Journal of Plant Protection and Pathology

Journal homepage & Available online at: www.jppp.journals.ekb.eg

Impact of Pesticides and Wild Plant Nano Silver Extracts on Soil Enzymes Activities as an Indicator of Soil Fertility

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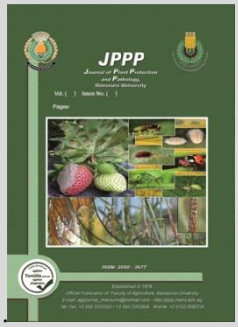

ABSTRACT

The study's goal was to assess the toxicity of Oxamyl, Abamectin, fenamiphos, cadusafos, *Datura stramonium* AgNPs , *Azadirachta indica* AgNPs, *Nerium oleander* AgNPs, *Citrullus coloroynthis* AgNPs produced in an environmentally friendly manner by combining an aqueous extract of the appropriate salt (sliver nitrate) with enzymes that serve as markers of soil fertility and poulution in tomato plants (*Lycopersicon esculentum*). Results showed the insecticides and the nanoparticles extracts in order of decreasing *Meloidogyne incognita* in tomato plants were Oxamyl > Abamectin > fenamiphos > cadusafos > *D. stramonium* AgNPs > *A. indica* AgNPs > *N. oleander* AgNPs > *C. coloroynthis* AgNPs. The activity of the enzymes was unaffected by *D. stramonium* AgNPs , *A. indica* AgNPs, *N. oleander* AgNPs and *C. coloroynthis* AgNPs applied on tomato plants. Plant extracts' nano silver particles may serve as a starting point for an effective biopesticide formulation. The concentration of available nitrogen, phosphoruse and potassium in the soil increased with the increase in the concentration of the urease, phosphatase and dehydrogenase enzymes is soil, respectivally. As a result, urease, phosphatase and dehydrogenases activity have been regarded as a more trustworthy gauge for the early assessment of quality changes brought on by soil management. also easurements of enzymatic activity can be utilised as biochemical markers of soil quality.

***Keywords*:** Nano silver particles, Pesticides, Enzymes,Tomato, Soil fertility

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.), one of the most significant vegetables in Egypt, is grown on the largest area comparing with any vegetable crop worldwide. Egypt is one of the countries with the largest acreage of tomatoes farmed by exporters and producers. Approximately 6.6 million tons of tomatoes were produced overall. (Anonymous, 2023). Enzymes produced by soil microbes catalyze a wide range of biochemical processes that result in the breakdown, N fixation, as well as the recycling of nutrients from organic matter, and nitrification (Balezentiene 2012). Human activities such as the use of metal nanoparticles (MNPs), and the impacts of global climate change can significantly affect soil microbial communities, Fernández *et a.,l* 2024. Pesticides are also impact soil enzymes, which are essential catalysts ruling the quality of soil life. Permethrin and cypermethrin were found to stimulate the multiplication of cultured organotrophic bacteria and actinomycetes, and to inhibit fungi growth (on average by 31.7%) and the enzymatic activity of the soil, reducing the soil biochemical fertility index (BA) by 27.7% (Borowik 2023). The impact of pesticides on dehydrogenase activity has been widely reported. Pesticides generally appear to have an adverse effect on dehydrogenase activity (Wassila Riah *et al*., 2014). Yan et al. 2011, shown either unchanged or decreasing phosphatase activity following various pesticide applications .

Urease and phosphatase, two soil enzymes, are essential for the cycling of N and P, respectively. Due to its function in the manufacture of essential components including chlorophyll, amino acids, and nucleic acids, nitrogen (N) is a key macronutrient for plant growth and development (Fu *et. al.*, 2020). The findings showed that urease activity is a good indication of the soil's nitrogen level. Nitrogen stress may be indicated by high urease activity. Urease activity increases when NH_4-N is more volatilized (Uzoma *et al.*, 2019). Metalloenzyme called urease breakdown of urea into CO_2 and ammonia, which can then be volatilized or converted by microbial nitrifiers into nitrate. On the other side, urease inhibitors can restrict the rate at which urea is converted to ammonia, potentially increasing the effectiveness with which N fertilizer is used and lowering gaseous losses. (Silva *et al.*, 2017 and Fu *et. al.*, 2020). The hydrolysis of urea by urease releases ammonia that can be utilized by crops and is one of the most active hydrolytic enzymes in the soil. Urease also plays a significant part in the N cycle. Because it can be utilized as a crucial indicator to assess soil organic matter and N-applied and more immediately respond to environmental change and agricultural management, so, soil urease is given increasing attention (Sun *et al.*, 2015). Urea fertilizers start to break down into ammonia gas thanks to an enzyme called urease. If this conversion occurs below the soil's surface, ammonia is transformed to NH_4-N, which is attached to soil particles, virtually instantly. Ammonia gas may escape back into the atmosphere through a process known as ammonia volatilization if conversion occurs on the soil surface or on surface residue. Volatilization losses are influenced by the surrounding environment at the moment of application. If

