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# The Nano Silver Molecules Enhancing the Trinitrotoluene Phytoremediation Using Potato Crop

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**Abstract.** Phytoremediation represents a great technique that uses green plants in the partial analysis of explosive compounds existing in soil via a variety of biochemical properties in plants to help manipulate contamination. The study was done to determine the effect of using nanosilver molecules and toluene concentrations for botanic manipulation and how to influence physiological growth characters of potato. A field experiment was done in the woody roof shade of Gardening and Farming Dept., Agriculture College, University of Anbar for the spring season 2021 on potato crop, and the study included the botanic manipulation review in different levels of trinitrotoluene and different concentrations of nanosilver molecules on some physiological properties, using simple experiments (mixes of TNT and nanosilver molecules) within the randomized complete block design in three replications as 30 experimental units. results revealed that 500 mg TNT kg<sup>-1</sup> soil + 500 mg NPs kg<sup>-1</sup> dominated in total nitrogen, phosphorus and potassium percentage in averages 1.92% , 0.58% , 1.85% successively, compared with the control treatment which was noticed in in chlorophyll A, B and total chlorophyll estimation, that successively scored (45.76, 27.13, 87.50 mg/100g) to the scores of control treatment (35.70 , 20.83 , 71.50 mg/100g). from the study, we conclude that the treatment at level (500\*500 TNT-NP<sub>s</sub>) has a positive effect on physiological properties of the studied potato.

**Keywords.** Potato, Phytoremediation, Nanosilver molecules.

## 1. Introduction

Agronomists and horticulturists face many challenges in the correct detection of plant growth and proper productivity limiting agents and working to provide them in the safe way and relying on modern technologies that achieve environmental balance and eliminate the environmental components contamination, especially in soil like the residual pesticides, chemical and military materials and the likes [1]. Potato crop is a vegetable that belongs to potato crop is a vegetable that belongs to family Solanaceae, considered essential and most consumed vegetable crop to main tuber crops [2]. Potato possessed a main role in the economic and nutritional system via providing appropriate food where it participates with other strategic crops to cover the increasing consumers requests [3] especially in European and African countries. Where, It's considered as a basic source of energy for containing benefiting nutrient, rich with amino acids which are 18 of 20 amino acids, essential and necessary for human [4].



Trinitrotoluene is contaminator that greatly exists in industrial locations and cities that underwent military operations. Primary operations were used like soil burn to eliminate this material; but this technique is regarded contaminating to environment as well as being costly, therefore, it's been replaced with a safer and cheaper technique, that is bio-manipulation of contaminated soils [5]. It is possible to overcome the contaminators toxicity via pollinating plants with bacteria capable of food assimilation where there's bacteria that can convert TNT to initial and secondary amino metabolites, which are less toxic than TNT [6] to quickly combine with organic materials and so reduce their bio-existence; this bacterial transform from TNT to amino metabolites also functions protecting plants from this material toxicity [7]. Nanotechnology is regarded a great and invented method to develop the agricultural fact and food production, and for the various ways to prepare nanosilver molecules, it was easy to use this technique beside being used in the genetically modified plants and to produce agricultural chemical products [8]. Scholars look forward to obtain safer methods to prepare nanosilver molecules. The safest method is using plant extracts or seeds to prepare nanosilver molecules; so, many scientists have used the plant substances like neem plant [9] and cactuses [10]. Phytoremediation is one of active invented technologies as cost, where the plants are being used to clean a wide range of ambient organic and inorganic pollutants [11]. Botanic manipulation includes many basic operations like the botanic transform that means transforming the organic contaminators to a less toxic, or less mobile and more stable form, and the botanic lysis or analyzing the organic contaminators via plant enzymes and plant volatility or organic contaminators volatility through the plant leaves, in addition to root group therapy in the area close to soil surface [12]. All the botanic therapy operations could be affected with the microorganisms attached to a plant; so, both microorganisms attached to roots and the plants could have a role in manipulation via reducing contaminators to support plant growth; so, the plants face less stresses than the contaminators pass through. As a result, these operations could decrease plant toxicity, increase growth and raise the possibility of botanic manipulation [13]. In a study of [14], it's found that the effect of nanosilver molecules on chlorophyll and NPK content increase. The study also stated that nanosilver molecules are environmentally safe within the concentrations.

