaptation of plants to progressive climate change factors, such as extreme temperatures, water deficiency, salinity, alkalinity and environmental pollution with toxic metals without threatening existing sensitive ecosystems (Yifen Shang *et al.*, 2019) . The biological role of nanoparticles depends on their physiochemical properties, application method (foliar delivery, hydroponics, soil), and the applied concentration .

4.2.1 The Effect of MgONPs on Speed of Germination

Mg is one of the essential nutrients for plant growth and plays a key role in both physiological and molecular processes . The results obtained from Table (4-1) showed enhanced speed of germination . When wheat seeds initially treated with MgONPs (100,200 and 300 ppm) and control ,among the three tested concentrations, seed showed the maximum height speed of germination at (100 ppm) concentration as compared to the other two concentrations and control (200,300 ppm) (0 without MgONPs) seed . Also the seed of the species *Abaa* 95 was germinated faster than *Rasheed* because of the difference in genetic characteristics between varieties . Seed is a basic input deciding the fate of productivity of any crop determining the speed of germination is very important . MgO NPs act to have generated new pores on seed coat during penetration, which helps entry of moisture and water and activate nutrients inside the seeds or nanoparticles may carry the nutrients along with them, which may lead to rapid germination and growth . Also, MgONPs might develop pores on the wall . The results obtained thus, are in agreement with (Jayarambabu, Reddy, 2017; Shinde *et al.*, 2020).

Table (4-1):The Effect of MgONPs on speed of Germination

Concentration Plant type	0	100ppm	200ppm	300ppm
<i>Abaa 95</i>	7.3	12	11.3	8.6
<i>Rasheed</i>	5	11	10.6	8.2

**Figure (4-4):Seed germination , a\ *Abaa 95*, b\ *Rasheed***

4.2.2 The Effect of MgO Nps on Mean of Germination

The Table (4-2) mentioned below is strongly suggests that MgONPs greatly influence all the parameters of mean of seed germination . The result show the maximum mean of seed (6) was recorded at 100 ppm, whereas, control seeds showed of (4.6, 3.6)% for *Abaa 95*, *Rasheed* respectively . It is well known fact that Mg is a macro-nutrient essentially required for plants growth and its ions play an important role in the activation of enzymes involved in seed germination . There is also a relationship between magnesium and the plant hormone gibberellin, which helps germination due to its rapid release of the alpha-amylase enzyme and the preparation of food for the

vegetarian embryo . (Rathore and Tarafdar, 2015; Guo *et al.*, 2015) .

Table (4-2):The Effect of MgONPs on Mean of Germination

Concentration Plant type	0	100ppm	200ppm	300ppm
<i>Abaa 95</i>	4.6	6	5.8	5.5
<i>Rasheed</i>	3.6	5.6	5	3.8

4.2.3 The Effect of MgONPs on Shoot height

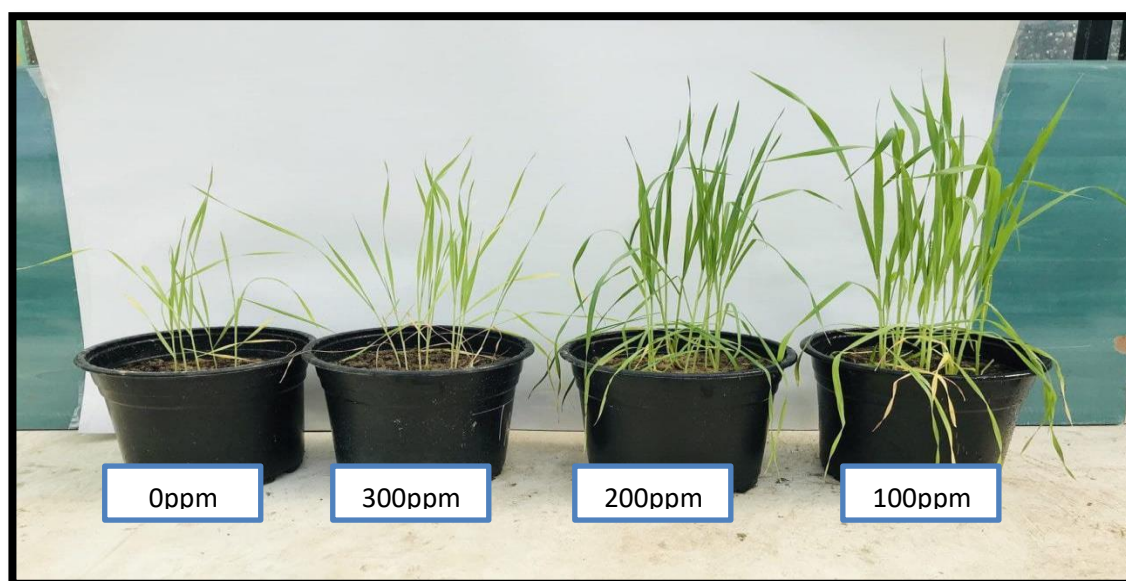


Figure (4-5): *Abaa 95* with different concentration of MgONPs

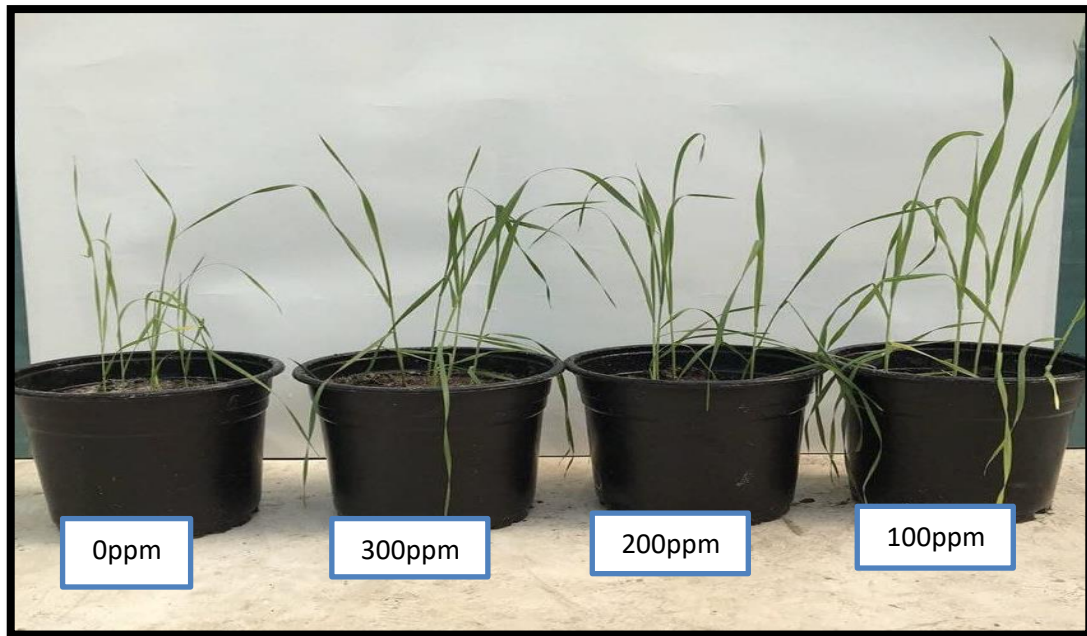
Figure (4-6): *Rasheed* with different concentration of MgONPs

Table (4- 3) The Effect MgO NPs concentrations and treatments on shoot height (cm) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	46.66 f	57.33 cd	56.33 cd	56.00 cd	54.91 bc		
	T ₂	47.33 f	66.00 a	58.00 c	54.66 cde	55.41 bc		
	T ₃	52.00 e	66.33 a	62.33 b	53.66 de	58.91 a		
<i>Rasheed</i>	T ₁	24.50 h	56.66 cd	56.66 cd	54.66 cde	48.62 d		
	T ₂	41.33 g	63.66 ab	62.00 b	55.66 cd	53.83 c		
	T ₃	41.66 g	64.66 ab	57.33 cd	56.00 cd	56.16 b		
Interference variety × Con.	<i>Abaa 95</i>	48.66 d	63.00 a	59.22 b	55.55 c		56.30 a	
	<i>Rasheed</i>	35.83 e	61.33 a	58.88 b	54.66 c		52.98 b	
Interference treatment × Con.	T ₁	46.83 d	55.33 c	55.16 c	54.83 c			51.22 c
	T ₂	44.33 e	64.00 a	59.50 b	57.00 c			55.79 b
	T ₃	35.58 f	65.50 a	60.50 b	57.16 c			56.91 a
Mean Con.		42.25 d	62.16 a	59.05 b	55.11 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($P < 0.05$).

The Results indicated in Table (4-3) showed the effect of MgO NPs on the shoot length of *Triticum* plant. The shoot length value of the plant variety *Abaa 95* in the third treatment T₃ (66.33) cm of MgO NPs at concentration 100 ppm is important, followed by the second highest value for the same parameter (62.33) cm , at MgO NPs concentration 200 ppm.

The results of the table also confirm a significant interference below the probability level 5% for the effect of interference between the plant and the concentration of MgO NPs , were higher concentration in 100 ppm then 200 ppm , while the lowest values of concentration were at 300 ppm when compared with the control. The lowest value was (55.55) cm.

To Explain the effect of four concentrations of MgO NPs , the concentration at 100 ppm have the highest values (62.16) cm when compared to the control concentration, followed by a concentration value (59.05) cm at 200 ppm, which is also a significant difference. Note the effect of varieties the result shows the superiority of *Abaa 95* (56.30) cm plant height on the variety *Rasheed* which its value is (52.98) cm.

The promotion effect of Magnesium on the elongation of shoot lets formed was illustrated in Table (4.1). The increase in plant height due to Mg can be attributed to its role in phloem loading and transportation of photo assimilates to younger plant parts. The application of magnesium raises the amount of branches per plant, which can be due to a faster rate of carbohydrate translocation, Pectic structure (Kleczkowski and Igamberdiev, 2021) . These results were also confirmed with the findings of (Raliya *et al.* 2014) ; (Vijai Anand *et al.*, 2020) .

4.2.4 The Effect of MgO Nps on Root Length

Table (4-4) The Effect of MgO NPs concentrations and treatments on root length
(cm) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	35.00 hi	46.00 de	45.00 def	44.66 def	44.83 b		
	T ₂	35.33 hi	55.66 ab	47.00 d	42.00 fg	45.08 b		
	T ₃	36.66 h	57.00 a	53.66 bc	41.00 g	47.08 a		
<i>Rasheed</i>	T ₁	23.66 j	45.66 de	45.66 de	43.66 efg	39.66 d		
	T ₂	32.66 i	54.00 bc	51.33 c	44.33 def	42.91 c		
	T ₃	34.00 hi	55.33 ab	46.66 de	44.66 def	45.58 b		
Interference variety × Con.	<i>Abaa 95</i>	35.66 d	52.77 a	48.44 b	44.22 c		44.94a	
	<i>Rasheed</i>	30.11 e	51.44 a	48.00 b	42.88 c		43.44 b	
Interference treatment × Con.	T ₁	35.33 e	45.16 c	43.16 d	42.33 d			41.29 b
	T ₂	34.00 e	54.66 a	49.00 b	45.33 c			45.20 a
	T ₃	29.33 f	56.33 a	50.33 b	45.33 c			46.08 a
Mean Con.		32.88 d	52.11 a	48.22 b	43.55 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The data of table (4-4) showed clearly significant differences at the level of probability 5% for most concentrations positive when compared to the control treatment, the highest value, at a concentration of 100 ppm in the treatment of the third T₃ for the plant *Abaa 95* (57.00) cm, followed by the same plant and the same treatment, but at a concentration of 300 ppm (41.00) cm. On the other hand, there is the lowest concentration at 300 ppm for the T₁ treatment which was (43.66 cm) for *Rasheed*.