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DOI: 10.21608/jppp.2025.342790.1292

fertilizer is used along with a urease inhibitor, this loss can be significantly decreased (Uzoma *et al.,* 2019). One of the elements that limits plant growth is phosphorus (P), and in surface soil organic P may make up 20–80% of the total P (Turner and Haygarth 2005 ; Sinegani and Sharifi, 2007; Redel et al. 2007). After being hydrolyzed into orthophosphate by phosphatases in the soil, phosphorus is made available to plants. so, soil phosphatase activities have a significant impact on the bioavailability of organic P (Wang *et al.,* 2011). phosphatases often catalyse P through orthophosphate esters and anhydrides , also Phosphates are essential for the biochemical mineralization of organic phosphorus bonds. (Nannipieri *et al.,* 2011). According to several reviews, phosphatases have been extensively investigated in soil because they catalyze the hydrolysis of ester-phosphate linkages, releasing phosphate (P), which can be assimilated by plants or microbes (Halstead and McKercher, 1975 and Quiquampoix and Mousain, 2005). An essential stage in the biological oxidation of soil organic matter is the transfer of hydrogen from organic substrates to inorganic acceptors by dehydrogenases. (Zhang *et al.,* 2010). Dehydrogenases are a microbiological redox system indicator that can be used to monitor microbiological oxidative activity on soil (Subhani *et al.,* 2011). As a result, phosphatase and urease activity regarded as a more trustworthy gauge for the early assessment of quality alterations brought on by soil act Adetunji *et al.,* 2020). Alos, According to Piotrowska *et al.,* (2011) measurements of enzymatic activity can be utilised as biochemical markers of soil quality.

Thus, the current study could be helpful in providing some information in this field, which could aid in the implementation of an effective management program to lessen the anticipated harm caused by this harmful insect in tomato plants and to determine the adverse effects of insecticidal treatments on soil enzymes. The current study's objective was to evaluate the toxicity of Oxamyl, Abamectin, fenamiphos, cadusafos, *Datura stramonium* AgNPs, *Azadirachta indica* AgNPs, *Nerium oleander* AgNPs and *Citrullus coloroynthis* AgNPs in soil of tomato fields during 2021/2022 and 2022/2023 seasons.

MATERIALS AND METHODS

Tested insecticides and silver nanoparticles extracts

This study was conducted at the experimental farm of the Faculty of Agriculture, South Valley University, Qena, Egypt. A 20-liter backpack sprayer with a single nozzle was used to apply each of the investigated compounds (Table 1) as a foliar and soil treatment.

Table 1.Tested insecticides and silver nanoparticles extracts.

Copounds	Active ingridients	Rate/Fed.
Nasr Oxyme 24% SL	Oxamyl	3 L/200 L.w
Terfego 2% SC	Abamectin	2.5 L/200 L.w
Dento 40% EC	fenamiphos	3 L/200 L.w
Ragbe 20% CS	cadusafos	1.5 L/200 L.w
Datura stramonium AgNPs	Atropine and Datorin , muscoplamine	1 L/200 L.w
Azadirachta indica AgNPs	Azadirachtin	1 L/200 L.w
Nerium oleander AgNPs	oleandrin and oleandrigenin	1 L/200 L.w
Citrullus coloroynthis AgNPs	Cucarbetacins and Glucosides, aglycones	1 L/200 L.w

The compounds were diluted with water at a rate of 200 liters of spray liquid per feddan, and two sprays were performed (2021/2022 and 2022/2023 seasons). Water was the sole spray applied to the control plots. Additionally, every effort was made to prevent drift between the treated plots. The randomized complete block design (RCBD) was used in the experiment's design. The cultivar under test was called Super Jakal. Deionized water that had not been treated was used for the control treatment. After being brought to the lab, each sample was inspected using a binocular microscope.

Effect of tested compounds on soil enzymes

Loamy soil from the surface (0–20 cm) was gathered and brought to the lab in a soil bags. To get rid of roots, plastics, and stones, the soil was crushed, air-dried, and then sieved over a 1 mm screen. The soil has little organic matter and a light texture. Before the experiment began, the physical properties, nutrients, pH, and electrical conductivity were determined. lists of the physicochemical characteristics of the soil employed in these investigations are shown in Table (2).

Analysis of Soil:

The particle-size distribution was established using the pipette technique. (Richards, 1954; Jackson, 1969), and the USDA textural class triangle was used to identify the matching textural class. The modified Walkely and Black method (USDA, 1996) was used to determine the amount of organic carbon in the soil. A Collins calcimeter was used to quantify the inorganic carbonate content (% CaCO3) (Jackson 1973; USDA, 1996). A digital pH meter was used to measure the pH of the soil in a 1: 2.5 ratio soil to water suspension. An electrical conductivity meter was used to evaluate the electrical conductivity (EC) of the soil to water extract with a 1:5 ratio, the microkjeldahl method, as outlined by Jackson (1973), was used to calculate the amount of nitrogen that was accessible, the available phosphorus was extracted using 0.5 M $NaHCO_3$ at pH 8.5 (Olsen *et al.,* 1954) and measured spectrophotometrically. At pH 7.0, 1 N ammonium acetate was used to extract the available potassium, and the flame photometer was used to measure the amount (Jackson, 1973).