## 2. Materials and Methods

### 2.1. Experiment Layout

The experiment was laid out during spring season 2021 in lath house of Garden architecture department in the College of Agriculture / Al- Anbar University. The farm was prepared and weeds removed and soil was wrapped with polyethylene to prohibit weeds germination. Then, potato Class Burren of elite order on 01 Jan 2021 in anvils with diameter and height 30 \* 50cm. treatment were divided into three replications as 30 anvils a replication. TNT was then added to all the treatments according to the required levels on 15 March 2021. After that, nanosilver particles were added on 01 April 2021 on the basis of the prepared concentrations. The crop service operations like irrigation, hoeing and weeding in the growth season and used the design (Randomized Complete Block Design RCBD) to add TNT material with nanosilver particles to the plant root system according to treatment. Measurement were taken as follows: : total nitrogen%, total phosphorus%, total potassium %, chlorophyll A, chlorophyll B and total chlorophyll. They were prepared according to the way the resolve in acetone [15].

### 2.2. Nanosilver Molecules

The nanosilver particles were prepared via plant extract of *Cupressus* leaves in the lab of Sciences College / Al- Anbar University. Tree leaves have been collected from a public garden. A quantity of leaves was taken and washed with distil water to be left drying for 24 hour on a thermal drying machine under 45°C degree temperature. 4 grams of dry leaves was mixed with 100ml distil water and the mix was taken to a flask and put on magnetic stirrer for 60 minutes. After that, the mix was put in a centrifuge at 3000rpm, then the solution was filtered and the extract became ready. To prepare nanosilver molecules, 0.79g of silver nitrate was taken and resolved in 250ml distilled water to obtain silver solution in 2000ppm concentration. After that, different concentrations were made, where

100ppm was prepared via taking 5ml of prepared silver nitrate solution, to which, 5ml plant extract was added and then transmitted to magnetic stirrer with continuous stirring and heating on  $35\pm 5^{\circ}\text{C}$  for 15 minutes. This operation was repeated for two solutions of silver nitrate (500 -1000 ppm). Then, the optical features of the prepared solutions using the UV/visible rays photometer for the wavelengths 350-650 nm to determine the structure of nanosilver molecules.

The study treatment included:

T1 control treatment, T2 100 mg kg<sup>-1</sup> TNT soil, T3 100 mg kg<sup>-1</sup> TNT soil + 100 mg kg<sup>-1</sup> NPs, T4 100 mg kg<sup>-1</sup> TNT soil + 500 mg kg<sup>-1</sup> NPs, T5 100 mg kg<sup>-1</sup> TNT soil + 1000 mg kg<sup>-1</sup> NPs, T6 500 mg kg<sup>-1</sup> TNT soil, T7 500 mg kg<sup>-1</sup> TNT soil + 100 mg kg<sup>-1</sup> NPs, T8 500 mg kg<sup>-1</sup> TNT soil + 500 mg kg<sup>-1</sup> NPs and T9 500 mg kg<sup>-1</sup> TNT soil + 1000 mg kg<sup>-1</sup> NPs.

