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The effect of NPK nano-fertilizer on tomato plants *Lycopersicom esculentum* L.

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Abstract

The study was done in a nursery in the Governorate of Najaf to assess the effect of NPK nano-fertilizer on vegetative growth traits and nutrient content in tomato plants.

The experimental design used was a randomized complete block design (RCBD) factorial experiment, where the NPK nano-fertilizer was used at four concentrations: 0, 0.5, 1 and 1.5 g/L. The recommended dose by the manufacturer is the 1 g/l dosage. Three replications were used for each treatment of the experiment.

The means of the treatments were compared by using the least significant difference (LSD) test at 0.05 level of significance. After the experimental period, various plant growth indicators were measured.

The performance of the NPK nano-fertilizer at the concentration of 1 g/L was found to be significantly effective on vegetative growth characteristics with maximum plant height, leaf area and the number of leaves and the fresh and dry weight of leaves.

Keywords : Nano fertilizer , Npk , Tomato plant

I. Introduction

Tomato (Solanum lycopersicum L.), or as it is called in other regions, is an important crop of the Solanaceae family. It is native to warm and temperate areas and is part of the genus Solanum, including potatoes and eggplant, and several other wild plants. The word "tomato" comes from the Aztec language of Central Mexico, from the word tomatl, meaning "swelling fruit. Bandora (some Arabic dialects) comes from the Italian pomodori. Tomatoes are native to South America, but were introduced to other parts of the world after the Spanish conquered the Americas. They are now extensively grown, and frequently grown in greenhouses in order to keep them at the optimum temperature (Abdel-Moneim, 1998).

Tomatoes are used in many ways, raw or as a main ingredient in various dishes, sauces and drinks. It is a vine that grows up to 3 m tall. The stems are thin and weak and it may grow along ground level unless supported. It is an annual in outdoor temperate regions but is also a perennial in its natural habitats. Most of the countries consider tomato as a vegetable, but that is not the right classification according to ScienceBob (Verma, 2007).

Nitrogen is most likely to affect dry matter production and the other important effects (on organic composition, physiological characteristics, biomass synthesis, and plant distribution) are important but less pronounced (Schmierer et al., 2021). Moreover, phosphorus deficiency causes a decrease in leaf area, photosynthesis and carbon metabolism (Chaudhary et al., 2018). Potassium is a cation that controls stomatal opening, osmotic pressure and charge balance. It is also involved in activation of enzymes, maintenance of membrane potential and transport of membrane proteins. Potassium is not bound to organic molecules like nitrogen and phosphorus (Wang & Wu, 2020).

Magnesium is a key nutrient, as important as phosphorus for plant growth. It is used for the following purposes:

Photosynthesis: It is the central atom in chlorophyll molecule, thus it is the main responsible for the photosynthesis process.

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Energy Production: It is involved in the production of ATP and it activates enzymes that catalyse biochemical processes.
Protein Synthesis: It also participates in the synthesis of ribosome, which is the place that synthesizes protein in cells.
Nutrient Transport: It helps the plant to transport sugars from the leaves to the rest of the plant for energy production and growth.

II. Materials and Methods

Randomized Complete Block Design (RCBD) was used in the experiments under investigation in the factorial experiment with two factors and their interactions. The fertilizer concentration used in the factor consisted of four concentrations of the fertilizer (nano NPK) (0 g/L, 0.5 g/L, 1 g/L, and 2 g/L), where the recommended concentration by the fertilizer manufacturer was 1 g/L. Three replicates were performed for each treatment.

The seeds of tomatoes were collected from local areas from the accredited agricultural offices of the governorate of Najaf.

Statistical Analysis of the Laboratory Experiment

The laboratory experiment used two factors and two factors interaction with randomized complete block design (RCBD) with 3 replications per treatment. The significant differences between the means were determined from the least significant difference (RLSD) test at 0.05 level of significance. (Steel et al., 2017).

Studied Characteristics

III. Results

1- Plant Height (cm)

The results showed a significant increase ($P \leq 0.05$) in the height of tomato plants treated with NPK nano-fertilizer compared to the control treatment. The efficiency of the nanoparticles in rapid penetration through leaf stomata and tissues is responsible for this increase, which results in a balanced supply of nitrogen (promoting elongation), phosphorus and potassium to the growing tips. 2- Leaf Area (cm²(

The leaf area of tomato plants was significantly higher for all concentrations used than for control treatments in the statistical analysis. A significant increase in leaf area was seen in conventional fertilization at the highest dose level given in the experiment.