Table 2. Physico-chemical properties of soil

Sand	Silt	Clay	Texture	pH (1:2.5)	EC ($dS\ m^{-1}$)	Calcium Carbonate(%)	Organic Matter (%)	Available N(mg/ kg)	Available P(mg/ kg)	Available K(mg /kg)
71	22	7	Sandy loam	8.36	1.21	6.86	0.84	114.12	11.5	240

The dehydrogenase activity was conducted in accordance with Casida *et al.,* (1964). Using 2,3,5-triphenyl tetrazolium chloride (TTC) as an electron acceptor instead of oxygen (O_2), it is based on the idea that TTC is reduced to triphenyl formazan (TPF), the amount of which is directly proportional to the activity of the enzyme dehydrogenase. At 37°C, the activity is measured in µg of TPF produced g^{-1} soil h^{-1}. However, the method used to measure phosphatase activity was the same as Tabatabai and Bremner's (1969) method. P-nitrophenol (P-P) is produced by hydrolyzing P-

nitrophenol phosphate (P-NP), which is utilized as a substrate. Phosphatase activity is evaluated by extracting and quantifying P-nitrophenol. The activity is measured in µg of hydrolyzed P-nitrophenol phosphate g^{-1} soil h^{-1}. However, the method used to measure urease activity was the same as that described by Watts and Chrisp (1954). A coloring agent is complexed with the unhydrolyzed urea. The amount of urea present has a direct correlation with the color's intensity. At 37 °C, the urea hydrolyzed is calculated and expressed as µg g^{-1} h^{-1}.

Preparation of silver nanoparticles

Fresh plants were cleaned and allowed to air dry for a week at room temperature then ground into a fine powder using a tissue grinder (IKA A10, Germany) and kept in a dry, airtight container. A shaker set at 180 rpm for 24 hours was used to shred 100 grams of powder that had been dissolved in 1000 milliliters of sterile distilled water. Using Whatman No. 1 filter paper, the resulting extract was filtered. The filtrate was then collected in a 1000 Erlen-meyer flask and kept at 4° C until it was needed (Verástegui et al., 1996). To decrease the Ag+ ions, 100 ml of freshly made AgNO3 (2 mM) solution was added drop-wise to 100 ml of the stored aqueous extracts at 50–60° C while being continuously stirred for 1 h. Before being used, the resulting solutions were incubated at 37° C in a dark environment. Tus, one of the frst syntheses consisted in the photo reduction of AgNO3 using ultrasonic irradiation.

Characterization of AgNPs:

UV analysis

The "Shimadzu UV-2401 PC, Japan" scanning spectrophotometer was used to determine the optical density (OD) of azadirachtin's silver nanoparticles (AgNPs) for UV–visible spectrum analysis. Between 200 and 800 nm, measurements were taken at a scanning speed of 300 nm/min with a resolution of 1 nm. The reduction of Ag+ ions was tracked using the UV–vis spectra of 1 ml aliquots of the sample and 2 ml deionized as water in a quartz cell (Wiley *et al.,* 2006). A volume of 2 mM silver nitrate was used to modify the baseline as a blank.

The transmission electron microscopy (TEM) analysis:

Following the reaction, samples were taken for transmission electron microscopy (TEM) investigation of the precipitate that gathered at the bottom of the cylindrical flasks and the suspension above. The size and shape of extract nanoparticles were examined at 70 kV using a transmission electron microscope (TEM) called the "LEOL-2010, Japan" that was outfitted with a digital "Kodak Megaplus 1.6i camera" and image processing and analysis software (AMT, USA). The collection was pared by placing a drop of every mixture on a copper grid coated with carbon and allowing it to dry at room temperature, as previously mentioned by Kumar *et al.,* (2009). The resulting nanoparticles' size distribution was estimated using TEM micrographs.

The fourier Transform Infra-Red (FTIR):

A Perkin-Elmer spectrophotometer was used to record the AgNPs' FTIR spectra at room temperature, which fell between 4000 and 400 cm^{-1}. Diffuse reflectance spectra were recorded in the 200–800 nm wavelength range using the UV140404B spectrophotometer. Numerical data was plotted using the 'Origin 7' software (Slman *et al.,* 2018).

X-Ray (XRD) Diffraction:

Using XRD measurements, the resulting solution of the silver nanoparticles has been spun for thirty minutes at 10,000 rpm. The solid AgNP residues were twice cleaned with double-distilled water before being dried at 80 degrees Celsius to create powder for X-ray powder diffraction investigations. Copper emission (Cu Ka, 1.5406) at 40 kV and 30 mA was used to record the patterns of XRD (X-ray diffraction) of powder on a Shimadzu XRD-6000 (Slman *et al.,* 2018).

RESULTS AND DISCUSSION

Confirm AgNPs formation :

Thorough investigation of silver nanoparticle biogenesis by *D. stramonium, A. indica, N. oleander,* and *C. coloroynthis* were used and documented in this work. When added to analyzed plant extracts, the aqueous silver ions transformed to silver nanoparticles. It was noted that the hue of the mixture for *D. stramonium, A. indica, N. oleander,* and *C. coloroynthis* turned from (white to brown), (yellow to brown), (yellow to dark brown), (white to brown), and (yellow to brown), respectively 24 hours before the reaction, which showed that silver nanoparticles were forming. Using a UV-vis spectrophotometer, the development and stabilization of the decreased silver nanoparticles in the solution with colloidal silver were observed. As silver nitrate was incubated with the plant extract for a longer period of time, the UV-vis spectra revealed a maximum absorption at 420 nm (Fig 1, 2, 3, & 4). UV-vis spectroscopy is a very useful and reliable technique for the primary characterization of synthesized nanoparticles which is also used to monitor the synthesis and stability of AgNPs (Sastry, *et.al*., 1998). In addition, UV-vis spectroscopy is fast, easy, simple, sensitive, selective for different types of NPs, needs only a short period time for measurement (Tomaszewska, *et. al.,* 2013).