Regarding the interaction between treatment and concentration the maximum amount, it is found at a concentration of 100 ppm in treatment T₃ (56.33) cm, then at a concentration of 200 ppm (50.33) cm, weight for the same treatment, and finally at a

concentration of 100 ppm in treatment T₁ (seed soaking)(45.16) cm . Note that the concentrations and treatments vary significantly at the 5% level of probability. Also, it could be seen that the effect of MgO NPs concentrations on wheat plant has significant differences among them when compare to control (32.88) cm.

The results from the interaction between plant and MgO NPs treatments revealed significant differences in treatment T₃ between plants (*Abaa 95* and *Rasheed*) as (47.08 and 45.58) cm respectively.

The response of plants to magnesium application had been observed, and it was revealed that plants readily took up magnesium, translocated to the growing regions of plants, and resulted in higher yield on the roots . Magnesium is one of the moving elements in the plant's body, so it is especially beneficial in the young sections, where it aids in cell division and plant growth) (Cakmak and Yazici, 2010) . The results became more pronounced. (Khot *et al.*,2012) .

4.2.5 The Effect of MgO NPs on Shoot Fresh Weight

Table (4-5) The Effect of MgO NPs concentrations and treatments on shoot fresh weight (g)

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment	
		0	100	200	300				
Abaa 95	T ₁	1.66 q	3.44 h	2.83 k	2.83 k	2.74 d			
	T ₂	1.71 p	4.27 b	3.72 f	2.06 n	2.86 c			
	T ₃	1.77 o	4.73 a	3.88 d	2.05 n	3.11 a			
Rasheed	T ₁	0.52 t	3.15 j	3.33 i	2.34 m	2.33 f			
	T ₂	0.64 s	4.14 c	3.80 e	2.37 m	2.69 e			
	T ₃	1.24 r	4.24 b	3.56 g	2.43 l	2.94 b			
Interference variety × Con.	Abaa 95	1.71 g	4.15 a	3.56 c	2.38 e		2.91 a		
	Rasheed	0.80 h	3.84 b	3.47 d	2.31 f		2.65 b		
Interference treatment × Con.	T ₁	1.50 i	2.58 g	2.24 h	2.22 h				2.51 c
	T ₂	1.18 j	4.20 b	3.72 d	3.08 f				2.84 b
	T ₃	1.09 k	4.49 a	3.76 c	3.30 e				2.99 a
Mean Con.		1.25 d	3.99 a	3.52 b	2.35 c				

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results indicated in Table (4-5) showed that when the plant was soaked and foliar plant with laboratory-prepared MgO nanoparticles, the fresh weight of the shoot increased at the levels 100, 200 and 300 ppm, respectively, when compared to the non-addition treatment of magnesium share with *Abaa 95*. Notes from the same result of *Rasheed* that there are significant differences between them at the level of probability of 5%. The highest concentration of shoot fresh weight is found in the third treatment T_3 , it is (4.24) g at 100 ppm, while the lower concentration is (0.52) g at control treatment.

It has been observed that there is an interaction between species and treatment which indicates T_3 treatment of the plant *Abaa 95* registered the highest values by approximately (3.11)g, and progressively decreased the plant's MgO NPs concentration to (2.74) g, and suggested the lowest value in the fresh weight of the MgO NPs of the plant *Rasheed*. There were significant differences between them at the probability level of 5%. There is a significant distinction.

Here, the results of the impact of the varieties the variety *Abaa 95* is superior to the variety *Rasheed*.

The third treatment T_3 (seed soaking + foliar application) was significantly higher than the other treatments at the 5% probability level, as inferred from the last field in the table. The top of the treatment, with a value of (2.99) g, outperformed the other transactions, which had values of (2.84) and (2.51) g respectively, growth parameters improved by MgO NPs treatment, especially shoot biomass, could be due to the increase in photosynthetic pigments and endogenous promoters, particularly IAA, which alleviate the negative effects of water deficiency. Iron enhances photosystem efficiency by activating many enzymes and contributing to RNA synthesis, which

increases biomass accumulation . As seen in Table (4- 3) , the increase in the plant's fresh weight is proportional to the length of the vegetative part nanoparticle might be internalized through the leaf stoma, entering into the vascular system of leaves, and then transported to other parts through the phloem . This explanation totally agrees with some researchers like (Kim, and Lee, 2012 ; Amany Ramadan *et al.*, 2020) .

4.2.6 The Effect of MgO NPs on Root Fresh Weight

Table (4-6) The Effect of MgO NPs concentrations and treatments on root fresh weight (g)
for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	0.74 m	2.12 e	1.45 g	1.34 h	1.97 c		
	T ₂	0.76 lm	4.23 b	2.17 e	1.06 j	2.00c		
	T ₃	0.82 l	7.14 a	2.54 d	0.92 k	2.85 a		
<i>Rasheed</i>	T ₁	0.23 p	1.47 g	1.95 f	1.12 ij	1.18 e		
	T ₂	0.35 o	3.87 c	2.53 d	1.20 i	1.42 d		
	T ₃	0.65 n	3.87 c	2.14 e	1.34 h	2.09 b		
Interference variety × Con.	<i>Abaa 95</i>	0.77 f	4.50 a	2.20 c	1.17 e		2.12 a	
	<i>Rasheed</i>	0.41 g	3.07 b	2.05 d	1.15 e		1.71 b	
Interference treatment × Con.	T ₁	0.74 h	1.20 f	1.16 fg	1.13 g			1.30 c
	T ₂	0.55 i	4.05 b	2.33 c	1.70 e			2.03 b
	T ₃	0.49 j	5.51 a	2.35 c	1.81 d			2.42 a
Mean Con.		0.59 d	3.79 a	2.13 b	1.16 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

Table (4-6) shows that the treatment with MgO NPs has affected the fresh weight of root in the third method of treatment T₃ . In the same treatment for the variety, it offered the maximum value (7.14) g at 100 ppm share in the plant variety *Abaa 95* . The lowest value is (1.34 and 1.12) g for the varieties *Abaa 95* and *Rasheed* , respectively, and there are significant differences between them at the level of probability of 5% .

It is noted that the interference between three treatment and different concentration have significant differences at the probability level 5%, between the values of concentrations and treatments . The lowest value for fresh weight of root as (0.49) g of control and the highest one (5.51),while the effect of the four concentration of MgO NPs on plat with significant differences the concentration 100 ppm take the value (3.79) g, the concentration of control takes lower value (0.59) g .

Plant varieties exhorted the highest values in the third treatment (2.85 , 2.09)g for *Abaa 95* and *Rasheed*, respectively. According to the effects of the interaction between plant varieties and the three treatments .The lower value related to raised and there are significant differences between the two species .

The application of biologically MgO NPs is penetrated easily inside the plant cells and causes effects on plant biomass and chlorophyll content improved growth rate of seedlings may be due to the enhancement in water and nutrient uptake by root , so the treatment of nanoparticles increase the weight of fresh root . The increase in biological yield, as well as the length of the root system, is attributed to an increase in the plant root's wet weight, as seen in Table (4- 4) because nanopartical easy penetrate the root epidermis and endodermis, entering into the xylem vessel, and then transported to the aerial part of plants (Siddiqui *et al.*, 2015) . These results are consistent with the findings of (Jayarambabu *et al.*, 2016).

4.2.7 The Effect of MgONPs on Shoot Dried Weight

Table (4-7) The Effect of MgO NPs concentrations and treatments on shoot dried weigh(g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	0.42 k	0.74 f	0.65 g	0.65 g	0.62 d		
	T ₂	0.45 k	1.03 b	0.82 e	0.53 j	0.63 c		
	T ₃	0.45 k	1.12 a	0.84 de	0.53 j	0.74 a		
Rasheed	T ₁	0.16 m	0.66 g	0.73 f	0.55 ij	0.53 e		
	T ₂	0.17 m	0.86 d	0.83 e	0.57 i	0.61 d		
	T ₃	0.24 l	0.93 c	0.75 f	0.62 h	0.71 b		
Interference variety × Con.	Abaa 95	0.44 e	0.96 a	0.77 c	0.58 d		0.69 a	
	Rasheed	0.19 f	0.82 b	0.77 c	0.57 d		0.59 b	
Interference treatment × Con.	T ₁	0.35 i	0.61 f	0.58 g	0.55 h			0.57 c
	T ₂	0.31 j	0.95 b	0.79 d	0.69 e			0.66 b
	T ₃	0.29 j	1.02 a	0.82 c	0.70 e			0.68 a
Mean Con.		0.32 d	0.89 a	0.77 b	0.58 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

Table (4-7) illustrates the effect of MgO NPs on shoot dried weight concentration in plant which there is significant increase in the dried weight at 100 ppm for treatment T₃ (seed soaking + foliar application) the higher value share in *Abaa 95*(1.12) g . On the other hand , there are significant differences between them at the level of probability of 5% ,while for *Rasheed* the lowest concentration at 300 ppm for the T₁ treatment was (0.55) g .

There are significant differences between the concentrations of 100 ppm and 200 ppm in contrast to control for the two plant species, as shown by the interaction between plants and treatments.

The same tables also shows significant increase when the studied varieties of wheat overlapped with the addition of different concentrations of magnesium, as it reached the highest value of shoot dried weight (0.96) g , when the *Abaa 95* cultivar interfered with

a concentration of 100 ppm , the lowest was found when the *Rasheed* cultivar with a concentration of 300 ppm as (0.57) g , the results also showed that the effect of three the concentrations used on the plants have static differences when compared with the control concentration, which is consecutively from the largest to the smallest values 100, 200 and 300 ppm .

The overlap between varieties and treatments T_3 is outperformed T_2 and then T_1 , respectively, for both studied varieties. Similarly , in the case of shoot length and shoot volume of treated plant showed in Table (4- 3) and Table (4- 5) there is more growth than the untreated plant .The experimental results also revealed that as the rate of application of MgO NPs increased, the dry weight at 300 ppm and control decreased at 300 ppm and control. The stunted growth and low yield was observed for control plant and the reason could be due to the reduction in soil nutrient supply to the crop without any MgO NPs spray (Adhikari, 2019) .

