Tikrit Journal for Agricultural Sciences (2022) 22 (3):78-83
https://doi.org/10.25130/tjas.22.3.9

IRAQI Academic Scientific Journals
العراقية المجلات الأكاديمية العلمية

ISSN:1813-1646 (Print); 2664-0597 (Online)
*Tikrit Journal for Agricultural Sciences*
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

# Physiology of nano fertilizers in agriculture aspect /

**Mohamed Abdulla Ahmed** *

*Horticulture and Landscape Department, Collage of Agriculture, Tikrit University, Iraq*

**KEY WORDS:**

plant physiology, nano-fertilizers, plant growth, Chemical effect of fertilizer, Nanoparticle Synthesis

**ARTICLE HISTORY:**

**Received**: 19/07/2022

**Accepted**: 27/08/2022

**Available online:** 30/9/2022



## ABSTRACT

With increased demand for traditional agricultural practices, they are increasingly insufficient. The use of nano-fertilizers is essential when aimed to increase plant production. In 2003, nanotechnology started to be used in agriculture and food industry. This led to change in agricultural production systems. Nanotechnology has brought fundamental changes in agriculture. This included new tools have been used to detect plant pests and treat them quickly. Improve plant ability to absorb nutrients and fertilizers was also involved. Agriculture faced many challenges, such as climate change, increase consumption of agricultural products, and reduced cultivated areas. This required promotions in agricultural development to achieve economic and agricultural stability. Hence, the importance of using nanotechnology has emerged. This technology increases the possibility of finding solutions and treatments for many agricultural problems. In addition, dealing with main challenges in agriculture, such as low productivity of cultivated area and large uncultivated land. The loss of fertilizers, pesticides, and plant products are also considered. Such problems can all be faced through several applications, including nano-fertilizer technology. The technology can achieve remarkable addressing in agricultural problems such as reducing lack of nutrients. Facilitate plant response to nano-fertilizers through rapid synthesis during cellular metabolism. This improves agricultural aspect and positively influences community service and, consequently, environmental development.



## INTRODUCTION

### Nanotechnology

Nano-fertilizers are essential in increasing productivity food qualities. Several researchers believe these modern fertilizers will secure world's growing food needs. In addition, they provide range of economic, environmental and health benefits. Nano-fertilizers have proven their importance in agricultural sciences (Mousavi and Rezaei, 2011).

This type of fertilizer is considered the tool helps solving the challenges farmers face. They used in managing technologies by obtaining high-yielding crops and minimizing the use of chemicals (Prasad et al., 2014). Nanotechnology has been described as one of the fastest spreading technologies worldwide, and called the next technological revolution. Nair et al. (2010) explained that nano materials have all properties necessary for use in agriculture. These properties included effective concentration with high solubility, stability and good efficacy, and controllable time of release. They are also less toxic and safe, used in small quantities, and avoid repeated additions to plant which gives good result.

The mechanism of nano-fertilizers action is due to their excellent physical and chemical properties. This is due to their surface area and quantitative effect. The effectiveness of nanoparticles depends

* *Corresponding author: E-mail*: mohmeed.abdullah@tu.edu.iq

on their size. The smaller the size, the higher the ratio of surface area: size. This leads to an increase in the speed of chemical reactions (Guzman et al., 2009). It was found that nanoparticles cause many physiological changes for plants. These changes depend on properties of the particles in terms of chemical composition, size, reactivity and most importantly the effective concentrations (Khodakovskaya et al., 2012).