The existence of certain functional groups and the plant extract's dual activity as a capping and reducing agent were verified by FTIR analysis of silver nanoparticles. FTIR spectroscopy is frequently used to find out whether biomolecules are involved in the synthesis of nanoparticles, which is more pronounced in academic research (Lin, 2014). Nanoparticle size, shape, and morphology have all been determined using transmission electron microscopy (TEM). It indicates that the nanoparticles made of silver are widely distributed and primarily spherical, while certain of the NPs were discovered to have irregularly shaped structures, as seen in Figures 1, 2, 3, and 4. Several studies reported the synthesis of AgNPs have been shown to be simple, cost effective, dependable, and environmentally friendly approaches and much attention has been given to the high yield production of AgNPs of defined size using various biological systems including bacteria, fungi, plant extracts (Gurunathan, 2013 and Kalishwaralal, *et. al.,* 2008). The physicochemical properties of nanoparticles can affect cellular uptake, biological distribution, penetration into biological barriers. Therefore, the development of AgNPs with controlled structures that are uniform in size, morphology, and functionality are essential for various biological applications (Duan, X.P.; Li, 2013 and Albanese, *et. al.,* 2012).

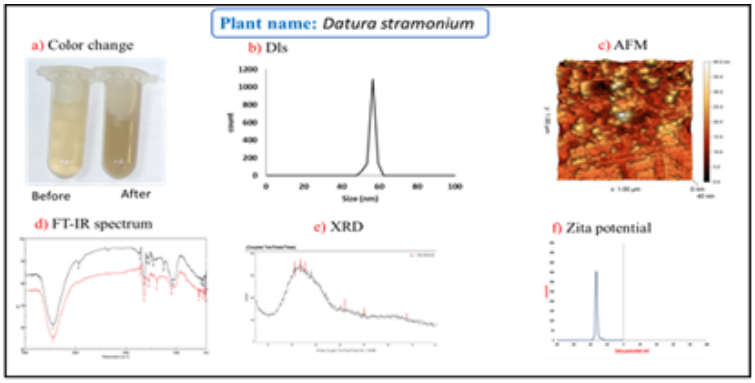

Fig. 1. Examinations of AgNPs formation by aqueous extract of *D. stramonium*.

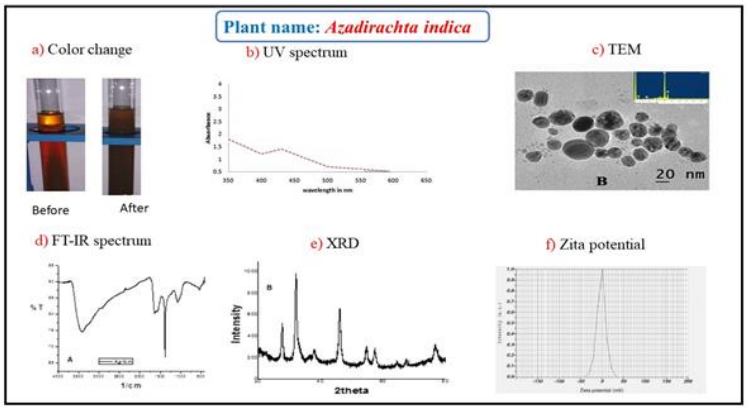

Fig. 2. Examinations of AgNPs formation by aqueous extract of Neem (*A.indica*) extract.

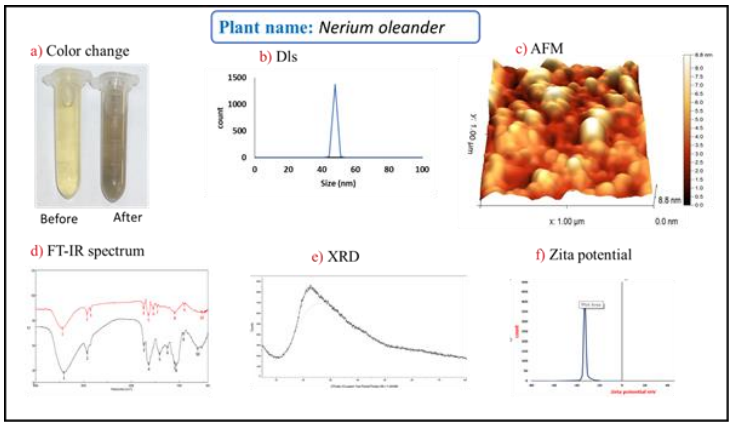

Fig. 3. Examinations of AgNPs formation by aqueous extract of *N. oleander*.