4.2.8 The Effect of MgONPs on Root Dried Weight

Table (4-8) The Effect of MgO NPs concentrations and treatments on root dried weight (g)

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety $\times$ treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	0.24 l	0.72 e	0.46 gh	0.44 h	0.65 c		
	T ₂	0.25 kl	1.42 b	0.73 e	0.35 i	0.66 c		
	T ₃	0.27 k	2.36 a	0.87 d	0.32 j	0.95 a		
<i>Rasheed</i>	T ₁	0.08 n	0.48 g	0.65 f	0.35 i	0.39 e		
	T ₂	0.13 m	1.28 c	0.84 d	0.36 i	0.47 d		
	T ₃	0.22 l	1.28 c	0.73 e	0.44 h	0.69 b		
Interference variety $\times$ Con.	<i>Abaa 95</i>	0.25 f	1.50 a	0.74 c	0.38 e		0.70 a	
	<i>Rasheed</i>	0.14 g	1.02 b	0.69 d	0.37 e		0.57 b	
Interference treatment $\times$ Con.	T ₁	0.25 h	0.40 f	0.38 fg	0.36 g			0.43 c
	T ₂	0.19 i	1.35 b	0.79 c	0.56 e			0.67 b
	T ₃	0.16 j	1.82 a	0.79 c	0.61 d	0.81 a		
Mean Con.		0.20 d	1.26 a	0.71 b	0.38 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($P < 0.05$).

The table (4- 8) Explains the significant effect of root dried weight characteristic for factors of wheat varieties, added magnesium concentrations, and all studied interactions. The results indicated that the root dried weight was significantly affected by the magnesium soaking and spray solution as the highest value was (2.36) g in the cultivar *Abaa* 95 while the lowest value was found for the variety *Rasheed* (0.35)g .

The results of the interaction of MgO NPs with the varieties of wheat showed a significant effect, as the MgO NPs treatment of the magnesium spraying solution with sucking outperformed with the challenging type and gave the highest root dried weight (0.95) g , and the minimum root dried weight was (0.39) g ,when MgO NPs interfered with *Rasheed* variety.

The results of the interaction between the MgO NPs and the addition of different magnesium treatment indicated a significant effect, as the interaction of the non- and the concentration 100 ppm gave the highest root dried weight of (1.82)g .A significant increase was also observed when the effect of the wheat varieties under study, and it was found that the cultivar *Abaa* took a value of about (0.70) g , greater than the variety *Rasheed* by about (0.57) g.

Magnesium is one of thirteen mineral nutrients that come from soil, and when dissolved in water, is absorbed through the plant's roots. Sometimes there are not enough mineral nutrients in soil and it is necessary to fertilize in order to replenish these elements and provide additional magnesium for plants. With an exposure to plants by MgONPs , nanoparticles penetrate into the cell wall and cell membrane of root epidermis accompanied by a complex series of events to enter plant vascular bundle (xylem), and move to the stele simplistically to be translocated finally at leaves . The increase in biological yield, as well as the length of the root

system, is attributed to an increase in the plant root's wet weight, as seen in the Table (4-4) and Table (4-6) .(Farooqui *et al.*, 2016 ; Jayarambabu *et al.*, 2017).

4.3 The Effect of MgO NPs on physiological aspects

Magnesium is well known for its critical function in chlorophyll synthesis. Besides that, Mg is essential in many plant physiological processes due to its role in phloem loading, as a cofactor and allosteric modulator for over 300 enzymes (including Calvin cycle, kinases, RNA polymerases, and ATPases), and in chelation to nucleotidyl phosphate forms) (Bhatla, and Lal,. 2018).

4.3.1 The Effect of MgO Nps on Chlorophyll a Contain

Table (4-9) The Effect of MgO Nps concentrations and treatments on chlorophyll a for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	2.13 op	2.67 g	2.59 h	2.55 i	2.52 b		
	T ₂	2.15 o	2.86 b	2.73 f	2.38 l	2.53 b		
	T ₃	2.21 n	2.90 a	2.78 de	2.30 m	2.55 a		
Rasheed	T ₁	2.05 q	2.64 g	2.65 g	2.44 k	2.45 d		
	T ₂	2.06 q	2.80 cd	2.75 ef	2.49 j	2.49 c		
	T ₃	2.11 p	2.83 c	2.73 f	2.54 i	2.55 a		
Interference variety × Con.	Abaa 95	2.16 f	2.81 a	2.71 c	2.49 d		2.52 a	
	Rasheed	2.07 g	2.76 b	2.70 c	2.41 e		2.51 b	
Interference treatment × Con.	T ₁	2.16 h	2.50 f	2.43 g	2.42 g			2.47 c
	T ₂	2.10 i	2.83 b	2.74 c	2.61 g			2.52 b
	T ₃	2.09 i	2.86 a	2.75 c	2.66 d			2.55 a
Mean Con.		2.11 d	2.79 a	2.70 b	2.45 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05)

The results of the statistical analysis in Table (4- 9) showed that there is a significant effect due to the treatment of plants with MgO nanoparticles in the proportion of chlorophyll a , as the results indicated that the level of magnesium 100ppm amount applied to the wheat plant ,especially to the species (*Abaa 95*) recorded the highest significant values under the probability level 5% of chlorophyll in plant leaf reached (2.90) mg/g fresh weight upon treatment (foliar And plant soaking) when compared to the level of magnesium 200ppm , which gave an average of (2.78) mg/g fresh weight . Similarly, for the treatment of (soaking and foliar the plant), the largest significant differences in the results of the *Rasheed* (2.83) mg/g fresh weight were also for the concentration of 100, followed by the second and first treatments, respectively. While the concentration 300 for nano magnesium for the two variety (2.55), (2.44) mg/g fresh weight , respectively, have the lowest values.

Accordingly,the interaction between the plant and the nano magnesium oxide concentrations indicated that the plant *Abaa 95* had the highest concentration as (2.81) mg/g fresh weight, at 100 ppm, while the variety *Rasheed* had the lowest concentration at 300 ppm as (2.41) mg\g fresh weight .

The two-way interaction between the nano magnesium oxide concentration and the given process, on the other hand, yielded simple results as shown in the table, with the best values appearing at the lowest magnesium concentration as (2.86) mg/g fresh weight at T_3 , and the least results for the treatment named soaking Plant only, where the measured value was (2.42) mg/g fresh weight at 300 ppm when compared to the control values.

The Data showed the four concentrations treated with wheat to the control value as (2.11) mg/g fresh weight . We find that the strongest concentrations are 100, 200, and 300 ppm respectively .

reviewing the numbers in the table, we discover that there is an overlap between the plant and the treatment when the plant is foliar and soaked, it has the highest tangible values, followed by the soaking method, which has the lowest tangible values. along the same line, the effect of treatment T₃ as (2.55) mg/g fresh weight have highest is T₁ the lowest is (2.47) mg/g fresh weight .Finally, regarding the effect of the cultivars, type (*Abaa 95*) showed a significant superiority when compared to the variety *Rasheed* as (2.52 , 2.51) mg\g fresh weight respectively.

4.3.2 The Effect of MgO NPs on chlorophyll b contain

Table (4-10) The Effect of MgO NPs concentrations and treatments on chlorophyll b (mg/g) for two varieties

Varieties	Treatment methods	Mgo NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	0.69 l	0.83 f	0.80 ghi	0.79 hij	0.79 b		
	T ₂	0.70 l	0.93 ab	0.85 ef	0.75 jk	0.79 b		
	T ₃	0.70 l	0.96 a	0.88 de	0.73 k	0.81 a		
<i>Rasheed</i>	T ₁	0.61 n	0.82 fgh	0.83 fg	0.76 j	0.75 d		
	T ₂	0.64 mn	0.90 cd	0.87 de	0.76 j	0.78 c		
	T ₃	0.65 m	0.92 bc	0.84 f	0.77 ij	0.81 ab		
Interference variety × Con.	<i>Abaa 95</i>	0.69 e	0.91 a	0.85 c	0.76 d		0.80 a	
	<i>Rasheed</i>	0.63 f	0.88 b	0.84 c	0.76 d		0.78 b	
Interference treatment × Con.	T ₁	0.67 f	0.77 e	0.76 e	0.75 e			0.76 b
	T ₂	0.67 fg	0.91 b	0.86 c	0.81 d			0.80 a
	T ₃	0.65 g	0.94 a	0.86 c	0.82 d			0.80 a
Mean Con.		0.66 d	0.89 a	0.84 b	0.76 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results in Table (4-10) indicated the efficacy of the nanoparticles in increasing the amount of chlorophyll. B, the concentration of chlorophyll as (0.96 and 0.92) mg/g

fresh weight with T₃ treatment (soaking and foliar application treatment), while the lowest values were in the foliar treatment only as (0.79 and 0.76) mg/g fresh weight. The values of the second treatment T₂ are mediating between the two treatments, the result was share *Abaa 95* and *Rasheed* respectively.

The other side the a observation of the results of the two-way interference between the concentrations of MgO NPs and plant, there were significant differences under the probability 5%, as the species *Abaa 95* (0.91) mg/g fresh weight outperformed the species *Rasheed* as (0.88) mg/g fresh weight, at the concentration of 100ppm, which differed significantly from the other treatments. Although, statistically significant differences were observed in the chlorophyll due to the correlations between concentrations and the treatments, the treatment with a concentration of 100 gave the best values as (0.94) mg/g fresh weight followed by T₂ as (0.91) mg/g fresh weight, while the lowest value was in the treatment T₁ as T₃(0.75) mg/g fresh weight with 300 ppm. It was found that all the effects of the three oxide magnesium nanoparticles concentration shown in the table outperformed the control concentration at the rates (0.89, 0.84, 0.76) mg/g fresh weight respectively. Likewise, the effects of the three treatments were outperformed the control treatment as (0.80, 0.80, 0.76) mg/g fresh weight respectively. Certainly, the effect of plant varieties showed the plant *Abaa 95* was superior as (0.80) mg/g fresh weight to *Rasheed* as (0.78) mg/g fresh weight.

4.3.3 The Effect of MgO NPs on chlorophyll a+b

Table (4-11) The Effect of MgO NPs concentrations and treatments on chlorophyll a+b (mg/g) fresh weight for two varieties

Varieties	Treatment methods	Mg oNPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment	
		0	100	200	300				
<i>Abaa 95</i>	T ₁	2.83 o	3.51 g	3.39 h	3.34 i	3.32 c			
	T ₂	2.84 o	3.80 b	3.58 f	3.15 l	3.34 bc			
	T ₃	2.91 n	3.86 a	3.66 de	3.03 m	3.36 a			
<i>Rasheed</i>	T ₁	2.66 q	3.47 g	3.48 g	3.20 k	3.20 e			
	T ₂	2.70 q	3.70 d	3.63 e	3.25 j	3.27 d			
	T ₃	2.76 p	3.75 c	3.57 f	3.32 i	3.35 ab			
Interference variety × Con.	<i>Abaa 95</i>	2.86 f	3.72 a	3.56 c	3.26 d		3.32 a		
	<i>Rasheed</i>	2.71 g	3.64 b	3.54 c	3.17 e		3.29 b		
Interference treatment × Con.	T ₁	2.83 h	3.27 f	3.20 g	3.18 g				3.24 c
	T ₂	2.76 i	3.75 b	3.61 c	3.43 e				3.33 b
	T ₃	2.75 i	3.81 a	3.61 c	3.49 d				3.36 a
Mean Con.		2.78 d	3.68 a	3.55 b	3.21 c				

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The data of Table (4-11) showed that the effects of MgO NPs had significant differences in different concentrations of MgO NPs as well as the methods of plant treatment , the highest value of the weight of chlorophyll a+b (3.86) mg/g fresh weight , at a concentration of 100ppm and treatment of T₃ plant *Abaa 95* , while the same concentration, for the same treatment but for the plant *Rasheed* is (3.75) mg/g. On the other hand , there are significant differences between them at the level of probability of 5% . The lowest amount of chlorophyll a+b in the plant was recorded at the concentration of 300 ppm in T₁ treatment and the plant share was *Rasheed* as (3.20) mg/g.