Aslani et al. (2014) explained that the interaction between nanoparticles and plant cell leads to modification of gene expression. This leads to biological pathways can affect the development and growth of plant. The nanoparticles have unique characteristics to modify the physiochemical properties of plant. These particles cause effect on plant growth varies depending on surface composition, shape, chemical composition, size, concentration, solubility and aggregation. The response of plants to nanoparticles varies according to plant type, growth stage and mineral type. Nanotechnology is one of the essential technologies involved in multiple fields. This technology relies on the synthesis of nanoparticles (NPs) have different properties of minerals they were originated from; various shapes and volume based on the engineering of metal particles (Rao and Gan, 2015)

In recent years, interest has been increased in production of metallic nano materials. They are used in various fields involving biomedical, agricultural, environmental and industrial fields (Singh et al.,2016). The importance of such material is primarily due to their high surface to volume ratio and extremely small size. Consequently, increases their contact surface with other objects (Gahlawat et al., 2016).

Nanoparticles are synthesized in one of two ways; Building from bottom to up. This way relies on engineering nanostructures starting from their ions. It is done by bio-chemical methods and by building nano materials. The other way implies destruction from top to bottom, which done by physical processes such as grinding (Shedbalkar et al., 2014). The term nano, initially taken from the Greek term Nanos, means a dwarf or very small. The unit of measurement is nanometer; one part of a billionth of a meter. That is, every 1 nanometer = $10^{-9}$ meters, or one of millionth of a millimeter.

Nanoparticles are defined as tiny particles with at least one dimension, ranging from 1–100 nanometers (Christian et al. 2008). Nanoparticles are also known as aggregates, molecular or atomic, with small dimensions ranging from 1-100 nanometers. They are possessing several unique properties such as high surface energy and high confinement quantum (Olchowik et al.,2017). The science of nanotechnology is a modern field plays an essential role in various fields. It can be defined as the science that deals with production and processing of materials within nanometer sizes. These one-dimensional particles can be invested in the field of medicine, chemistry, atomic physics and other fields (Shanmugam and Heera, 2015).

Nanoparticles have unique properties in electronic, magnetic and chemical stimulation. They are also characterized by high stability, low reactivity, biocompatibility, and relative lack of toxicity. This makes them widely applied in various fields of biomedicine, such as diagnosis and treatment of cancers, drug industry and delivery of genes. Some metal nanoparticles also possess antiviral, antibacterial and antifungal properties (Vetchinkina et al., 2018).

**Nanoparticle Synthesis Methods**

Nano materials are built by two main mechanisms, which are bottom-up and up-down:

A- Bottom-up: most of the reactions occurred are oxidation and reduction reactions. These include reducing the components of the material to the atomic level. More self-assembly leading to nanostructures is associated. Physical forces work to integrate the basic units into more stable structures. This method is considered the best because of the complete control over the sizes of nanoparticles and the lack of waste products. (Rajeswari and Kalpana,2018).

B - Up to bottom: It is the most expensive method that includes the use of relatively large compounds which can be controlled externally. In other words, it depends on the fragmentation of large solid materials into smaller pieces using a large physical force. This method requires more much energy. It is not possible to obtain ideal surfaces for nanoparticles due to the physical forces used in preparing them (Nadaroğlu et al., 2017: Soni et al., 2018).

In general, there are three basic protocols for constructing nanoparticles:

**Chemical approach**:

Includes colloids, gel-sol and L-B films. These methods are characterized by the following:

- Requires simple techniques
- Inexpensive as it needs less equipment compared to physical methods.
- Less temperatures for manufacturing is enough.
- Quantities of nano materials manufactured by these methods are large.
- Can manufacture nano materials in different sizes and shapes.
- They are safe methods.

**Physical approach:**

An up-down mechanism usually processes this method. The material is reduced to a nano state by physical techniques such as ultra-sonication, microwave irradiation and electrochemical method. In this method, a heating tube at a barometric weight can be used to combine nanoparticles by condensing vaporization. The source element of the nanomaterial is evaporated into a gas by heating inside a float. This method is used in building nanoparticles for gold, silver, lead, cadmium and many other metals (Gour and Jain, 2019).