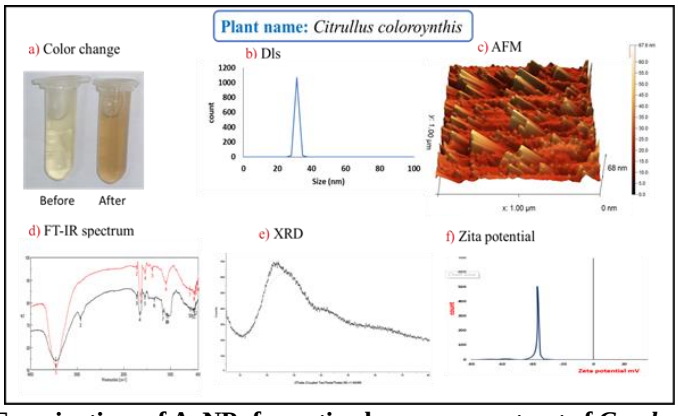

Fig. 4. Examinations of AgNPs formation by aqueous extract of *C. coloroynthis*.

Efficacy of examined substances on soil enzymes

1- Activity of dehydrogenase:

Dehydrogenase activity in soil beneath tomato plants treated with *A. indica* AgNPs, *N. oleander* AgNPs, *C. coloroynthis* AgNPs still unchanged but in case of *D. stramonium* AgNPs, When comparing dehydrogenase activity to the control, the greatest decrease was seen three days after pesticidal application (0.15 µg TPF g^{-1} soil h^{-1}) as

opposed to the soil sample that was examined one day after the application of pesticides (0.16 µg TPF g^{-1} soil h^{-1}). Dehydrogenase activity was decreased (0.10, 14, 14 and 11 µg TPF g^{-1} soil h^{-1}) in the presence of Oxamyl, Abamectin, Fenamiphos, and Cadusafos in comparison to the control. The dehydrogenase enzyme was restored Table (3).

Table 3. Tested materials' effects on dehydrogenase activity (µg of TPF g^{-1} soil h^{-1})

Substances	µg of TPF g^{-1} soil h^{-1} / Days Post-treatment					
	1	3	5	7	10	15
Oxamyl	0.17 ±0.01	0.10 ±0.01	0.12 ±0.00	0.11 ±0.01	0.12 ±0.01	0.13 ±0.01
Abamectin	0.16 ±0.01	0.14 ±0.01	0.10 ±0.00	0.13 ±0.00	0.15 ±0.01	0.15 ±0.01
fenamiphos	0.18 ±0.01	0.14 ±0.01	0.14 ±0.02	0.16 ±0.01	0.14 ±0.00	0.14 ±0.01
cadusafos	0.15 ±0.01	0.11 ±0.00	0.10 ±0.01	0.12 ±0.01	0.11 ±0.01	0.13 ±0.00
Datura stramonium AgNPs	0.16 ±0.01	0.15 ±0.01	0.16 ±0.00	0.16 ±0.01	0.15 ±0.01	0.15 ±0.01
Azadirachta indica AgNPs	0.12 ±0.01	0.11 ±0.01	0.12 ±0.00	0.13 ±0.00	0.14 ±0.01	0.15 ±0.01
Nerium oleander AgNPs	0.14 ±0.01	0.14 ±0.01	0.14 ±0.02	0.15 ±0.01	0.14 ±0.00	0.14 ±0.01
Citrullus coloroynthis AgNPs	0.11 ±0.01	0.11 ±0.00	0.11 ±0.01	0.12 ±0.01	0.11 ±0.01	0.12 ±0.00
Control	0.16 ±0.01	0.16 ±0.01	0.16 ±0.00	0.15 ±0.00	0.16 ±0.02	0.16 ±0.01

In comparison to the control, the insecticidal treatment lowered the dehydrogenase activity. *C. coloroynthis* AgNPs and *N. oleander* AgNPs have shown a minor effect (Table 3).

2- Activity of Phosphatase:

The soil showed the largest decrease in phosphatase activity following three days of Oxamyl, Abamectin, fenamiphos, cadusafos uses (1.87, 2.11, 2.83 and 2.85 µg p-NP g^{-1}soil h^{-1}, respectively), contrasted with the control sample that was examined concurrently (2.84 µg p-NP g^{-1}soil h^{-1}) after the third day of applications, the soil's phosphatase activity decreased the most. (1.87 µg P-NP g^{-1} soil h^{-1}). The activity of phosphatase was restored after three days of application in case of *A. indica* AgNPs, *N. oleander* AgNPs, *C. coloroynthis* AgNPs Table (6). There was no decrease in phosphatase activity in the soil following *D. stramonium* AgNPs , *A. indica* AgNPs, *N. oleander* AgNPs, *C. coloroynthis* AgNPs applications than control (Table, 4).

