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# The Effect of Zinc Oxide Nanoparticles on the Vegetative Characteristics of *Solanum lycopersicum*

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**Received: 12 December 2022** **Accepted: 27 Januart 2023**

**DOI: https://doi.org/10.24237/ASJ.02.01.726A**

## Abstract

This study was conducted in the agricultural nursery / Al-Khalkis from September 2021 to April 2022, the study was carried out with the aim of studying the effect of Nano-zinc oxide on the vegetative characteristics of the *Solanum lycopersicum* plant X-ray and SEM scanning electron microscope.The average particle size of zinc oxide was 23.42 nm. The results indicate that the treatment of 100 mg.$L^{-1}$ gave the highest values for plant height, number of leaves, fresh and dry weight of the vegetative complex and chlorophyll content which reached 27.66 cm, 10.66 leaf $^{1-}$, 25.1 g, 16.3 g SPAD.

**Keywords:** Oxide Zinc, Nanomaterial, *Solanum lycopersicum*, Dry Weight

# تأثير الجزيئات النانوية لأوكسيد الزنك على الخصائص الخضرية لنبات الطماطم

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## الخلاصة

أجريت هذه الدراسة في المشتل الزراعي / الخالص من سبتمبر 2021 إلى أبريل 2022 ، وأجريت الدراسة بهدف دراسة تأثير أوكسيد الزنك النانوي على الخصائص الخضرية لنبات الطماطة وتشير نتائج المسح بالمجهر الإلكتروني ان متوسط حجم جزيئات أوكسيد الزنك كان 23.42 نانومتر. وأشارت النتائج إلى أن معاملة 100 مجم / لتر 1 أعطت أعلى

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قيم لطول النبات ، عدد الأوراق ، الوزن الرطب والجاف للمركب الخضري ومحتوى الكلوروفيل الذي بلغ 27.66 سم ، 10.66 ورقة $^{-1}$ ، 25.1 جم ، 16.3 سباد.

**الكلمات المفتاحية** : أوكسيد الزنك، المواد النانوية، نبات الطماطم، الوزن الجاف.

## Introduction

*Solanum lycopersicum* are a widespread agricultural crop, and one of the world's most consumed vegetables. According to statistics, the tomato crop ranks second in world consumption after potatoes. [1] Regularly, tomato is a perennial plant while for it is considered a self-crossing annual crop when produced for commercial purposes [2,3]. It is regarded as an annual crop and, sown during the warmest time of the year when the temperature between 25 °C to 29 °C .Furthermore, *Solanum lycopersicum* has important nutritional value due to a high content of mineral elements and B-carotene and lycopene pigments the indicator of red color . In addition, tomatoes one of the earliest natural antioxidants and has significant therapeutic proprieties such as, keep the blood vessels healthy and safeguard against scurvy disorders [4] and plays an important role in diet food system because it contains lycopene, vitamins, ascorbic acid, and β-Carotene, calcium [5, 6]. Recent studies confirmed using *Solanum lycopersicum* in terms of their role in the recovery from different types of diseases. This consideration is owing to the presence of carotenoids and especially lycopene, which is an unsaturated allylic compound that performs by lessening cellular maturing and repressing cardiovascular hazard, cancer, and others [7,8].

Nanotechnology could be a quickly advancing innovation that has the potential to usher in a modern period of logical revelation in each field [9]. Nanoparticles (NPs) are unit assets with a unmistakable measurement from 1 to 100 nm and unimaginable auxiliary and physicochemical characteristics due to their chemical, physical, biomedical, and optical properties. Nanoparticles relate with plants, causing an assortment of morphological and physiological changes depending on their properties [10]. The effectiveness of NPS is measured by their physical, chemical composition, estimate, shape, surface, and effective doses [11].