**Biological approach:**

One of disadvantages of the chemical and physical methods is they are relatively expensive. In addition, the chemical method includes using elements and compounds that may have a toxic and dangerous effect on researchers. Also, some risks are far more dangerous than just on the environment and neighboring living things. Moreover, some physical and chemical mechanisms produce uncontrollable nanoparticles that do not fit the desired shape, size and purity. It is necessary to search for a safer, more accurate and less expensive method (Gudicandula and Maringanti, 2016)

The biological method, also called green method, involves obtaining more homogeneous materials with fewer defects. In this method, nanoparticles can be built by a microorganism such as bacteria, fungi, and algae, and a plant or a plant extract. Several characteristics of the organism such as biochemical pathways, enzymatic activities, cell growth stages, and ideal reactions are important. These are considered to determine the organism or its extract to construct nanoparticles (Hussain et al., 2016). In this way, nanoparticles are produced within normal functions of the organism. Because bacteria are fast-growing, low-cost, and easy to control in their environment, they are the most widely used in the building process. Some bacterial species can block the toxicity of some metals and heavy minerals.

The construction of nano materials can be intracellular or extracellular with enzymes. Farms of eukaryotic organisms that are easy to cultivate with simple biomass such as yeasts and molds are used. Factors such as incubation and metal ion solution affect nanoparticle size (Nadaroğlu et al., 2017).

**properties of Nano materials**

Materials at nano level have new properties and characteristics not presented even in the original materials. There is an inverse correlation between volume of the material and its surface area. The effective surface area increases at the nano level. As a result, strong interactions are stimulated, and number of atoms on the surface is increased. It is known that atoms of any material surfaces are responsible of chemical interaction with the others. These surfaces possess unbound electrons. In contrast, electrons inside the material are bound, therefore, they do not participate in the chemical reaction.

On this basis, materials or nanoparticles acquire new mechanical, optical, electrical and biological properties. For these reasons, the absorbability of plant nutrients increases and resistance to biological stresses improves. In addition, efficiency of nano pesticides and other agricultural chemicals increase and the quantities of materials used are reduced (Owen and Depledge, 2005).

**Physiological role of nano-fertilizers in plants:**

Nano fertilizers play important physiological roles in plant nutrition include:

1-Increasing activity of plant photosynthesis processes (by increasing content of chlorophyll in leaves).

2- Improving plant ability to withstand different abiotic stress conditions.

3-Enhanceing plant ability to resist diseases.

4-Maintaining genetic traits (gene expression) required for different agricultural crops. This expression leads to establish metabolic or physiological pathways.

5- Increasing the active substances in plant.

6- Nano fertilizers are also used to cover traditional fertilizers to facilitate absorption and increase their efficiency.

7-Soaking seeds in nano-fertilizers improve their germination.

Furthermore, some plants can easily absorb nanoparticles. The interaction of plant cell with nanoparticles modifies plant gene expression and biological pathways associated. Ultimately, the growth and development of the plant are influenced (Aslani et al., 2014). Mishra et al. (2017) reported that nanotechnology represents solutions of new agriculture. They expected it to be an environmental power of modern agriculture in nearest future. This integrative approach has an excellent potential to deal with global challenges for safe and sustainable food production.

**Applications of nano-fertilizers in agriculture**:

Nanoparticle technology has many applications in the field of agriculture, including:

1-Th increasing need for agricultural products to secure food for human and animals causes problems to the soil. This can be effectively treated by using nano-fertilizers.

2-The effectiveness of nano-fertilizers has been proven by several studies. It was confirmed the role of this type of fertilizers in improving plant growth and combating agricultural pests.

3- Some types of nutrients also improve growth of some plant seedlings. In addition, they have essential positive effects on many important agricultural crops.

**CONCLUSION**

Based on reviewed, use of nano instead of traditional fertilizers in fertilization programs is effective and successful. This type achieves many advantages in agriculture aspect. The nano-fertilizers are used in less amount, and is considered as carriers of compounds. This increases the ability to control releasing and feeding process. It also increases the plant response to due to easy entry into plant cells. The ability to store this fertilizer for longer periods is higher. That achieve many physiological benefits for plant and positively impact the environment. The economic return for farmers by reducing expenses and increasing profits is highly significant compared to traditional fertilizers.