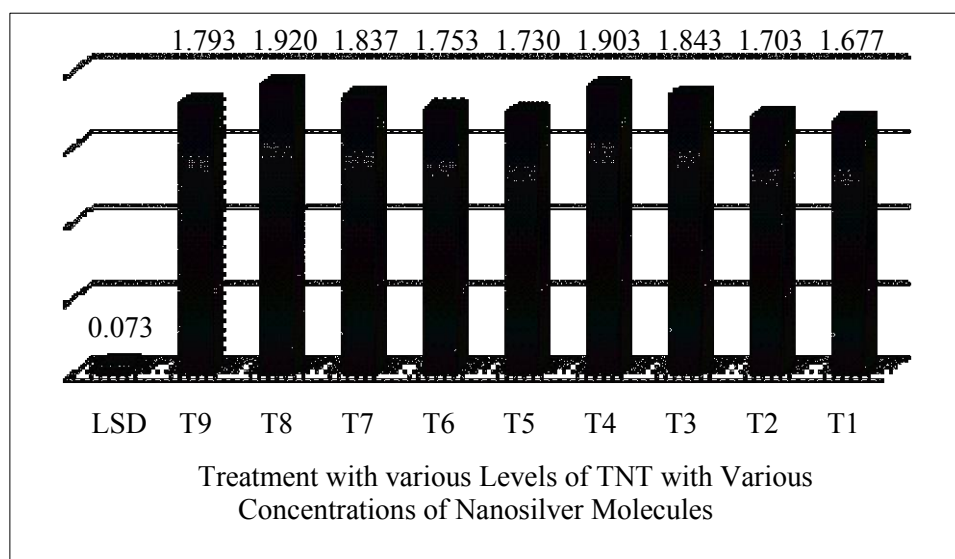
### 2.3. Statistical Analysis

Used the design (Randomized Complete Block Design RCBD) and the means were compared according to L.S.D test at probability level 5%[16] .

## 3. Results and Discussion

### 3.1. Leaves Nitrogen Percentage

It's clear from fig. (1) results the existence of significant differences among treatments, where the treatment T8 (500 ml/kg TNT soil + 500 mg/kg NPs) dominated to give the maximum content 1.92%, in comparison with the control treatment that scored 1.67%.



**Figure 1.** Nitrogen Content % in Leaves of Potato Crop.

Figure (2) results showed significant differences among the levels of TNT treatment with nanosilver molecules in phosphorus percentage, where the treatment at level 500 ml/kg TNT soil + 500 mg/kg NPs gave maximum phosphorus percentage as 0.58%, while the control treatment has given a minimum level 0.45%, followed by treatment T4 that scored a high phosphorus percentage 0.56%, compared with the control treatment.

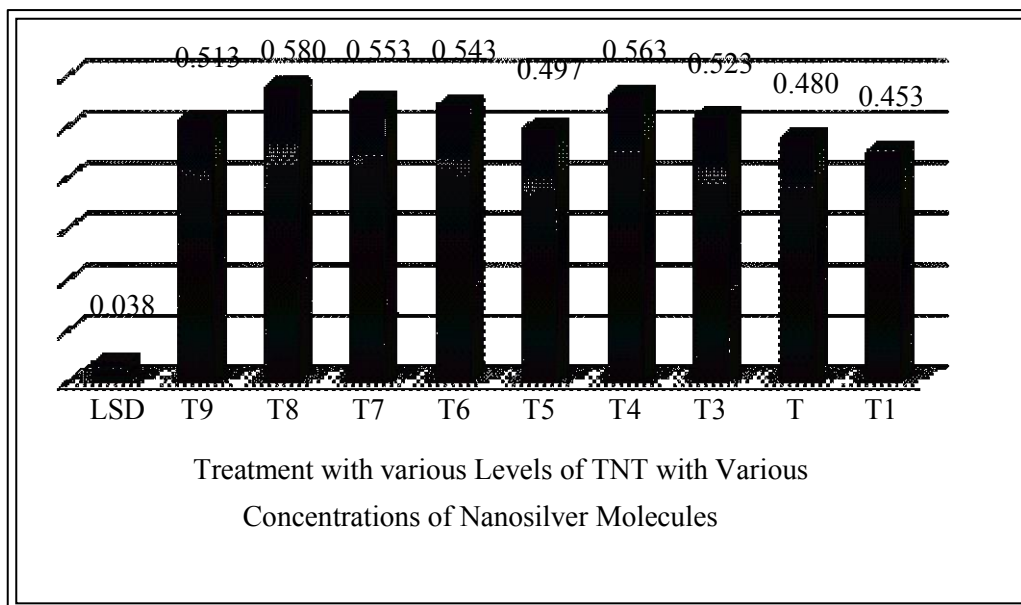


Figure 2. Phosphorus Content % in Potato Leaves.

3.2. Leaves Potassium Percentage

It's noticed from fig.(3) results that significant differences exist among treatments where the T8 treatment exceeded the other treatments, to give maximum potassium percentage as 1.85%, then the T4 treatment which scored 1.83% and the T7 treatment which gave 1.81%, compared with the control treatment T1 which scored minimum percentage 1.64%.