Table 4. Tested materials' effects on phosphatase activity (µg of P-NP hydrolyzed g^{-1} soil h^{-1})

Substances	µg of P-NP hydrolyzed g^{-1} soil h^{-1} / Days Post-treatment					
	1	3	5	7	10	15
Oxamyl	2.93 ±0.02	1.87 ±0.03	2.31 ±0.03	2.86 ±0.00	2.68 ±0.01	2.53 ±0.04
Abamectin	2.66 ±0.01	2.11 ±0.02	2.42 ±0.02	2.56 ±0.00	2.44 ±0.02	2.27 ±0.01
fenamiphos	2.73 ±0.02	2.83 ±0.00	2.82 ±0.01	2.72 ±0.03	2.83 ±0.02	2.82 ±0.02
cadusafos	2.92 ±0.01	2.85 ±0.03	2.77 ±0.01	2.85 ±0.00	2.86 ±0.01	2.75 ±0.02
Datura stramonium AgNPs	2.72 ±0.01	2.72 ±0.02	2.82 ±0.01	2.82 ±0.01	2.62 ±0.01	2.81 ±0.03
Azadirachta indica AgNPs	2.82 ±0.01	1.97 ±0.03	2.85 ±0.02	2.46 ±0.00	2.48 ±0.01	2.72 ±0.04
Nerium oleander AgNPs	2.76 ±0.01	2.88 ±0.03	2.74 ±0.01	2.68 ±0.00	2.47 ±0.02	2.81±0.01
Citrullus coloroynthis AgNPs	2.93 ±0.02	2.93 ±0.00	2.97 ±0.01	2.92 ±0.03	2.92 ±0.02	2.93±0.01
Control	2.83 ±0.01	2.83 ±0.03	2.88 ±0.01	2.84 ±0.00	2.85 ±0.01	2.83±0.02

3- Activity of Urease:

The results of this investigation demonstrated that Abamectin, fenamiphos, cadusafos inhibited urease activities. Throughout the sampling period, urease activity was found to be inhibited by Oxamyl, Abamectin, Fenamiphos, and Cadusafos when applied in comparison to the control (109, 1.05, 101 and 1.03 µg urea hydrolyzed g^{-1} soil h^{-1}). Following three days of application as opposed to 1.17 µg of urea hydrolyzed g^{-1} soil h^{-1} for the control application (Table, 5).

D. stramonium AgNPs , *A. indica* AgNPs, *N. oleander* AgNPs, *C. coloroynthis* AgNPs had an insignificant impact on total urease activity in comparison to the control. It is possible to draw the conclusion that the microbiological activities (i.e., enzyme activities) in soils were unaffected by the *D. stramonium* AgNPs, *A. indica* AgNPs, *N.oleander* AgNPs, *C. coloroynthis* AgNPs 1.18, 1.18, 1.16 and 1.16 applied to tomato plants, however these activities decreased when insecticidal was applied (Table 3, 4, and 5).

These findings are consistent with those of Lingxi *et al.*, (2020), who hypothesized that the long-term coexistence of ciprofloxacin, chlorothalonil, and chlortetracycline changed the way chlorothalonil dissipated in soil and had an impact on the levels of soil enzyme activity.

Table 5. Tested materials' effects on urease activity (µg of urea hydrolyzed g^{-1} soil h^{-1})

Substances	µg of urea hydrolyzed g^{-1} soil h^{-1} / Days Post-treatment					
	1	3	5	7	10	15
Oxamyl	1.27 ±0.02	1.09 ±0.04	1.31 ±0.01	1.13 ±0.03	1.13 ±0.01	1.12 ±0.00
Abamectin	1.15 ±0.01	1.05 ±0.02	1.15 ±0.03	1.13 ±0.01	1.12 ±0.04	1.14 ±0.01
fenamiphos	1.17 ±0.02	1.01 ±0.02	1.12 ±0.03	1.17 ±0.01	1.19 ±0.00	1.13 ±0.01
cadusafos	1.15 ±0.01	1.03 ±0.04	1.16 ±0.00	1.14 ±0.01	1.13 ±0.03	1.15 ±0.01
Datura stramonium AgNPs	1.18 ±0.05	1.18 ±0.01	1.16 ±0.03	1.18 ±0.00	1.18 ±0.02	1.18 ±0.01
Azadirachta indica AgNPs	1.19 ±0.02	1.18 ±0.04	1.17 ±0.01	1.17 ±0.02	1.17 ±0.01	1.17 ±0.00
Nerium oleander AgNPs	1.16 ±0.01	1.16 ±0.02	1.16 ±0.02	1.17 ±0.01	1.17 ±0.04	1.16 ±0.01
Citrullus coloroynthis AgNPs	1.15 ±0.02	1.16 ±0.03	1.16 ±0.02	1.15 ±0.01	1.15 ±0.00	1.16 ±0.01
Control	1.17 ±0.01	1.17 ±0.04	1.16 ±0.00	1.16 ±0.01	1.16 ±0.03	1.17 ±0.01

Iin addition to the potential of pesticide residues to contaminate groundwater and soil surface. In this regard, Luntao *et al.*, (2024) reported that the combined impact of MPs and insecticides on soil nitrogen transformation and microbial activities remains unclear. While, Xiaoxia *et al.*, (2020) examined the effects of a commercial Cu (OH)2 nano pesticide formulation (NPF) on bacterial populations and enzyme activities in loamy soil with a 3.61 percent organic matter content over a 21-day period. No matter the exposure dose, acid phosphatase activity stayed constant, but at doses of 5 mg kg^{-1} or above, there were significant (p 0.05) changes in invertase, urease, and catalase activities. Pesticide usage also reduces soil enzyme function, which is utilized as a biological indication of fertility of the soil and biological activities in the soil environment, according to