In a similar context, the nano-fertilizer (NPK) showed high efficiency, and all its concentrations showed significant positive differences. The lowest concentration had the highest average leaf area when compared to the other treatments and the control treatment that had the lowest. This shows that nanotechnology does have an efficient performance at low concentration for vegetative growth improvement.

3- Number of Leaves

The results of the statistical analysis showed clear and significant differences in the number of leaves of tomato plants when treated with nano-fertilizer (NPK), with a significant advantage. The low concentration had the highest average number of leaves per plant than the control treatment which had the lowest average number. The outcome of these results shows that nanotechnology is efficient in stimulating vegetative growth and also enhances the plant's leaf mass.

4- Fresh Weight (g)

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The statistical analysis of the results obtained from the study showed that all the fertilizer concentrations used had significant and noticeable effects on the vegetative growth indicators of tomato plants compared with the control treatments. The results of the fertilization with NPK (nano-fertilizer) showed that there was a significant improvement in all the studied indicators. The lowest concentration of the nanoparticles resulted in the best values of leaf area, fresh weight and leaf number compared to other concentrations and the control treatment which had the lowest. The results show the efficiency of nanotechnology in vegetative growth and plant biomass production, while using less quantity of fertilizer than the conventional method of fertilization.

5- Dry Weight (g)

The results of the current study revealed a clear and significant response in the dry weight of tomato plants to all fertilizer treatments used compared to the control treatments. The nano-fertilizer (NPK) demonstrated a clear and significant advantage, with its precise and low concentrations achieving the highest dry weight rates.

g/L 1.5	g/L 1	g/L 0.5	0	**NPK** / **Results**
M 3	M 1.5	C.M 90	C.M 75	**Plant Height**
C.M 4	C.M 3	C.M 2.5	C.M 2	**Number of Leaves**
g 25	g 19	g 12	g 7	**Fresh Weight**
g 5	g 4	g 2	g 1	**Dry Weight**
100	85	75	60	**Number of Leaves**

A table showing the results of farms using fertilizer **NPK**

The table below presents the details of the obtained results, where the statistical data clearly indicate the positive impact of nanotechnology on the physiological efficiency of the plant. The most significant conclusions derived from them can be summarized as follows:-

1- Nano-Fertilizer Superiority "The results demonstrate a consistent superiority of Nano-NPK (represented by the green bars) across all growth indicators, including plant height, leaf area, leaf number, and biomass weight, compared to conventional fertilization and control treatments.

2- Concentration Efficiency: The data indicates that low concentrations of nano-fertilizer achieved the highest biological response. This shows the efficiency of nanoparticles in reaching the leaf stomata and tissues to enable optimum nutrient uptake even at lower concentrations.

3- Significant difference in 'Dry Weight' was seen between the plants treated with nano and those with conventional fertilizer, hence biomass accumulation was observed. This has proven to be effective in triggering important processes and improving the plant's tissue development, confirming the usefulness of nanotechnology in this regard.

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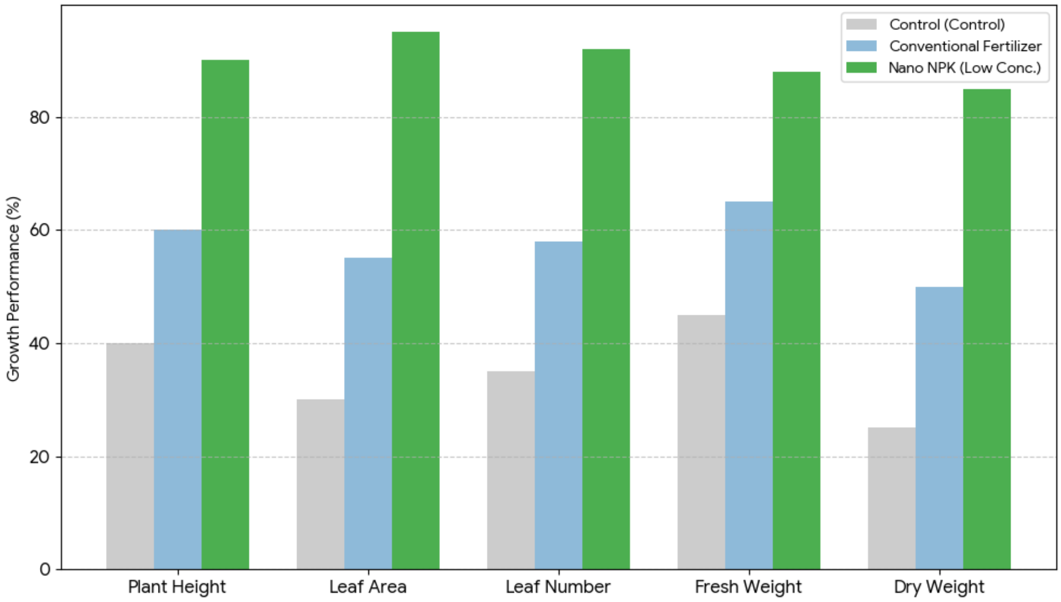