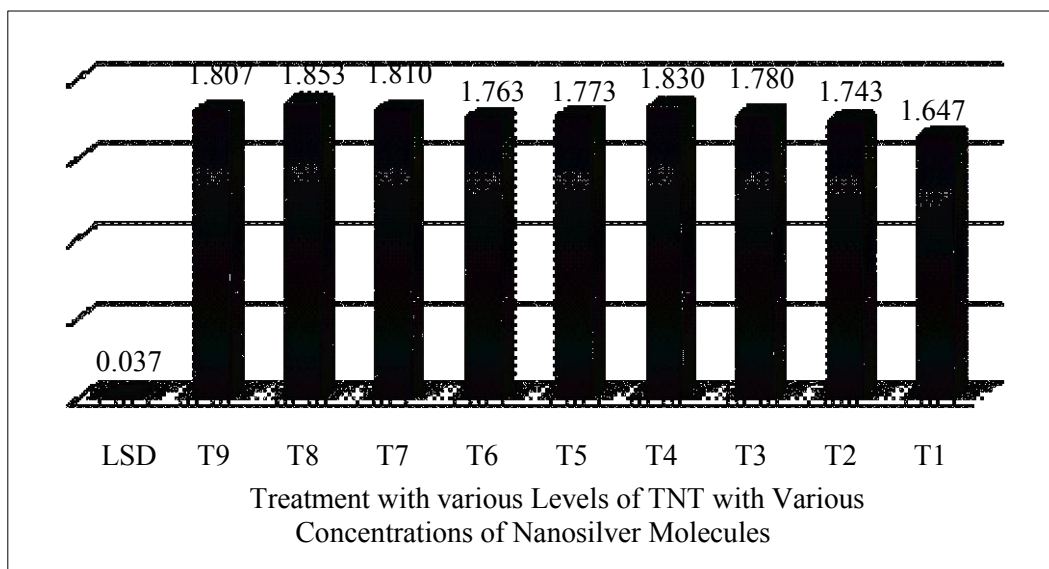
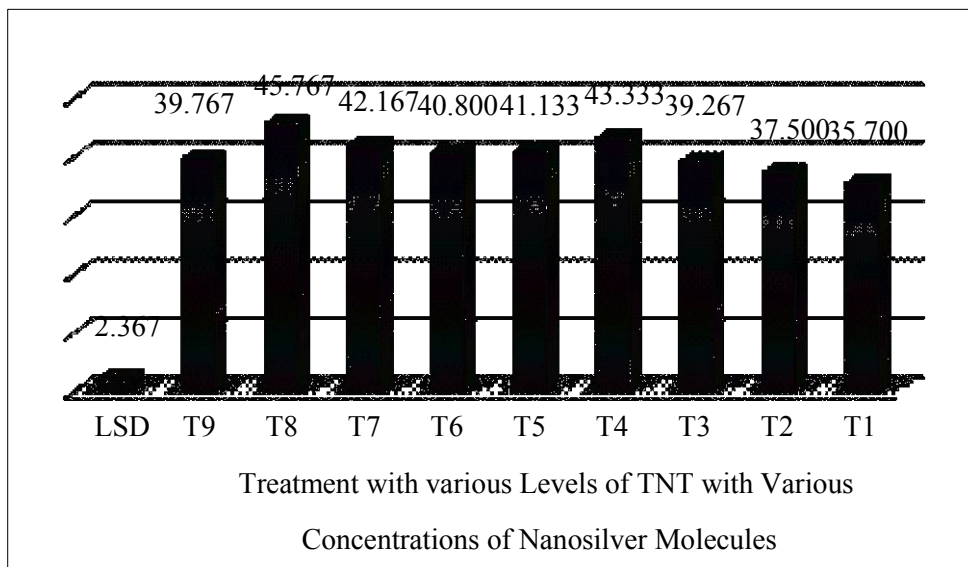


Figure 3. Potato Leaves Potassium Percentage.