The overlap between varieties and concentrations of MgO NPs, obtains the highest value at 100 ppm concentration (3.72) and (3.64) for *Abaa 95* and *Rasheed* respectively, and there are significant differences at 5% probability level between other value. On the other hand, the effects of MgO NPs concentrations were observed significantly probability level among all four concentrations (0, 100, 200 and 300) ppm, respectively.

clearly from the table that there were significant differences between the three treatments with MgO NPs treatment T₃ occupied the highest values of chlorophyll a & b and then treatment T₂ (foliar plant only), and finally treatment T₁ (soaking seeds only) .

The interaction between the plant and the methods of treatment with MgO NPs, and both plants were significant for the other treatments .

The effect of MgO NPs on *Triticum sp* plants and the extent of response to that effect, the plant *Abaa 95* significantly superior to the plant *Rasheed* .

4.3.4 The Effect of MgO NPs on chlorophyll a/b contain

Table (4-12) The Effect MgO NPs concentrations and treatments on chlorophyll a\b (mg/g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	3.07 def	3.22 abcd	3.20 abcde	3.18 abcdef	3.17 abc		
	T ₂	3.10 cdef	3.27 ab	3.23 abcd	3.14 bcdef	3.19 ab		
	T ₃	3.10 cdef	3.32 a	3.24 abc	3.11 bcdef	3.24 a		
<i>Rasheed</i>	T ₁	3.02 f	3.20 abcde	3.21 abcd	3.14 bcdef	3.11 c		
	T ₂	3.04 ef	3.24 abc	3.23 abc	3.15 bcdef	3.12 bc		
	T ₃	3.06 def	3.25 abc	3.22 abcd	3.16 abcdef	3.20 a		
Interference variety × Con.	<i>Abaa 95</i>	3.10 d	3.25 a	3.20 abc	3.16 bcd		3.20 a	
	<i>Rasheed</i>	3.09 d	3.24 ab	3.19 abc	3.14 cd		3.14 b	
Interference treatment × Con.	T ₁	3.12 abc	3.18 ab	3.18 ab	3.17 ab			3.14 b
	T ₂	3.09 bc	3.22 a	3.21 a	3.20 ab			3.16 b
	T ₃	3.04 c	3.23 a	3.21 a	3.20 a			3.21 a
Mean Con.		3.12 b	3.20 a	3.19 a	3.17 ab			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results of Table (4-12) induced that MgO NPs resulted in a significant increase in the ratio of chlorophyll a\b the highest value was of the *Abaa 95*, at 100 ppm

concentration, and in the method of seed soaking and foliar plants (T_3) was (3.32), while the second value was for the same method of treatment (T_3), but in the another concentration 200 ppm. On the other hand , the highest value of *Rasheed* was (3.25) , in MgO NPs concentration 100 ppm in the third method treatment (soaking seeds + foliar plant) T_3 . Although there are no significant differences between values because they are similar to the letters they contain, they are numerically different, while it was less valuable for ratio of chlorophyll in the MgO NPs concentration 300 ppm, and T_3 in the *Rasheed* was (3.14) .The values vary between different MgO NPs concentrations as well as different treatment methods, some of them are significant and others are not significant, although there is a significant difference.

So, the result of the interaction between varieties and MgO NPs, the concentration of 100 ppm in the *Abaa 95* was (3.25) and differed significantly from the rest of the concentrations . In another side, the lowest value was (3.14) for *Rasheed* with 300 ppm MgONPs concentration.. As for the effect of the four concentrations of the concentrations of 100 ppm (3.20) and 200 ppm (3.19) were significantly different . while the lowest rise was not significant at 300 ppm when compare to control value (3.12) . Finally, concerning the effect of the treatments, the third treatment (soaking seeding + foliar plants) was significantly higher than the other treatments at 5% probability level. The top of the transactions with (3.21) value was superior to other transactions that were (3.16 and 3.14) values respectively.

4.3.5 The Effect of MgO NPs on carotene contain

Table (4-13) The Effect of MgO NPs concentrations and treatments on carotene (mg/g) for two varieties

Varieties	Treatment methods	Mg ONPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	0.71 lm	0.86 ef	0.82 gh	0.80 hi	0.82 b		
	T ₂	0.71 lm	0.95 ab	0.87 ef	0.77 jk	0.82 ab		
	T ₃	0.72 l	0.97 a	0.91 cd	0.75 k	0.84 a		
Rasheed	T ₁	0.66 n	0.84 fg	0.85 f	0.77 ijk	0.78 c		
	T ₂	0.69 mn	0.93 bc	0.89 de	0.78 ijk	0.80 c		
	T ₃	0.69 mn	0.95 ab	0.86 ef	0.79 hij	0.83 ab		
Interference variety × Con.	Abaa 95	0.72 d	0.92 a	0.87 b	0.78 c		0.82 a	
	Rasheed	0.68 e	0.90 a	0.87 b	0.78 c		0.81 b	
Interference treatment × Con.	T ₁	0.70 e	0.79 d	0.77 d	0.77 d			
	T ₂	0.70 e	0.94 a	0.88 b	0.84 c	0.82 a		
	T ₃	0.69 e	0.96 a	0.89 b	0.85 c	0.83 a		
Mean Con.		0.70 d	0.91 a	0.87 b	0.78 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($P < 0.05$).

The data of Table (4-13) showed that the carotene of a plant had significant differences with different concentrations and treatments with MgO NPs. The highest value at 100 ppm concentration approximately (0.97) mg/g followed by value (0.95) mg/g at 200 ppm for treatment (soaking seeds + foliar application), both values belong to a plant *Abaa 95* significant differences and the values were less than the share of *Rasheed* , as it almost touched (0.95) mg/g .When observing the table , we find that there are significant differences and the values were less than the share of *Rasheed* , as it almost touched. (0.77) mg/g.

On the other hand , the interference between the three treatment and wheat plant , there were significant differences between the carotene values of both plants, the best results were for the treatment (seed soaking + foliar application), as (0.84 and 0.83) mg/g respectively. and the share of (*Abaa 95*, *Rasheed*), on the other hand, the value of

the second treatment in a plant was (0.82 and 0.80) mg/g respectively. for the treatment (foliar application) .

The same table's results showed a significant effect of the intervention between the three nanoparticle concentrations used in the study and plant , with the concentration of 100 ppm surpassing to the other concentrations when compared to the control concentration for both varieties .

Certainly, on the one hand , the effect of plant varieties, the *Abaa 95* significantly superior to the *Rasheed* .

The study the chlorophyll content in *Triticum* effect on chlorophyll a, chlorophyll b, carotenoids, chlorophyll a/b and total chlorophyll content exposed to different concentration of MgO nanoparticle was observed Table (4-9\ 4-10\ 4-11\ 4-12\ 4-13) Shows the application of biosynthesized nano magnesium improved nutrient uptake and crop yield by increasing light absorption, photosynthesis activities, and enzyme release for mobilizing native plant nutrients. One possible explanation is that Mg is a structural component of chlorophyll and many co-enzymes, Nano-Mg particles may be triggering produce of the co-enzymes (co-factor). Without magnesium, chlorophyll cannot absorb the solar energy needed for photosynthesis. Magnesium also has important implications for partitioning, photoassimilate utilization, photophosphorylation (including ATP formation), and photo-oxidation in leaf tissues, as well as the production of reactive oxygen species (Moynier, and Fujii, 2017) . The current study confirmed the presence of a high response for adding magnesium, which is due to its role in increasing production, the fact that the plant demands it in relatively large amounts, and the fact that it is one of the main nutrients, as well as having a primary role in the synthesis of the chlorophyll molecule and NPs alter the

photosynthetic efficiency, photochemical fluorescence, and quantum yield in plants (Siddiqui *et al.*, 2015 ; Al-Sahaf, 1989). The data is compatible with the result of (Rathore and Tarafdar, 2015).

4.3.6 The Effect of MgO NPs on relative water

The data of Table (4-14) shows that the relative water in the plant differed significantly depending on the concentrations and treatments with MgO NPs. The maximum value (85.60)% was obtained at a concentration of 100 ppm, followed by a value (84.26)% obtained at a concentration of 200 ppm for the same procedure (soaking seeds + foliar application) *Abaa 95* . When looking at the table, it indicates that there are major variations and that the values were lower than the share of plant *Rasheed* , which was almost (22.30)% .

Table (4- 14) The Effect of MgO NPs concentrations and treatments of relative water contain for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	14.30 lm	79.56 d	44.46 f	33.56 g	49.25 c		
	T ₂	15.26 kl	84.26 b	80.10 cd	21.36 i	49.91 b		
	T ₃	16.33 k	85.60 a	80.33 cd	19.36 j	51.37 a		
<i>Rasheed</i>	T ₁	10.53 n	77.36 e	79.43 d	22.30 i	43.18 e		
	T ₂	13.00 m	81.30 c	80.13 cd	22.56 i	47.57 d		
	T ₃	14.00 lm	81.36 c	80.02 cd	30.26 h	50.40 b		
Interference variety × Con.	<i>Abaa 95</i>	15.20 e	83.10 a	79.93 b	25.04 d		49.40 a	
	<i>Rasheed</i>	12.61 f	80.01 b	68.27 c	24.76 d		47.83 b	
Interference treatment × Con.	T ₁	15.31 h	27.93 e	24.81 f	21.96 g			45.37 c
	T ₂	13.50 i	82.78 a	79.95 b	62.28 d			49.58 b
	T ₃	12.90 i	83.48 a	80.07 b	78.40 c			50.89 a
Mean Con.		13.90 d	81.55 a	74.10 b	24.90 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The interaction data between plant and MgO NPs. concentrations revealed that the concentration exceeded 100 ppm significantly at the 5% probability level, particularly in *Abaa 95*. for relative water contain as (83.10)%, rising concentrations to 300 ppm causes the relative water contain value to drop to its lowest point by about (80.01)%. in the plant *Rasheed* .

Also, the overlap values between the plant and the three treatment methods show that the T₃ treatment of the *Abaa 95* registered the highest values by approximately (51.37)% , and gradually decreased the water content of the to(49.25)% and indicated the lowest value in the water content of the *Rasheed* . There were significant variations between them at the probability level of 5 %.