It was detailed that the application of fitting amounts of ZnO NPs to the roots, shoots, and grains of wheat has a capacity to control the plant's development, recognizing that these nanoparticles

are the source of Zn that can in the long run lighten Zn insufficiency in plants [12]. Conversely, the abundance concentration of ZnO-NPs seriously obstructs tomato-root and - shoot development, diminishes the substance of chlorophylls -a and -b, and eventually hampers photosynthetic adequacy and a few other chlorophyll fluorescence parameters [13].

## Materials and Methods

The experiment was conducted in the home garden for a period of 1-11 to 1-4 -2021 in order to study the effect of zinc oxide nanoparticles on the growth of tomato plant.

**Studied Traits**

**1. Preparation of zinc oxide nanoparticles**

Field emitting scanning electron microscope Field Emission Scanning Electron Microscopy (FE-Sem) The The examinations were carried out using a scanning electron microscope at Kashan University / Iran. The scanning electron microscope has a magnification power ranging from 25-250,000 times. The sample is visualized by scanning it with beams of high-energy electrons. The electrons collide with the sample's atoms ,thus producing signals (containing On X-rays, secondary electrons, and light) that includes information about the structure of the surface. Thus, the scanning electron microscope can produce images with a very high analysis of the surface of the sample and show minute details that may reach a size ranging from 1-5 nanometers. Moreover, these microscopic images are three-dimensional, which help to understand the surface structure of the sample (14)

**2. Vegetative Traits**

The chlorophyll content of the leaves ($mg.g^{-1}$) fresh weight 1-4 Chlorophyll was estimated in the laboratories of the College of Science, University of Diyala, where the content of fresh leaves from A, B and total was estimated by taking a known weight of the leaves of soft tomato plants(50), and they were cut into several small pieces by scissors and mashed in a ceramic mortar with the presence of a quantity of acetone 5-10 ml concentration 80% depending on the weight of the sample taken, then separate the filtrate from the sediment using a centrifuge at a

speed of 1600 g for 10 minutes until the color of the precipitate becomes free of green dye, then collect the extract in tubes with a capacity of 10-25 ml covered with opaque paper in order to block the light from The Chlorophyll prevented the dye from oxidizing by light, and the volume was completed by adding acetone. Then the optical density of the filtrate was measured using a shimadzo UV-1700 spectrophotometer at wavelengths of 663.64 nm.

**3. Plant Height (cm)**

The height of all treated plants was measured using the tape measure listed from the soil surface to the top of the plant, and the average was .extracted for eac treatment .

**4. Fresh and Dry Weight of The Vegetative Complex Of The Plant**

The fresh weight of the vegetative mass of the plants in the experimental units was taken and the same plants were dried in an electric oven at 70 °C containing a vacuum until the weight was stable, then the dry weight was calculated using a sensitive scale .

**5. Number of Leaves (leaf. plant$^{-1}$)**

The average number of leaves was calculated for each plant of the experimental unit.

## Results and Discussion

Figure (1) shows the X-ray diffraction patterns for the structure of zinc oxide nanoparticles, as the results in this figure showed that the highest peaks of the diffraction angles are (31.78, 34.42 and 36.26 2θ) Table (1) and that these peaks indicate the nature of the crystal structure of ZnO. These peaks matched the standard values for zinc oxide nanoparticles (JCDPS ZnO) Annex (2) and these results agree with [15].