Impact of Nano-NPK on Tomato Growth Indicators

IV. Discussion

In addition to the synergistic effect caused by the interaction between vegetative growth indicators, the results of the current study showed a significant tangible response in all vegetative growth indicators of tomato plants as a result of using nano-NPK fertilizer compared to the control plants. This was clearly observed in the fresh and dry weight biomass productivity, number of leaves, leaf area and plant height.

The results indicate that the significant increase in vegetative growth indicators obtained with the use of nano-NPK fertilizer is due to its vital role in activating cellular functions. It helps to activate enzymes and improves photosynthesis and carbohydrate metabolism. It also stimulates enzyme action and is an important part of energy transfer reaction and carbohydrate metabolism, thereby influencing the growth, height, size and weight. The results are similar to those of Ilyas et al. (2014), Ayyub et al. (2019), Kasinath et al. (2020), Janet et al. (2016), and ELHadidi et al. (2017) who found significant increase in vegetative growth characteristics.

The study also showed the significant effect of potassium supplementation on the increase of total chlorophyll content, which supports the results obtained by Al-Tamimi (2019) where potassium supplementation resulted in a significant increase in the total chlorophyll content. This could be due to the fact that potassium activates a number of enzymes, which are involved in different physiological processes like synthetase, oxidoreductase, dehydrogenase, transport enzymes, and release of energy kinases to name a few besides its participation in chlorophyll formation and synthesis.

There are also many other critical processes in plants under the influence of potassium that affect the production and transport of carbohydrates (Ceylan et al., 2016). Sugars are transported long distance from their site of production (leaves) to other parts of the plant through the phloem and this is greatly influenced by potassium availability (Ba et al., 2020.(

Numerous studies have suggested that nutrient spraying can help to improve the antioxidant system in plants and mitigate environmental stresses to which they are exposed, including drought stress (Ahmad et al., 2018), heat stress (Siddiqui et al., 2018), soil acid stress (Kibria et al., 2021) and high temperatures (Boaretto et al., 2020). During drought, the amount of energy used in photosynthesis centers is reduced (Flexas et al., 2020).

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In a study by Ali (2019) on the effect of foliar spraying, the results showed a significant increase in the height of pepper plants at a concentration of 3000 ppm, reaching 72.00 cm. The chlorophyll content also increased to 24.85% and 23.56% at concentrations of 2000 and 3000 ppm, respectively, compared to 16.71% in the control treatment.

Other studies have also shown that foliar spraying improves growth characteristics and yield. For example, a 4% concentration in tomato plants resulted in a significant increase of 85.68 cm (Ilyas et al., 2014). In a study by Saasia and Al-Amri (2018) on potato plants, spraying with a concentration of 1000 mg/L increased the number of leaves to 40.04 leaves/plant compared to 37.26 leaves/plant in the control treatment. Leaf area also increased to 3.13 dm^2 compared to 2.81 dm^2, and chlorophyll content rose to 483.77 mg compared to 455.32 mg in the control.

Ciecko et al. (2022) indicated that spraying potatoes significantly increased the nitrogen content in tubers at a concentration of 7.5 kg/ha. Similarly, a study by Orlovius and McHou (2020) showed that fertilization significantly increased potato yield by 60 kg/ha.

V. Conclusions:

:The current study leads us to the following conclusions

Tomato plants treated without fertilization showed the lowest resu The 2 g/L treating tomato plants, as evidenced by its improvement in most plant characteristics.

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