The treatments had an impact, as showed by the significant differences in the results at the 5% probability level. The third procedure, T₃, had the greatest influence on the water content of the plant's shoot , with a value of (50.89)% compared to T₁ (soaking seeds only), which had a value of (45.37)%. For other result noticed, the interaction between concentrations and treatment methods with MgO NPs was significant.

The application of MgO NPs greatly improved, proline, FAA, TSP, phenol, and IAA. Growing compatible solutes (TSS, proline, and FAA) increases plant cell resistance to soil growth by increasing cytoplasmic osmotic pressure led to increase relative water contents which is an indicator of crop water status, both of which are needed for plant growth . This opinion is compatble with what found by (Linh *et al.*, 2020) .

4.3.7 The Effect of MgO NPs on leaf area

Table (4- 15) The Effect of MgO NPs concentrations and treatments on leaf area cm² for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	10.00 hi	21.64 d	13.54 f	13.00 fg	17.47 b		
	T ₂	11.12 gh	27.36 b	22.25 d	11.33 gh	17.71 b		
	T ₃	11.23 gh	31.25 a	24.00 c	11.23 gh	19.15 a		
<i>Rasheed</i>	T ₁	8.58 i	17.40 e	18.33 e	12.33 fg	14.16 c		
	T ₂	9.14 i	24.33 c	23.00 cd	12.40 fg	14.88 c		
	T ₃	9.25 i	27.14 b	21.66 d	12.83 fg	17.71 b		
Interference variety × Con.	<i>Abaa 95</i>	10.82 f	26.76 a	21.32 c	12.52 e		17.25 a	
	<i>Rasheed</i>	8.99 g	22.95 b	19.60 d	11.82 e		16.45 b	
Interference treatment × Con.	T ₁	10.19 g	12.66 f	12.03 f	11.81 f			14.52 c
	T ₂	9.96 g	25.85 b	22.32 c	15.94 e			17.59 b
	T ₃	9.57 g	29.19 a	23.12 c	19.53 d			18.43 a
Mean Con.		9.90 d	24.86 a	20.46 b	12.17 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

It is inferred from Table (4-15) showed that the effect of MgO NPs on leaf area of the plant . The highest significant concentration is under the probability level of 5% for the third treatment T₃ (31.25) cm² for a concentration of 100 ppm, as can be seen from the table. The second value of the plant *Abaa 95* was (24.00 and 11.23) cm², which relates to (200 and 300) ppm, respectively, for the same treatment . The result for *Rasheed* , has higher value in 100 ppm and for T₃ treatment which is (27.14) cm².

In the interaction between MgO NPs concentrations and plants, the concentration of 100 ppm in *Abaa 95* plants took the highest values and varied significantly from the rest of the concentrations (26.76) cm²., whereas the lowest value is (11.82) cm² in with 300 ppm MgO NPs concentration and treatment method seed soaking + foliar

application T₃. Whatever the preference among the plants for *Abaa 95* approximately (17.25) cm² but *Rasheed* is (16.45) cm².

There were also significant differences between the three methods, with MgO NPs treatment T₃ having a leaf area values, followed by treatment T₂ (foliar application only), and finally treatment T₁ (seed soaking only).

Leaf area is an important measurement in most physiological and agronomical studies as it reflects the photosynthetic capability of the crop. Plants interact with applied NPs through the leaves, and hence, leaf stomata and hydathodes play an important role in the foliar uptake of NPs. The stomatal pathway is highly capacitive due to its large size exclusion limit above 10 nm and its high transport. Just a small proportion of stomata lead to the uptake process, which can be improved by frequently wetting and drying a foliar-applied solution. The nanoparticles (NPs) that penetrate the leaf surface to enter the leaf and translocate to other plant components, stomata or hydathodes traverse cell walls of palisade parenchyma. As a result, the efficacy of stomata in the ingestion of magnesium nanoparticles and a circuit role in enhancing all metabolic processes within the plant body and making it healthy to carry out biological roles in photosynthesis and transpiration and form the highly amount of chlorophyll pigment enabled to make leaf area greater to receive more than what is in the atmosphere. (Kanjana, 2020).

4.3.8 The Effect of MgO NPs on membrane stability

Table (4-16) The Effect of MgO NPs concentrations and treatments on membrane stability % for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment	
		0	100	200	300				
Abaa 95	T ₁	16.66 c	12.50 f	13.46 ef	13.50 ef	13.15 c			
	T ₂	16.53 c	7.66 ij	10.26 g	15.23 cd	13.02 c			
	T ₃	16.43 c	6.33 j	9.26 gh	16.36 c	12.15 d			
Rasheed	T ₁	24.13 a	13.33 ef	13.00 ef	14.53 de	15.98 a			
	T ₂	20.63 b	8.33 hi	9.50 gh	14.50 de	14.20 b			
	T ₃	19.33 b	8.33 hi	10.46 g	14.16 de	12.59 cd			
Interference variety × Con.	Abaa 95	16.52 b	9.05 f	10.48 e	14.01 d				12.98 b
	Rasheed	21.36 a	10.35 e	11.08 e	15.27 c				14.05 a
Interference treatment × Con.	T ₁	17.85 b	13.58 d	14.88 c	15.46 c				
	T ₂	18.58 b	8.80 f	9.98 e	13.41 d		12.80 b		
	T ₃	20.39 a	7.33 g	8.96 f	12.98 d		12.65 b		
Mean Con.		18.94 a	9.70 d	10.78 c	14.64 b				

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($P < 0.05$).

The results of Table (4-16) showed that MgO NPs has a beneficial effect on improving and increasing the strength of plasma membranes and preserving cell structure through low electrical conductivity values, implying that the rate of cell membrane perfusion is low. The treatment showed the lowest values in concentration 100 ppm, and then the values elevated as the concentration increased when compared to the control concentration where the lowest value (6.33)% is found in the T₃ highest (15.23)% in the first treatment of plant *Abaa 95*. The same concepts about the effect of nano magnesium on membrane stability is found in the cultivar *Rasheed*.

It illustrated the effect of plants in the table, Since the letters associated with the numbers are identical, there are no major differences between them. The first class,

Abaa 95, had a value of (12.98%), while the second class, *Rasheed*, had a value of (14.05) % .

On the other hand, the results of the table recorded significant differences using the three treatments interaction to both plants despite the numerical differences between them . The values are gradually decreasing from lowest value to the highest values compar to control. However, by comparing the influence of the four MgO NPs concentrations, the concentration at 300ppm had the maximum value(14.64) %, followed by a value (10.78 and 9.70) % percent at 200 and 100 ppm, respectively.

The presence of a significant effect on the activity of the catalase enzyme, the supraoxide decimotase enzyme, and the peroxidase enzyme respectively when various amounts of magnesium were added and the method of stabilizing CO₂ , led to protecting the photosynthesis ability and cell organelle integrity from oxidative damage under environmental condition and make the membrane more stability, plant cells have cell walls, with almost no phagocytosis. Before entering plant cells, ENMs have to penetrate the cell wall and cytoplasm membrane. The pore sizes of plant walls are typically in the range of 3–8 nm, with the thickness of about 5–20 nm function as natural sieves (Carpita and Gibeaut, 1993). Nanoparticle with sizes smaller than the largest pore are expected to pass through and reach the plasma membrane, while the larger particle aggregates will not enter into plant cells (Shabala and Hariadi, 2005) .

4.3.9 The Effect of MgO NPs on permeability of Na⁺

Table (4-17) The Effect of MgO NPs concentrations and treatments on Na⁺ (%) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	23.96 d	10.31 p	14.11 m	21.63 l	16.24 c		
	T ₂	23.81 e	5.85 w	9.31 r	20.43 h	16.02 d		
	T ₃	21.63 f	5.83 w	8.32 t	21.47 g	14.31 f		
<i>Rasheed</i>	T ₁	57.01 a	12.92 n	10.46 o	19.74 i	24.99 a		
	T ₂	54.81 b	7.61 u	8.49 s	19.06 j	22.49 b		
	T ₃	29.66 c	6.76 v	9.84 q	18.72 k	14.85 e		
Interference variety × Con.	<i>Abaa 95</i>	23.13 b	7.38 g	9.55 e	19.15 c		15.06 b	
	<i>Rasheed</i>	47.16 a	9.10 f	10.58 d	19.17 c		21.24 a	
Interference treatment × Con.	T ₁	25.65 c	17.65 f	19.74 e	20.09 d			20.51 a
	T ₂	39.31 b	6.73 k	9.08 i	12.21 g			18.67 b
	T ₃	40.48 a	6.29 l	8.90 j	11.69 h			15.28 c
Con. Mean		35.15 a	8.24 d	10.06 c	19.16 b			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results of Table (4- 17) showed a significant decrease in the infiltration (Na⁺) values when treating (soaking seeds + foliar application) such variety *Abaa 95* as well as the best concentration of such 100 ppm , while the results (10.46 , 19.74) % were in the sequence 200 and 300 ppm according to the treatment and concentration. However in general , they are higher values than the control rates as (21.63) % , which shows a good response by the plant *Rasheed* where the values of less influence are (6.76) % . It is generally higher than the control which is (29.66) respectively.

In comparison to the interaction data between the three treatments (seed soaking, foliar plant, and seed soaking + foliar application) and MgO NPs concentration, the lowest values were for concentrations of 100 ppm, followed by values of 200 ppm, and

300 ppm. As the higher concentration value increased, the lower value was (6.29) % for T₃, and the highest was (20.09) % for T₁.

Although *Abaa 95* obtained approximately (15.06) % from plant varieties, *Rasheed* obtained (21.24) % . So , there are no significant differences in the effect of plants among them .On the other hand, there have been significant differences in the effect of MgO NPs procedures. Treatment T₃ has the lowest values (15.28) %, followed by treatment T₂ (foliar only) and eventually treatment T₁ (seed soaking only) . Magnesium has a strong influence on membrane transport processes in plant cells.Mg effects on transport activity in tonoplast and chloroplast membranes Physiological amounts of Mg have a direct effect on the activity of both slow (SV) and fast (FV) activating vacuolar ion channels, thereby playing an important role in cytosolic homeostasis and cell turgor control. (Pottosin and Muniz ., 2002).