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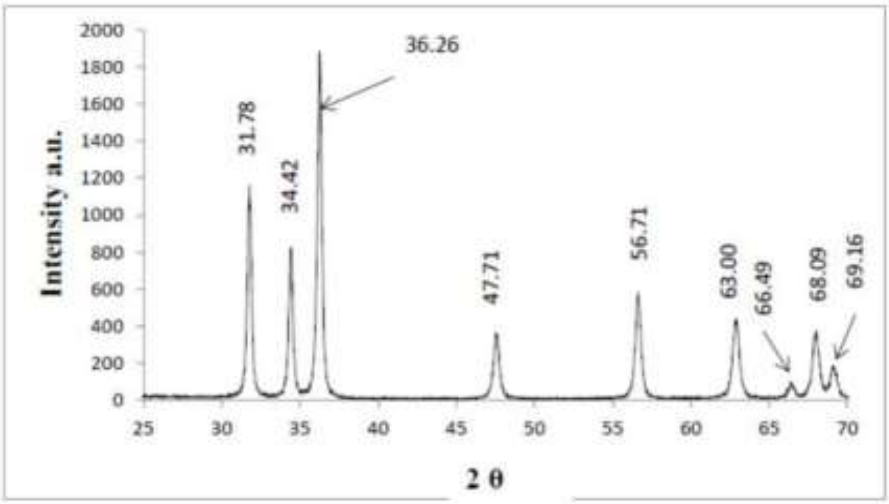


**Figure 1:** XRD patterns of zinc oxide nanoparticles

**Table 1: X-ray diffraction values and average grain size of zinc**

| NO | PEAK POSITION 2Θ (*) | FWHM B SIZE (*) | DP(NM) | DP AVERAGE (NM) |
|---|---|---|---|---|
| 1 | 36.2650 | 0.2706 | 31.058 | 32.52 |
| 2 | 31.7862 | 0.02713 | 30.648 | |
| 3 | 4.4295 | 0.02328 | 35.868 | |

Figure (2) shows that the nanoparticles were prepared in the nanometer range. The FESEM images indicated that some of the nanoparticles were well separated from each other while most of them were present in a lumpy form. This agglomeration is due to electrostatic effects in addition to the aqueous suspended effect, revealing this nanoparticle agglomeration behavior in agreement with [16].

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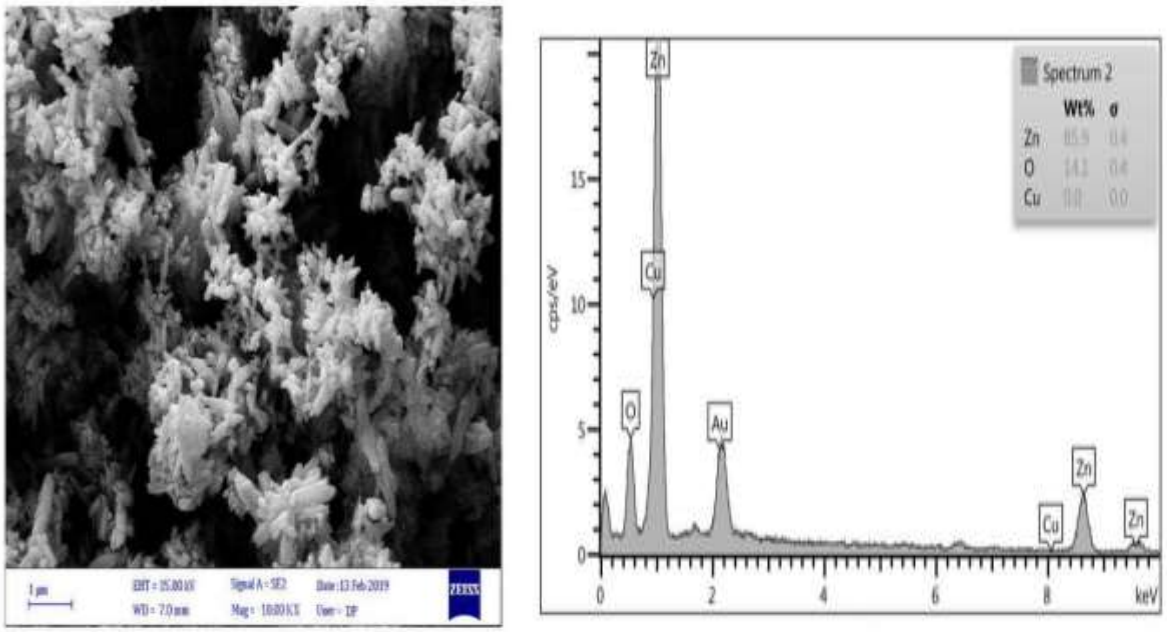