**REFERENCES**

Aslani, F.; S. Bagheri; N. M. Julkapli; A. Juraimi; F. S. Hashemi and A. Baghdadi. (2014). Effect of engineered nanomaterials on Plant growth: An overview. The Scientific World Journal. 2014: 1-28.

Christian, P., Von der Kammer, F., Baalousha, M. and Hofmann, T. (2008). Nanoparticles: structure, properties, preparation and behavior in environmental media. Ecotoxicology. 17: 326–343 p

Gahlawat, G., S. Shikha, B.S. Chaddha, S.R. Chaudhuri, S. Mayilraj and A.R. Choudhury. (2016). Microbial glycolipoprotein-capped silver nanoparticles as emerging antibacterial agents against cholera. Microbial Cell Factories, 15: 25. https://doi.org/10.1186/s12934-016-0422-x.

Gour, A. and Jain, N. K. (2019). Advances in green synthesis of nanoparticles. Artificial cells, nanomedicine, and biotechnology. 47(1): 844–851 p.

Gudikandula, K. and Maringanti, S. C. (2016). Synthesis of silver nanoparticles by chemical and biological methods and their antimicrobial properties. Journal of experimental nanoscience. 11(9): 714-721 p

Guzman, M.G.; J. Dille, and S. Godet. (2009). Synthesis of silver nanoparticles by chemical reduction method and their anti- bacterial activity. Int. J. Chem. Biomol. Eng., 2(3): 104-111.

Hussain, I., Singh, N. B., Singh, A., Singh, H. and Singh, S. C. (2016). Green synthesis of nanoparticles and its potential application. Biotechnol Lett. 38: 545–560 p.

Khodakovskaya, M.V.; K. Desilva; A.S. Biris; E. Dervishi and H Villa Garcia. (2012). Carbon nanotubes induce growth enhancement of Tobacco cells. ASC Nano. J., 6(3):2128-213.

Mishra, S., Keswani. C. Abhilash, P.C. Fraceto. L.F. and Singh. H.B (2017) and. Integrated approach of agri-nanotechnology. challenges trends. Front. Plant Sci. 8(471): 1-12.

Mousavi, S. and M. Rezaei. (2011). Nanotechnology in agriculture and food production. J. Appl. Environ. Biol. Sci., 1(10):414-419.

Nadaroğlu, H., Güngör, A. A. And İnce, S. (2017). Synthesis of Nanoparticles by Green Synthesis Method. International Journal of Innovative Research and Reviews. 1(1): 6-9 p

Nair, S.H.; Nair, B.G.; Maekawa, T.; Y. Yoshida and Kumar, D. S. (2010). Nanoparticulate material delivery to plants. Plant Science, 179:154-163.

Olchowik , J., Aleksandrowicz -Trzci´ nska , M., Bzdyk , R. M., Studnicki M ., Bederska-Błaszczyk , M ., and Urban , A. (2017) . The Effect of Silver and Copper Nanoparticles on the Condition of English Oak (*Quercus robur* L.) Seedlings in a Container Nursery Experiment. Forests. 8(310): 19 p.

Owen, R., M. Depledge. (2005). Nanotechnology and the environment, risks and rewards. *Mar Pollut Bull*, 50,609-12.

Prasad, R. ; Kumar, V. and Prasad, K., S. (2014). Nanotechnology in sustainable agriculture: Present concerns and future aspects, African Journal of Biotechnology, 13(6):705-713.

Rajeswari, V. D. and Kalpana, V. N. (2018). A Review on Green Synthesis, Biomedical Applications, and Toxicity Studies of ZnO NPs. Bioinorganic Chemistry and Applications. 3569758: 12 p.