Antonious (2003) and Monkiedje *et al.,* (2002). Additionally, the amount of enzymes and substrates present in the processes, which is influenced by temperature, granulometric composition, pH, and the quantity of activators and inhibitors, within other factors, is the primary regulator of the rate of enzymatic reactions in soil, which varies with the seasons (Gianfreda and Rao, 2010; Jian *et al.,* 2016). According to a number of research, pesticide treatments either have no effect on soil enzyme activity or cause it to decline (Kalam *et al.,* 2004; Yan *et al.,* 2011). More research is being done by scientists to elicit local knowledge about plant materials for pest management and their impact on soil fertility that smallholder growers possess. One of the few research on the application of traditional pesticides and plant extract nanoparticles to lower Meloidogyne incognita on tomato plants in Upper Egypt is the current study. In contrast to the synthetic pesticide, the authors predicted that plant material extracts will lessen the harm and abundance caused by Meloidogyne incognita infestations. The purpose of the project was to give farmers a safer and less expensive method of controlling insect pests by employing extracts from locally accessible plant materials. This would ensure that there would be less residue buildup in their land and products and boost their output. According to Allam *et al.,* 2023 results revealed that the toxicity of pesticides for termites in decreasing order as follows: chlorpyrifos insecticide > *D. stramonium* > *N. oleander* > *P. regia* > *C. coloroynthis* > *C. procera.* One could draw the conclusion that the use of biopesticides is possible, especially *D. stramonium* AgNPs , *A. indica* AgNPs, *N. oleander* AgNPs, *C. coloroynthis* AgNPs in control *M. incognita* on tomatoes, however they don't have the same effect as synthetic pesticides, but they can be used in modern pest management programs where using synthetic pesticides is either prohibited or unwanted.

Effect of tested compounds on N, P and K availability in soil.

Available nitrogen:

The findings obtained in this study proved that The accessibility of nitrogen in the soil is related to the activity of the urease enzyme (Table, 6). The concentration of available nitrogen in the soil increased with the increase in the concentration of the urease enzyme. So urease activity is a good indication of the soil's nitrogen level. One of the most active hydrolytic enzymes in the soil, urease hydrolyzes urea to liberate ammonia that can be used by plants.

Table 6. Effect of tested compounds on available Nitrogen in soil (mg/ kg of soil)

Compounds	Available Nitrogen (mg kg^{-1}) / Days Post-treatment					
	1	3	5	7	10	15
Oxamyl	115.51	113.51	133.51	123.51	123.50	122.50
Abamectin	118.20	117.20	118.20	117.20	116.20	126.20
fenamiphos	124.14	121.14	120.14	128.14	133.14	123.14
cadusafos	120.50	123.50	122.50	121.50	117.50	122.50
Datura stramonium AgNPs	124.55	122.55	121.15	123.15	122.15	122.50
Azadirachta indica AgNPs	125.01	123.01	122.01	122.11	116.11	115.11
Nerium oleander AgNPs	124.04	121.04	118.04	118.12	117.12	118.12
Citrullus coloroynthis AgNPs	118.55	119.55	119.45	119.31	119.11	118.11
Control	117.12	115.12	116.15	117.22	116.11	114.22

Additionally important to the N cycle is urease. Soil urease is receiving increased attention because it can be used as a key indicator to evaluate soil organic matter and N-applied and adapt more quickly to environmental change and agricultural management (Sun *et al.,* 2015). urea fertilizers start to break down into ammonia gas thanks to an enzyme called urease. If this conversion occurs below the soil's surface (Uzoma *et al*., 2019).

Available phosphoruse

The biggest decrease of phosphoruse avilability was observed in soil after 3 days of Oxamyl, Abamectin, fenamiphos and cadusafos applications (9.07,10.02 and 11.02 mg/kg of soil, respectively), contrasted with a control sample that was examined concurrently (11.98 mg/kg of soil) Table 7. Also, the results in table 4 and 7 found that , The availability of phosphoruse in the soil is related to the activity of the phosphatase enzyme . The concentration of available phosphoruse in the soil increased with the increase in the concentration of the phosphatase enzyme.

Table 7. Effect of tested compounds on available phosphorous in soil (mg/ kg of soil)

Compounds	Available phosphorous (mg kg^{-1}) / Days Post-treatment					
	1	3	5	7	10	15
Oxamyl	11.70	9.70	10.70	11.70	10.70	10.70
Abamectin	10.02	10.02	10.55	11.55	10.55	10.55
fenamiphos	11.25	11.02	11.21	11.14	11.13	11.11
cadusafos	11.68	11.49	11.39	11.59	11.60	11.60
Datura stramonium AgNPs	11.59	11.55	11.77	11.62	10.60	11.60
Azadirachta indica AgNPs	11.65	11.65	10.01	10.88	10.90	11.90
Nerium oleander AgNPs	11.59	11.29	10.78	10.98	10.15	11.15
Citrullus coloroynthis AgNPs	12.88	12.98	12.91	12.85	12.61	12.51
Control	11.77	11.98	12.05	11.88	11.91	11.81

So phosphatase activity is a good indication of the soil's phosphoruse level. After being hydrolyzed into orthophosphate by phosphatases in the soil, phosphorus is made available to plants. So, soil phosphatase activities have a significant impact on the bioavailability of organic P (Wang *et al.,* 2011). Phosphatases often catalyse P through orthophosphate esters and anhydrides , also Phosphates are essential for the biochemical mineralization of organic phosphorus bonds. (Nannipieri *et al.,* 2011).