**Figure 2:** FESEM and curve EDX Nano zinc oxide

The results showed that among the three groups of *Solanum lycopersicum* the mean number of leaves was 4.33 ± 0.33, 7.00 ± 0.57, 10.66 ± 1.76 leaves,respectively, while the mean length of stem was (10.66 ± 1.20, 18.00 ± 2.08, 27.66 ± 6.17 cm ,respectively); and mean concentration of chlorophyll was 15.83 ± 2.45, 27.46 ± 0.29,36.10 + 1.55 ml/L, respectively. The results also showed that the difference in the number of leaves and concentration of chlorophyll between the three groups was statistically significant (P = 0.018 and 0.001). In contrast, the difference in stem length was statistically insignificant (P = 0.053). In conclusion, the number of leaves and concentration of chlorophyll increase significantly with an increased concentration of Zinc oxide (Zno) nanoparticles .

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**Table 2**: Shows the number of leaves, length of stem, and concentration of chlorophyll of tomato plants among different concentrations of Zinc oxide (Zno )nanoparticles.

| Groups | | N (9) | Number of leave ( Leave) ( Mean ± SE)* | Lengh of Steram (cm) ( Mean ± SE)* | Chlorophll ( ml/L) ( Mean ± SE)* |
|---|---|---|---|---|---|
| 1-Concentration(0) | | **3** | **4.33±0.33** | **10.66±1.20** | **15.83±2.45** |
| 2- Concentration(50) | | **3** | **7.00±0.57** | **18.00±2.08** | **27.46±0.29** |
| 3.Concentration(100) | | **3** | **10.66±1.76** | **27.66±6.17** | **36.10±1.55** |
| *P*-Value* | **Cos (0) vs cos(50)** | | **0.134** | **0.224** | **0.003** |
| | **Cos (0) vs cos(100)** | | **0.006** | **0.020** | **0.001** |
| | **Cos (50) vs cos(100)** | | **0.055** | **0.124** | **0.011** |
| | **Difference Between Groups** | | **0.018** | **0.053** | **0.001** |
| *P* Value < 0.05 *Values are expressed as median ± standard error | | | | ***One – way ANOVA** | |

**Table 3:** Shows the wet weight and dry weight of tomato plants among different concentrations of Zinc oxide (Zno) nanoparticles .

| Groups | | N (9) | Wet Weight ( ml/L) ( Mean ± SE)* | Dray Weight ( ml/L) ( Mean ± SE)* |
|---|---|---|---|---|
| 1-Concentration(0) | | 3 | 8.80± 2.48 | 5.5± 1.74 |
| 2- Concentration(50) | | 3 | 19.66± 1.32 | 10.56± 1.10 |
| 3.Concentration(100) | | 3 | 35.13± 1.48 | 16.30± 1.65 |
| *P*-Value* | Cos (0) vs cos(50) | | 0.006 | 0.0224 |
| | Cos (0) vs cos(100) | | 0.001 | 0.020 |
| | Cos (50) vs cos(100) | | 0.001 | 0.124 |
| | Difference Between Groups | | 0.001 | 0.007 |
| *P* Value < 0.05 *Values are expressed as median ± standard error | | | | *One – way ANOVA |

The results showed in table 3 that the mean wet weight and dry weight among the three groups of tomato plants was (8.80 ± 2.48, 19.66 ± 1.32 ml/L, 35.13 ± 1.48 ml/L respectively); and mean length of stem was (5.50 ± 1.74, 10.56 ± 1.10, 16.30 ± 1.65 ml/L, respectively). The

results also showed that the difference in the wet weight and dry weight between the three groups was statistically significant (P = 0.001 and 0.007). In conclusion, the wet weight and dry weight increase significantly with an increased concentration of Zinc oxide (Zo) nanoparticles.

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