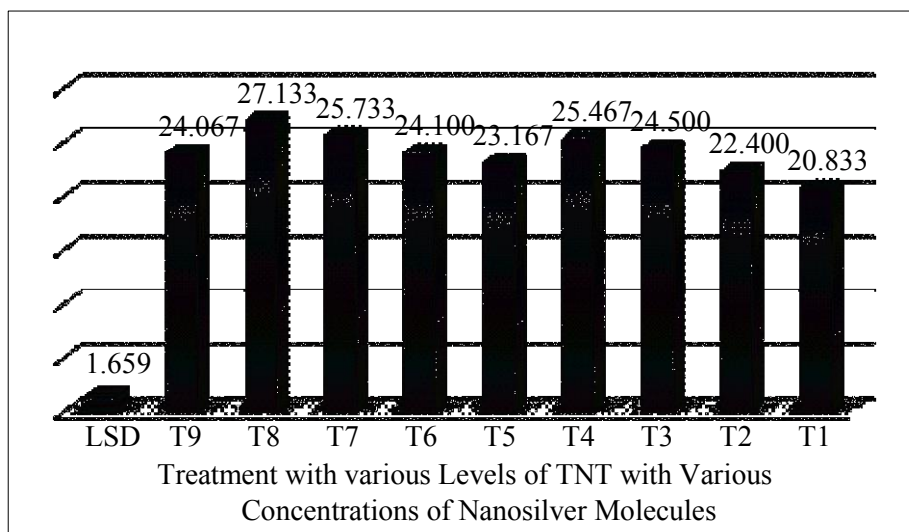
3.3. Chlorophyll A Content (mg.g<sup>-1</sup>) in Plants

Figure (4) shows the superiority of treatment T8 exceeded the other treatments in its chlorophyll A content to reach 45.76 mg.g<sup>-1</sup>, followed by treatment T4, T7, T5 and T6, to achieve (33 , 42.76 , 41.13 , 40.80 mg.g<sup>-1</sup>), compared with the control treatment that scored 35.70 mg.g<sup>-1</sup>.



**Figure 4.** Chlorophyll A Content (mg.g<sup>-1</sup>) in Plants.

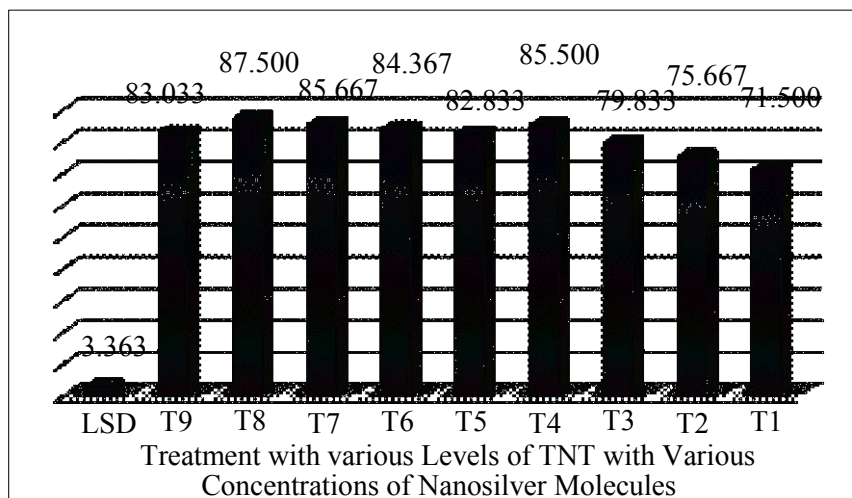
Figure (5) refers to the presence of significant differences among treatments; so, T8 treatment achieved a highest chlorophyll B content that reached 27.13 mg.g<sup>-1</sup>, compared with the control treatment that scored 20.83 mg.g<sup>-1</sup>.



**Figure 5.** Chlorophyll B Content (mg.g<sup>-1</sup>) in Plants.

Figure (6) results state the superiority of treatment T8 on the other treatments to give the highest total content 87.50 mg.g<sup>-1</sup>, followed by treatment T7 that scored 85.66 mg.g<sup>-1</sup>, while the treatment T4 has made a high content 85.50 mg.g<sup>-1</sup> in comparison with control treatment that made 71.50 mg.g<sup>-1</sup>.