Available potassium:

The accessibility of potassium in the soil is related to the activity of the Dehydrogenase enzyme (Table, 8).

Table 8. Effect of tested compounds on available potassume in soil (mg/ kg of soil)

Compounds	Available Urease (mg kg^{-1}) / Days Post-treatment					
	1	3	5	7	10	15
Oxamyl	255	231	241	239	240	244
Abamectin	249	246	236	246	256	255
fenamiphos	261	244	243	253	251	250
cadusafos	238	239	236	256	255	260
Datura stramonium AgNPs	269	268	266	265	261	260
Azadirachta indica AgNPs	262	260	259	261	263	268
Nerium oleander AgNPs	271	270	268	272	270	272
Citrullus coloroynthis AgNPs	260	259	257	254	252	256
Control	255	252	245	231	233	232

The concentration of available potassium in the soil increased with the increase in the concentration of the

Dehydrogenase enzyme. So Dehydrogenase activity is a good indication of the soil's potassium level. An essential stage in the biological oxidation of soil organic matter is the transfer of hydrogen from organic substrates to inorganic acceptors by dehydrogenases. (Zhang et al., 2010). Dehydrogenases are a microbiological redox system indicator that can be used to monitor microbiological oxidative activity in soil (Subhani *et al.*, 2011).

CONCLUSION

According to the investigation's findings, *Datura stramonium* AgNPs, *Azadirachta indica* AgNPs, *Nerium oleander* AgNPs and *Citrullus coloroynthis* AgNPs help defend against soil fertility deterioration. However, the obtained results demonstrated that their impact was inferior to that of synthetic pesticides. To lower the amount of chemical pesticide residues on soil and environments, and improve agricultural yields. Urease, phosphatase, and dehydrogenase activity have been viewed as a more reliable gauge for the early assessment of quality changes brought on by soil management because the concentration of available nitrogen, phosphorus, and potassium in the soil increased with the increase in the concentration of urease, phosphatase, and dehydrogenase enzymes in soil, respectively. Enzymatic activity measurements can be used as biochemical markers of the quality of the soil.

Authors' Contributions: All authors are contributed in this research.

Funding: There is no fund in this research.

Institutional Review Board Statement: All Institutional Review Board Statement are confirmed and approved.

Data Availability Statement:

Data presented in this study are available on fair request from the respective author.

Ethics Approval and Consent to Participate: This work carried out at plant protection department and followed all the department instructions.

Consent for Publication Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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تأثير المبيدات الحشرية ومستخلصات الفضة النانوية من النباتات البرية على نشاط إنزيمات التربة كمؤشر على خصوبة التربة

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الملخص

هدفت هذه الدراسة إلى تقييم سمية كل من مبيد أوكساميل، أيامكتين، فيناميفوس، كادوسافوس، ومستخلصات الفضة النانوية من النباتات البرية مثل عشبة جيمسون (*Datura stramonium*) ،النيم *(Azadirachta indica)* ،الدفلى أو الغار الوردي (*Nerium oleander*) ، القرع البري *Citrullus coloroynthis* المنتجة بطريقة صديقة للبيئة من خلال الجمع بين مستخلص مائي من الملح المناسب (نترات الفضة) مع الإنزيمات التي تعمل كعلامات لخصوبة التربة والتلوث في نباتات الطماطم (*Lycopersicon esculentum*). أظهرت النتائج أن المبيدات الحشرية ومستخلصات الفضة النانوية من النباتات البرية بالترتيب التنازلي حسب تناقص مرض نيماتودا تعقد الجذور *Meloidogyne incognita* في نباتات الطماطم كانت أوكساميل < أيامكتين < فيناميفوس < كادوسافوس < عشبة جيمسون < النيم < الدفلى < القرع البري. لم يتأثر نشاط الإنزيمات بجسيمات الفضة النانوية لمستخلص عشبة جيمسون، النيم، الدفلي، القرع البري والتي تمت على نباتات الطماطم. يمكن أن تكون جزيئات الفضة النانوية للمستخلصات النباتية بمثابة نقطة انطلاق لتركيبة فعالة للمبيدات الحيوية. زاد تركيز عنصر النيتروجين والفوسفور والبوتاسيوم المتاح في التربة مع زيادة تركيز إنزيمات اليورياز والفوسفاتيز وديهيدروجينيز في التربة على التوالي. ونتيجة لذلك، تم اعتبار نشاط اليورياز والفوسفاتيز وديهيدروجينيز مقياسًا أكثر موثوقية للتقييم المبكر للتغيرات النوعية الناجمة عن إدارة التربة. كما يمكن استخدام قياسات النشاط الأنزيمي كعلامات كيميائية حيوية لجودة التربة.

الكلمات الدالة: جزيئات الفضة النانوية، مبيدات الآفات, الإنزيمات، الطماطم، خصوبة التربة