4.3.10 The Effect of MgO NPs on permeability of k⁺

Table (4- 18) The Effect of MgO NPs concentrations and treatments on K ion for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	48.17 d	20.21 l	22.37 ij	23.25 hi	28.90 c		
	T ₂	30.45 e	14.57 o	19.24 m	25.21 g	28.45 c		
	T ₃	28.66 f	13.21 p	18.05 n	25.23 g	21.29 e		
<i>Rasheed</i>	T ₁	65.37 a	22.21 j	21.25 k	25.20 g	33.54 a		
	T ₂	60.70 b	17.91 n	18.16 n	24.26 g	30.02 b		
	T ₃	56.23 c	14.89 o	20.19 l	23.33 h	22.36 d		
Interference variety × Con.	<i>Abaa 95</i>	35.76 b	15.99 f	19.83 d	24.26 c		24.03 b	
	<i>Rasheed</i>	60.77 a	18.39 e	19.87 d	24.56 c		30.82 a	
Interference treatment × Con.	T ₁	42.45 c	24.22 d	24.27 d	24.75 d			31.00 a
	T ₂	45.57 b	16.24 g	19.13 f	21.73 e			26.19 b
	T ₃	56.77 a	14.05 h	18.70 f	21.28 e			25.09 c
Mean Con.		48.26 a	17.19 d	19.85 c	24.41 b			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The data of Table (4-18) mentioned that the permeability K^+ ion of cytoplasmic membranes in plant effected by MgO NPs. As a result, several different MgO NPs concentrations and treatments have statistically significant values, such as the first concentration 100 ppm (13.21) % and the second concentration 200 ppm (18.05) %, which have higher values than the control concentration T_3 . Although it is true that the concentration of 300 ppm (25.23) % was less valuable than the control (28.66) %, and for a three treatments *Rasheed* all treatment and concentrating have value less than control. In addition to the other results for effects of nanoparticles concentration the permeability values were higher in concentrations of 300 ppm and 200 ppm, with the lowest concentrations at 100 ppm as compared to the control. The lowest percentage was (17.19) %.

The interaction between three treatments and concentration was listed in Table (4.18). The three parameters displayed different statistical changes, with the maximum value (24.22)%, observed in concentration 100 ppm, followed by the other two values (16.24), (14.05) % respectively. The plant *Abaa 95* has no significant difference, than the other plant *Rasheed* in terms of the impact of plant varieties. The values are (30.82)% and (24.03)% respectively.

Significant increase of concentrations of free Mg from normal range inside cell is showing improving photosynthesis via multiple pathways such so K^+ transport from the cytosol to the stroma, possible interference with Mg homeostasis inside the chloroplast, and impaired regulation of transport events across the tonoplast (Shaul 2002; Salcido-Martínez *et al.*, 2020).

4.3.11 The Effect of MgO NPs on carbohydrate

Table (4-19) The Effect of MgO NPs concentrations and treatments on carbohydrate (g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	17.34 _s	29.33 h	25.86 k	25.68 l	25.65 d		
	T ₂	19.95 r	43.97 b	30.36 g	23.13 o	26.74 c		
	T ₃	20.85 _q	44.42 a	32.23 e	21.23 p	29.68 a		
<i>Rasheed</i>	T ₁	14.35 _v	27.87 j	28.86 i	23.73 n	23.70 f		
	T ₂	15.17 _u	32.43 d	30.74 f	24.26 m	24.55 e		
	T ₃	16.22 t	34.73 c	30.35 g	25.65 l	29.35 b		
Interference variety × Con.	<i>Abaa 95</i>	19.38 _g	39.24 a	29.98 c	24.54 e		27.86 a	
	<i>Rasheed</i>	15.24 _h	31.67 b	29.48 d	23.35 f		25.36 b	
Interference treatment × Con.	T ₁	18.53 j	24.70 g	23.69 h	23.44 i			24.13 c
	T ₂	17.56 _k	38.20 b	30.54 d	27.36 f			27.50 b
	T ₃	15.84 l	39.57 a	31.29 c	28.60 e			28.21 a
Mean Con.		17.31 _d	35.46 a	29.73 b	23.94 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($P < 0.05$).

Table (4-19) shows the effect of the variety and the levels of MgO NPs concentrations and treatments and the interaction between them on the elevation of the wheat varieties under study. It is clear from the table that the wheat varieties under study and the magnesium levels had a significant effect on the rate of carbohydrate. It is evident from the table that the varieties of wheat differed significantly among themselves in the average of carbohydrate. The *Abaa 95* variety achieved the highest rate of plant carbohydrate of (27.86) g, while the variety *Rasheed* achieved the challenge of the lowest average carbohydrate as (25.36) g.

It is noticed from the results of the same table the increase of magnesium levels from 100 to 300 ppm led to a significant increase in the amount of carbohydrate of the

given level was 100 ppm, a height of (44.42)g, superior to the comparison treatment, which amounted to (43.97)g at 200ppm share with *Abaa 95* . The interference was shown in Table (4-19) between the classes shows the amount of carbohydrate was higher (27.86) for than *Rasheed* as (25.36)g.

Carbohydrate accumulation in the leaves induces feedback inhibition of Rubisco and reduces the rate of photosynthesis in Mg deficiency. Mg is also used to provide charge balance in the light reaction. Drought or Mg deficiency inhibits photosynthesis, resulting in electron misallocation of oxygen and the development of ROS, which causes oxidative stress .These results confirmed what the researchers said about the use of nano magnesium at different levels which has improved the characteristic of plant (Cakmak, 2010).

4.3.12 The Effect of MgO NPs on protein

Table (4-20) The Effect of MgO NPs concentrations and treatments on protein(g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	2.25 kl	4.50 g	4.45 g	4.02 h	4.48 b		
	T ₂	2.27 kl	8.37 b	4.54 g	3.10 i	4.53 b		
	T ₃	2.29 k	8.81 a	5.25 e	2.75 j	4.76 a		
Rasheed	T ₁	1.75 m	4.50 g	4.50 g	3.89 h	3.65 d		
	T ₂	2.12 l	7.02 d	4.83 f	3.97 h	3.82 c		
	T ₃	2.16 kl	7.41 c	4.52 g	4.02 h	4.56 b		
Interference variety × Con.	Abaa 95	2.27 g	7.22 a	4.75 c	3.96 e		4.38 a	
	Rasheed	2.01 h	6.29 b	4.62 d	3.29 f		4.22 b	
Interference treatment × Con.	T ₁	2.20 i	3.95 f	3.54 g	3.38 h			3.73 c
	T ₂	2.19 i	7.69 b	4.67 d	4.47 e			4.52 b
	T ₃	2.02 j	8.11 a	4.89 c	4.50 e			4.65 a
Mean Con.		2.14 d	6.76 a	4.69 b	3.62 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results shown in Table (4-20) also indicate a significant overlap between the wheat varieties and the magnesium levels. It is evident from the table that although

wheat varieties showed an increase in protein content with a low magnesium level, they varied in the percentage of their response to nucleic effects and achieved the best interaction in *Abaa 95* variety with the treatment level 100 ppm achieved the highest rate of plant content which reached (8.81)g and the lowest rate for this characteristic an amount of (2.16)g in the non-potassium *Rasheed* variety.

It explained the effect of four concentrations of MgO NPs, the concentration at 100 ppm have the highest values (6.76) g when compared to the control concentration, followed by a concentration value (4.69) g at 200 ppm, which also indicates significant difference. Table (4-20) mentions that MgO NPs has the capability to regulate the activity of enzymes associated with nitrogen metabolism, hence facilitate plants to obtain more nutrients. Also, the NPs convert the nitrogen to organic nitrogen in the form of proteins and chlorophyll pigments which ultimately increase the biomass and dry weight of the plants (Ramadan *et al.*, 2020) .

4.3.13 The Effect of MgO NPs on k contain

Table (4-21) The Effect of MgO NPs concentrations and treatments on k contain (mg/g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interferenc variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	1.346 m	1.816 e	1.676 g	1.593 h	1.65 c		
	T ₂	1.366 m	2.036 a	1.820 e	1.480 k	1.65 c		
	T ₃	1.416 l	2.053 a	1.926 c	1.473 k	1.71 a		
<i>Rasheed</i>	T ₁	1.080 p	1.680 g	1.760 f	1.510 j	1.50 e		
	T ₂	1.223 o	1.970 b	1.880 d	1.540 i	1.60 d		
	T ₃	1.280 n	1.980 b	1.820 e	1.546 i	1.67 b		
Interference variety × Con.	<i>Abaa 95</i>	1.37 f	1.96 a	1.82 c	1.53 d		1.66 a	
	<i>Rasheed</i>	1.19 g	1.87 b	1.80 c	1.51 e		1.60 b	
Interference treatment × Con.	T ₁	1.34 h	1.55 f	1.51 g	1.51 g			1.55 c
	T ₂	1.29 i	2.00 a	1.85 c	1.72 e			1.66 b
	T ₃	1.21 j	2.01 a	1.87 b	1.74 d	1.68 a		
Mean Con.		1.28 d	1.92 a	1.81 b	1.52 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

Table (4-21) indicates that the largest number of potassium for the plant shoot was (2.053) mg / g and (1.980) mg / g in *Abaa 95* and *Rasheed* in the same procedure seed soaking and foliar plant process with 100 ppm of MgONPs.

Furthermore, there are significant differences between them at the 5% level, but there are numerical differences. In the same treatment seed soaking with 300 ppm the lowest amount of potassium for the plant leaf is (1.59) mg / g and (1.51)mg / g in *Abaa 95* and *Rasheed* respectively.

Interaction between plant and MgONPs concentrations reveals that the highest number of **K** is in the plant variety in the concentration of 100 ppm (1.96) mg / g, followed by a concentration of 200 ppm (1.82) mg / g, and the other variety in the concentration of 100 ppm is (1.87) mg / g.

Concerning the cooperation of wheat sp. and methods treatment the third treatment (seed soaking + foliar plant) outperformed the other treatments, particularly *Abaa 95*, where the highest value reached (1.71) mg / g, while the lowest value was at the concentration of 300 ppm treatment of *Rasheed* (1.50) mg / g.

Potassium (K^+) is an essential plant nutrient next to nitrogen (N) and phosphorous (P). It aids plants in the physiological processes such as transportation of water, nutrients and carbohydrates, photosynthesis, N utilization, stimulation of early growth, and in insect and disease resistance the changes in biomass per unit of time and leaf area indicating an important role in determining the growth response of plants under the effect of MgONPs , this is attributed to the efficiency of nanotechnology in increasing plant absorption of nutrients by increasing the amounts of dissolved ions, which increases the speed of their absorption because these ions in aqueous solutions will

change their arrangement and organization when exposed to the nanoparticle and then pass quickly through plant membranes. (Shang *et al.*, 2019 ; Marschner P.,2012).

4.3.14 The Effect of MgO Nps on Nitrogen Content

Table (4-22) The Effect of MgO NPs concentrations and treatments on nitrogen (mg/g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>.abaa 95</i>	T ₁	0.36 kl	0.72 g	0.71 g	0.64 h	0.71 b		
	T ₂	0.36 kl	1.34 b	0.72 g	0.49 i	0.72 b		
	T ₃	0.36 k	1.41 a	0.84 e	0.44 j	0.76 a		
<i>.rasheed</i>	T ₁	0.28 m	0.72 g	0.72 g	0.62 h	0.58 d		
	T ₂	0.34 l	1.12 d	0.77 f	0.63 h	0.61c		
	T ₃	0.34 kl	1.18 c	0.72 g	0.64 h	0.73 b		
Interference variety × Con.	<i>abaa 95</i>	0.36 g	1.15 a	0.76 c	0.63 e		0.70 a	
	<i>rasheed</i>	0.32 h	1.00 b	0.74 d	0.52 f		0.67 b	
Interference treatment × Con.	T ₁	0.35 i	0.63 f	0.56 g	0.54 h			0.59 c
	T ₂	0.35 i	1.23 b	0.74 d	0.71 e			0.72 b
	T ₃	0.32 j	1.29 a	0.78 c	0.72 e			0.74 a
Mean Con.		0.34 d	1.08 a	0.75 b	0.58 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

Table (4-22) shows the effect of cultivar and nanoscale magnesium levels, and the interaction between them, on the average content of the element in the plant for the wheat varieties under study. It is evident from the table that the wheat cultivars under study and the magnesium levels significantly affected the nitrogen content in. It is noticeable that the *Abaa 95* variety gave the highest rate for this characteristic, which was (1.41) mg / g , while the *Rasheed* variety gave the lowest rate for this characteristic, which was (0.62) mg / g.