Shanmugam, S. and Heera, P. (2015). Nanoparticle Characterization and Application: An Overview. International Journal of Current Microbiology and Applied Sciences. Microbiol. App. Sci.4(8):379- 386 p

Shedbalkar, U., R. Singh, Wadhwani, S. Gaidhani, and B.A. Chopade. (2014). Microbial synthesis of gold nanoparticles: Current status and future prospects. Advances in Colloid and Interface Science, 209: 40-48. https://doi.org/10.1016/j.cis.2013.12.011

Singh, P., Y.-J. Kim, D. Zhang and D.-C. Yang. (2016). Biological synthesis of nanoparticles from plants and microorganisms. Trends in biotechnology, 34: 588– 599.

Soni, M., Mehta, P., Soni, A. and Goswami, G. K. (2018). Green Nanoparticles: Synthesis and Applications. IOSR Journal of Biotechnology and Biochemistry. 4(3): 78-83 p

Vetchinkina, l., Loshchinina, E., Kupryashina, M., Burov, A., Pylaev, T. and Nikitina, V. (2018). Green synthesis of nanoparticles with extracellular and intracellular extracts of basidiomycetes. Peer journal. 6 (5237): 24 p.

# التأثيرات الفسلجية للأسمدة النانوية في نمو النبات

**محمد عبدالله احمد**

قسم البستنة وهندسة الحدائق – كلية الزراعة – جامعة تكريت – صلاح الدين - العراق

**الكلمات المفتاحية:**
فسيولوجيا النبات، الأسمدة النانوية، نمو النبات، التأثير الكيميائي للأسمدة، تصنيع الجسيمات النانوية

**الخلاصة**

باتت ممارسات الزراعة التقليدية غير كافية على نحو متزايد مقترنة بزيادة الطلب عليها اذ يعد استخدام الاسمدة النانوية امرا مهما اذا كان الهدف زيادة الانتاج , ففي عام 2003 بدأت الاستفادة من تكنولوجيا النانو في مجال الزراعة وصناعة الاغذية , مما ادى الى تغيير نظم الانتاج الزراعي وقد احدثت تكنولوجيا النانو تغييرات جذرية في الزراعة حيث تم استخدام ادوات جديدة لمعالجة الآفات النباتية والكشف السريع عنها ونحسين قابلية النبات على امتصاص المغذيات والاسمدة , وواجهت الزراعة العديد من التحديات منها التغير المناخي وزيادة استهلاك المنتجات الزراعية وتقلص المساحة المزروعة مما استوجب ضرورة النهوض بالتنمية الزراعية لتحقيق الاستقرار الاقتصادي والزراعي , ومن هنا اتت اهمية استخدام تكنولوجيا وتقنية النانو والاتي تمكن من استحداث سبل في امكانية ايجاد الحلول والعلاج للعديد من المشكلات الزراعية , هذا بالضافة الى التحديات الرئيسية المرتبطة بمجال الزراعة , ومنها انخفاض الكفاءة الانتاجية في المساحة المزروعة وكبر حجم المساحات غير المزروعة غفدان المخصبات ومبيدات الحشرات وضياع المنتجات النباتية كل هذا يمكن مواجهته من خلال عدة تطبيقات ومنها تقنية الاسمدة النانوية والتي تحقق معدلات انجاز ملحوظة في معالجة المشكلات الزراعية ومنها نقص العناصر الغذائية وسهولة استجابة النبات للأسمدة النانوية من خلال سرعة تمثيلها بالايض الخلوي , للنهوض بالمجال الزراعي الامر الذي يحقق الاثر الايجابي في خدمة المجتمع وتنمية البيئة . وتكنلوجيا النانو تعمل على حل عدة مشكلات منها الركود وانخفاض غلة المحاصيل وانخفاض المواد العضوية ونقص المواد الغذائية وتقلص في الاراضي الصالحة للزراعة وتوفير المياه ومقاومة النباتات للإجهادات والاقتصاد في الاسمدة المستخدمة اذا ما قورنت بالأسمدة الاعتيادية.