**Figure 6.** Total Chlorophyll Content (mg.g<sup>-1</sup>).

The wide use of additional concentrations to nanosilver molecules reflect their positive effect ability in the microbial environmental system that hugely duplicated the nitrification process that functions increasing nitrogen, phosphorus and potassium in leaves [16]. It may also be attributed to the fact that the added silver nanoparticles led to an increase in the readiness of the level of nutrients in the soil, especially the major ones (NPK) because they replaced their equivalent ions in the soil, which results in the release of some important ions for plant growth. Also [17] in his study found that silver nanoparticles do not have any effects, neither on the used plants nor in the environment, which led to an improvement in seedling emergence, plant growth parameters, soil revitalization in the vicinity of the plant and the major elements in the soil. The reason for the increase in chlorophyll a and b and the total content of chlorophyll is due to the increase in nitrogen content Figure 1 by adding silver nanoparticles, as these particles stimulate or activate the growth characteristics of the plant by affecting the chloroplasts and increasing the content of chlorophyll and increasing the rate of photosynthesis, which is reflected on the increase in the content of chlorophyll in plant tissues exposed to silver nanoparticles, it was noted from this study a linear increase in the content of chloroplasts with a noticeable increase in the activity level of enzymes that help in the photosynthesis process, which was reflected on plant growth and increase in physiological growth indicators accordingly, and that the increase of chlorophyll a is a result of an increase in the nitrogen content was consistent with what was found [14]. Silver nanoparticles may contribute to improving some growth parameters and development of potato plants, if silver nanoparticles may turn into silver ions, which act like silver nitrate [18], as silver nanoparticles contributed to increasing the leaf area, which was reflected on other physiological growth characteristics. Also, the improvement of some physiological characteristics may be attributed to improving the effectiveness of some enzymes such as alpha-amylase, dehydrogenase, SOD enzyme, CAT enzyme and the plant's content of soluble sugars [19], which reduced the oxidative stress in the plant. Moreover, silver ions interact with hydrosulfate (SH<sup>-</sup>) and a group of proteins with DNA bases, which leads to inhibition of respiration processes or DNA disassembly. Occurrence as a specific surface area of nanoparticles, as by increasing their biological activity, the surface energy can increase accordingly [20]. Also, the increase in chlorophyll and ions in the study may be attributed to the ability to tolerate TNT toxicity, and this is consistent with what was found by [21] in the tobacco plant. It may also be attributed to the fact that the plant secretions may contribute to the transformation of this compound into less toxic compounds in the plant due to the addition of silver nanoparticles, and this may be a means of neutralizing the toxicity of this compound. Soil by 80%, which led to a reduction of its composition in the soil. Which causes an increase in the biomass of the plant, as this compound enters the metabolism of the amino group in

this compound, which leads to an increase of ions inside the cells due to the increased activity in them, and that TNT metabolism processes can lead to the production of amine group compounds that interact with humic compounds [22]. In another study, adding the solution containing TNT had a high ability and great ability to absorb by the plant, which quickly absorbed much higher concentrations, and this was observed through the detoxification pathways of TNT, so it works to reduce nitro through the reductive equations of nicotinamide coenzymes [23]. By reducing the cells with a toxic effect to the membranes involved in the transfer of reductants (endoplasmic reticulum, mitochondria, chloroplasts) that metabolize TNT, which positively affected the biological activities of the vegetative growth indicators under study [24]. On the other hand, TNT concentrations made the plant ability to reduce the consumption of each of the nicotinamide enzymes in the presence of hydrogen nitroreductase in limiting the stabilization of TNT transformation by an electron acceptor potassium ferricyanide, which works to convert NADPH-cytochrome-P450 reduction rates, which increased the plant's resistance to the effects. The negativity of TNT compounds is accompanied by the characteristics of vegetative growth as well as the percentage of dry matter in the plant and dry weight.

### Conclusion

Trinitrotoluene treatment was very effective to improve growth characteristics. It could be derived that the treatment at level (500\*500 TNT-NP<sub>s</sub>) possessed a positive effect on potato vegetative growth characters thereby potato plants reduced this toxic nitrogenous compound.

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