So, according to the findings of the interaction between wheat plant and methods procedure, the highest value of interaction indicates significant differences with the third treatment with a value (0.76) mg / g, followed by the second and first are seen

in the *Abaa* 95 plant., although the highest value of interaction is seen in the third treatment, which is significantly different from the first.

Finally, the table shows that there are significant differences between the effect of treatment at the probability level of 5%, with the highest value being (0.74) mg / g and the lowest value being (0.59) mg / g.

Plant vegetative growth, is highly dependent on the plant's ability to absorb N in sufficient quantities to cover metabolic requirements at all stages of its lifecycle Plant access to N and/or its use may be affected by physiological disorders caused by other nutrient deficiencies (e.g. Mg deficiency). Mg appears to be a major player in N uptake and utilization because it is involved in simultaneously regulating processes responsible for photosynthesis, assimilate processing, and partitioning among plant parts. Mg appears to be a key player in N uptake and consumption because it regulates processes involved in photosynthesis, assimilate processing, and partitioning among plant parts all at the same time. Since n is the most important atom in the chlorophyll structure, the amount of nitrogen increased as chlorophyll's response to magnesium increased. (Grzebisz *et al.* 2010; Grzebisz 2013).

4.3.15 The Effect of MgO Nps on P Contain

Table (4-23) indicates The amount of phosphorous released increased collectively with increasing the levels of addition of magnesium , and it achieved the level (0.49) mg / g was the highest amount, while the equations of the interference 100, 200 and 300ppm achieved the highest amount when compared to the control treatment. Therefore, the priority of the transactions can be arranged in increasing the amount of phosphorus released collectively as follows (T_3, T_2, T_1) respectively.

The treatment of interaction of magnesium with varieties achieved the highest total amount when treatment T_3 reached (0.33) mg, while the treatment of interaction of magnesium with treatment achieved the highest value when treatment T_3 reached (0.33) mg / g .

It turns out that in terms of species effect, the first class, *Abaa 95* , has a value of (0.31) mg / g, which is superior to the second *Rasheed* , which has a value of (0.28) mg / g.

Magnesium improves plant phosphorus availability by decreasing phosphorus precipitation and remaining more soluble by forming new, more soluble magnesium phosphates and avoiding or reducing the less soluble calcium phosphate in the soil. Furthermore, the presence of high amounts of magnesium in the soil solution can inhibit and reduce the interaction of dissolved phosphorus with CaCO_3 , which is present in most soils. so Mg functions as a phosphorous vector component within the plant, activating the majority of the enzymes involved in phosphorous reactions, especially those involved in carbohydrate hydrolysis and development, as well as ATPase activation. Mg can form stable bonds with over 90% of phosphate nucleotides in plants and serves as a cofactor in many enzymatic processes associated with phosphorylation, dephosphorylation, hydrolysis of various compounds, and a bridging element for the aggregation of ribosome subunits necessary for protein synthesis This agrees with the studies (Breesam and Tememe, 2015; Marschner 2012).

Table (4-23) The Effect of MgO NPs concentrations and treatments on p contain (mg/g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	0.16 u	0.36 i	0.32 l	0.29 m	0.29 c		
	T ₂	0.18 t	0.44 b	0.39 g	0.23 q	0.31 b		
	T ₃	0.20s	0.49 a	0.41 e	0.23 r	0.33 a		
Rasheed	T ₁	0.08 x	0.33 k	0.34 j	0.24 p	0.25 e		
	T ₂	0.08 w	0.42 d	0.41 f	0.26 o	0.28 d		
	T ₃	0.15 v	0.43 c	0.37 h	0.29 n	0.31 b		
Interference variety × Con.	Abaa 95	0.18 f	0.43 a	0.37 c	0.26 d		0.31 a	
	Rasheed	0.10 g	0.40 b	0.37 c	0.25 e		0.28 b	
Interference treatment × Con.	T ₁	0.18 j	0.27 g	0.26 h	0.25 i			0.27 c
	T ₂	0.13 k	0.43 b	0.39 d	0.33 f			0.30 b
	T ₃	0.12 l	0.46 a	0.40 c	0.34 e			0.32 a
Mean Con.		0.14 d	0.41 a	0.37 b	0.26 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

4.3.16 The Effect of MgO Nps on Ca⁺² Contain

Table (4-24) The Effect of MgO NPs concentrations and treatments on Ca⁺² contain (mg/g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa95</i>	T ₁	0.21 gh	0.28 cd	0.25 def	0.25 def	0.25 c		
	T ₂	0.21 gh	0.41 a	0.32 b	0.23 fg	0.27 b		
	T ₃	0.21 gh	0.42 a	0.33 b	0.23 fgh	0.30 a		
<i>Rasheed</i>	T ₁	0.07 j	0.27 cde	0.27 cd	0.24 f	0.21 d		
	T ₂	0.12 i	0.34 b	0.32 b	0.24 ef	0.24 c		
	T ₃	0.21 h	0.34 b	0.29 c	0.25 def	0.29 a		
Interference variety × Con.	<i>Abaa 95</i>	0.21 f	0.37 a	0.30 b	0.25 d		0.28 a	
	<i>Rasheed</i>	0.13 g	0.31 b	0.29 c	0.23 e		0.24 b	
Interference treatment × Con.	T ₁	0.21 f	0.24 de	0.24 e	0.24 e			0.23 c
	T ₂	0.16 g	0.37 a	0.31 b	0.26 d			0.27 b
	T ₃	0.14 h	0.38 a	0.32 b	0.28 c			0.28 a
Mean Con.		0.17 d	0.34 a	0.29 b	0.24 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The effect of MgO NPs on **Ca** of plant is shown in Table (4-24). Plants with a high value (0.42) mg / g belong to the *Abaa 95* and are used in treatment T₃ (seed soaking + foliar application).

Notice from the table that there are significant differences between different procedures and concentrations, the less concentration in 100 ppm is (0.24) mg / g share in the transaction T₁ (seed soaking), on the other side it obvious from the table findings that there are significant differences. The high concentration in 100 ppm is (0.38) mg / g share in the transaction T₁ (seed soaking& foliar application).

Finally, on the impact of the treatments, the third treatment (seed soaking + foliar application) is significantly higher than the other treatments at 5% probability level the uppermost of the treatment with (0.28) mg / g value is superior to other treatment that is (0.27 and 0.23) mg / g values respectively. While the preference was among the varieties of plant for *Abaa 95* approximately (0.28) mg /g , but *Rasheed* was (0.24) mg / g .

As like all the macronutrients (N, P, and K), Mg content in whole plant part increase amount of ca at wheat plant ,As a competing ion in cation exchange reactions, calcium (Ca) in excess may also interfere (similar to K) with Mg uptake This does not take place at low concentrations of Ca in the soil solution Although Mg has a higher mobility in the soil than Ca , Mg uptake has been repeatedly shown to be lower in soils with high Ca concentration in the soil solution.(Metson 1974; Mayland and Wilkinson 1989).

4.3.17 The Effect of MgO NPs on Mg^{+2} contain

Table (4-25) The Effect of MgO NPs concentrations and treatments on Mg^{+2} contain for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety $\times$ treatment	Mean variety	Mean treatment
		0	100	200	300			
<i>Abaa 95</i>	T ₁	0.63 k	0.86 e	0.77 g	0.76 g	0.80 c		
	T ₂	0.66 j	1.01 b	0.88 e	0.73 hi	0.81 bc		
	T ₃	0.66 j	1.07 a	0.92 d	0.72 i	0.84 a		
<i>Rasheed</i>	T ₁	0.48 m	0.81 f	0.86 e	0.75 gh	0.72 e		
	T ₂	0.57 l	0.97 c	0.92 d	0.76 g	0.75 d		
	T ₃	0.62 k	0.97 c	0.88 e	0.76 g	0.82 b		
Interference variety $\times$ Con.	<i>Abaa 95</i>	0.65 g	0.98 a	0.88 c	0.76 e		0.80 a	
	<i>Rasheed</i>	0.55 h	0.91 b	0.85 d	0.74 f		0.78 b	
Interference treatment $\times$ Con.	T ₁	0.64 h	0.76 f	0.75 fg	0.74 g			0.74 c
	T ₂	0.61 i	0.99 b	0.90 c	0.81 e			0.81 b
	T ₃	0.55 j	1.02 a	0.90 c	0.83 d			0.82 a
Mean Con.		0.60 d	0.95 a	0.87 b	0.75 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($P < 0.05$).

The results of the statistical analysis shown in Table (4-25) indicate the effect of nanoscale magnesium in the element of magnesium, as the concentration of magnesium in the vegetative shoot increased in the treatment of foliar plant and soaking seed. The concentration reached 100 ppm, then the concentration of 200 and 300 ppm, respectively, when compared with the control treatment by the amount (0.66 ,0.62) mg / g of both variety under study .

The results also showed that there was a significant effect under the level of probability of 5% for interference between different magnesium concentration and treatment , where the highest value was (1.02) mg / g at 100 ppm ,while the lowest value was (0.74) mg / g at 300ppm.

The effect of the four nanoparticles concentrations showed the most effects from the share of the lowest concentration, which is 100ppm. Note that the vegetative length increases when the concentration is low compared to high concentrations.

Applying nanoscale magnesium to plants at different concentrations and methods leads to an increase in absorption and a concentration of mg that becomes higher than the natural concentration in the plant, as it has important properties that help the plant in the processes of root and vegetative growth and increase the size of grain as it has an effective role in the process of photosynthesis and cell formation in addition to its ability to build strong roots and solid stems. Likewise, this element is one of the elements that occurs to slow decomposition as the plant benefits from this element throughout the period of germination and until the ripening of grain (Senbayram *et al.*, 2015;Kopittke *et al.*, 2019).

4.3.18 The Effect of MgO Nps on Weight of 100 grain

Table (4-26) The Effect of MgO NPs concentrations and treatments on weight of 100 grain (g) for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety ×treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	3.15 u	3.56 i	3.40 l	3.34 m	3.43 d		
	T ₂	3.19 t	3.83 b	3.59 g	3.26 q	3.45 c		
	T ₃	3.23 s	3.86 a	3.68 e	3.25 r	3.50 a		
Rasheed	T ₁	3.00 x	3.42 k	3.44 j	3.28 p	3.28 f		
	T ₂	3.00 w	3.75 d	3.64 f	3.31 o	3.36 e		
	T ₃	3.09 v	3.80 c	3.56 h	3.34 n	3.47 b		
Interference variety × Con.	Abaa 95	3.19 g	3.75 a	3.55 c	3.31 e		3.44 a	
	Rasheed	3.03 h	3.66 b	3.55 d	3.28 f		3.39 b	
Interference treatment × Con.	T ₁	3.07 l	3.31 g	3.29 h	3.28 i			3.32 c
	T ₂	3.10 k	3.79 b	3.61 d	3.42 f			3.45 b
	T ₃	3.16 j	3.83 a	3.62 c	3.49 e			3.48 a
Mean Con.		3.11 d	3.70 a	3.55 b	3.30 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results in Table (4-26) showed that the effect of adding magnesium and the interaction between the three study factors was significant in the average weight of 100 grains of wheat plant, and the results showed that there was a significant increase at the level of Mg 100 ppm in the average weight of 100 grains of wheat, as the values reached (3.86 and 3.80) g. Pot⁻¹ for *Abaa 95*, *Rasheed* respectively at the levels of (seed soaking & foliar plant), as measured by the comparison (MgO). The results also showed in Table (4-25) that the triple overlap between magnesium and variety led to an increase in the average weight of 100 grains of wheat, and the highest increase was in the treatment 100 ppm of (3.75) g pot⁻¹, with an increase of average weight compared to the treatment of 300 ppm of the *Rasheed* (3.28) g pot⁻¹ induced the highly favorable effects of MgO NPs on number of grains/spike, 100-grain weight and grain yield per pot in wheat under effect of treatment, since the values are reached from the top to the lowest gradually (3.48, 3.45, 3.32) g. Pot⁻¹ for (T₃, T₂, T₁) treatment respectively.

Hundred grain weight of wheat is one of the most important yield contributing characters of wheat for good yield, harvest index of crop fully depends on grain yield and biological yield of crop. From Table (4-25) since Mg is a mobile element in the plant, the concentration of Mg usually increases from the top to the bottom of the plant. (Mg), along with calcium and sulfur, is one of the three secondary nutrients required by plants for normal, healthy growth. Do not be confused by the term "secondary" as it refers to the quantity and not the importance of a nutrient.

A lack of a secondary nutrient is just as detrimental to plant growth as a deficiency of any one of the three primary nutrients (nitrogen, phosphorus and potassium) or a deficiency of micronutrients (iron, manganese, boron, zinc, copper and molybdenum). The yield increased probably due to the fact that plant got favorable growing condition

at vegetative stage, as a result , it became thick and produced more tillers which in turn increased the wheat yield. On the other hand, grain yield of wheat significantly affected by different treatments. It was reported that the highest grain yield was found when the crop grown with recommended fertilizer , because of the accumulation of carbohydrates and protein, as well as an increase in the chlorophyll content of the plant due to the action of nano magnesium, this positively affected the weight of a hundred grains of wheat, see tables (4-19) and (4-20) (Hossain *et al.*, 2013).

4.3.19 The Effect of MgONPs on number of Tiller

Table (4-27) The Effect of MgO NPs concentrations and treatments on number of tillers /plant for two varieties

Varieties	Treatment methods	MgO NPs Con. ppm				Interference variety × treatment	Mean variety	Mean treatment
		0	100	200	300			
Abaa 95	T ₁	2.15 k	2.85 e	2.72 g	2.72 g	2.64 c		
	T ₂	2.15 k	3.28 b	2.86 e	2.42 i	2.67 b		
	T ₃	2.23 j	3.42 a	3.01 d	2.42 i	2.77 a		
Rasheed	T ₁	1.85 m	2.72 g	2.75 f	2.42 i	2.43 e		
	T ₂	2.01 l	3.14 c	3.01 d	2.56 h	2.61 d		
	T ₃	2.01 l	3.14 c	2.85 e	2.56 h	2.68 b		
Interference variety × Con.	Abaa 95	2.17 f	3.18 a	2.87 c	2.52 e		2.68 a	
	Rasheed	1.95 g	3.00 b	2.86 d	2.51 e		2.58 b	
Interference treatment × Con.	T ₁	2.00 j	2.57 f	2.49 g	2.49 g			2.52 c
	T ₂	2.08 i	3.28 a b	2.93 c	2.73 e			2.67 b
	T ₃	2.12 h	3.28 a	2.93 c	2.78 d			2.70 a
Mean Con.		2.06 d	3.09 a	2.86 b	2.51 c			

* Mean values followed by the same letter are not significantly different according to Duncan's multiple range test (P < 0.05).

The results in Table (4-27) showed that the addition of magnesium, with different concentration and treatment with their interactions led to a significant increase in the of number of tillers between the two varieties in wheat, as the values reached (3.42 ,

3.01, 2.42) tillers /plant respectively, with treatment T₁ (seed socking) in the *Abaa 95* which superiority to *Rasheed* .

The relationship between treatment methods and MgONPs concentrations revealed a considerable superiority of the third treatment, namely seed soaking, namely at 100 ppm as compared to other treatments and concentrations, ranked second in terms of effect is the concentration of 200 ppm , if the values (3.28 and 3.28) tillers /plant respectively .The 100 ppm achieved by foliar plant was only ranked third in terms of the high value statistic (2.57) tillers /plant.

The lowest values are for 300 ppm concentrations, which result in (2.49) tillers /plant ,which is slightly different from the control treatment, which is (2.12) tillers /plant. While the preference was among the varieties of *Abaa 95* plant for approximately (2.68) tillers /plant, but *Rasheed* was (2.58) tillers /plant.

Finally, on the effect of the treatments, the third treatment (seed soaking+ foliar plant) is significantly higher than the other treatments at 5% probability level. The top of the transactions with (2.70) value is superior to other transactions that are (2.67 and 2.52) values respectively.

Number of tiller per plant was also appreciably increased by MgONPs which might be due to the activation of photosynthetic enzyme ribulose 1, 5 bisphosphate (RuBP) carboxylase, cell division, and osmoregulator by Mg which in turn promotes new branches and inducts new leaves see Table (4-26) Consistent with the findings of (Jayarambabu *et al.*, 2017 ; Shinde *et al.*, 2020).

Chapter Five

Conclusions & Recommendations

Conclusions

1. The positive impact on wheat plant seed germination, which is most probably due to the release of enzymes responsible for converting the stored compounds into simple compounds ready for the embryo.
2. As a result of the application of MgONPs, the vegetative mass of the plant increased, which was well represented in the fresh and dry weights of the plant. as a consequence, the physiological features of the plant improved.
3. The study found the application of (seed soaking + foliar application) method is the best among the three methods in bringing about good and desired changes.
4. The plant response to the lowest concentration of the four concentrations used, which is 100 ppm, in influencing the improvement of traits, whether vegetative, physiological or productive.
5. The genetic difference is available between the wheat cultivars used in the study, which was evident in the difference in the speed of germination and the values of all vegetative, physiological and productivity traits.
6. The nanoscale composition of magnesium particles has a good effect on the overall vegetative or physiological characteristics, especially the chlorophyll structure , because magnesium which is included in the composition of the chlorophyll structure .

Recommendations

1. Applying MgONPs to other strategic vegetable crops to compare the variances between improvement among all traits. because the techniques are environmentally friendly firstly and secondly, cheap and economically feasible.
2. Studying the second generation by planting seeds of wheat plants treated with magnesium nanoparticles in the new resulting plants.
3. Testing and estimating the level of enzymes to determine the effect of plants as a result of their treatment with MgONPs, and to indicate the increase of enzymes from their natural levels compared to the control treatment.
4. Genetic studying of treated wheat plants, to detect the variance in the genetic structure of treated wheat plants and study the genes responsible for the good quality of flour for bread making and the extent to which their quality characteristics improved.
5. using abaa 95 plant as the best variety for agriculture ,and the concentration 100 ppm concentration of MgONPs with the application seed soaking and foliar application .

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الخلاصة

أجريت التجربة في البيت الزجاجي التابع لجامعة المثنى ، كلية العلوم خلال موسم الزراعي في كانون الاول 2020. هدفت الدراسة لبيان تأثير دقائق المغنيسيوم النانوية بمستويات مختلفة (0, 100, 200, 300) جزء في المليون وبثلاث طرق مختلفة هي (نقع البذور ، رش النبات ، نقع البذور و رش النبات) على النمو والصفات العوامل الفسيولوجية لصنفين من نبات الحنطة *Triticum aestivum* L. وهما اباء 95 ورشيد . نفذت تجربة عامليه وفق التصميم العشوائي الكامل (C.R.D) بثلاث مكررات . تم تحقيق التخليق الحيوي لجسيمات اوكسيد المغنيسيوم النانوية من خلال إجراء تقنية التخليق الحيوي الخضراء و هي تتميز بكونها تقنية بسيطة وجديدة باستخدام مستخلص البصل *Allium cepa* (الأوراق الخضراء) كعامل اختزال طبيعي . تميزت جسيمات اوكسيد المغنيسيوم النانوية MgO NPs المصنعة بيولوجيًا عن طريق التحليل الطيفي للأشعة فوق البنفسجية المرئية ، وانحراف الأشعة السينية (XRD) ، ومسح المجهر الإلكتروني (SEM). وأظهرت النتائج إلى وجود فرق معنوي في جسيمات اوكسيد المغنيسيوم النانوية عند التركيز (100 جزء في المليون) عند استخدامه بطريقة (نقع البذور و رش النبات) مقارنة بالتركيزات الأخرى ، اذ كان تأثير الصنف اباء 95 أكثر تأثيرا من الصنف رشيد في جميع جوانب النمو الخضري مثل (متوسط الإنبات) (6) وسرعة الإنبات (12) و طول النبات (66.33 سم) ، وطول الجذر (57.00) سم ، والوزن الجاف والوزن الرطب لكل من (المجموع الخضري والجذري) اذ ظهرت اعلى نسبة في صنف أباء 95 للفحوصات مثل الكلوروفيل (2.90 ملغم / غم) ، كربوهيدرات (44.42 غم) ، بروتين (8.81 غم) ، مساحة الورقة (31.25 سم²) ، ثباتيه الغشاء (6.33%) ، وزن 100 حبة نباتية (3.86 غم) ، عدد الاشطاء (3.42) بينما كانت أقل النتائج لصالح نبات الرشيد مثل الكلوروفيل (2.49 ملغم / غم) ، الكربوهيدرات (23.73 غم) ، البروتين (4.50 غم) ، مساحة الورقة (12.33 سم²) ، ثباتية الغشاء (13.00%) ، وزن 100 حبة نبات (3.28 غم) ، عدد الاشطاء (2.42) .



جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة المثنى / كلية العلوم
قسم علوم الحياة

تأثير دقائق المغنيسيوم النانوية على الانتبات وبعض المؤشرات الفسلجية لصنفين من الحنطة الناعمة

هذه الرسالة مقدمة كجزء من متطلبات نيل درجة الماجستير
في علوم الحياة

من قبل

هدى سعد دواس

بكالوريوس علوم حياة / ٢٠٠٩

بإشراف

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