*Plant Archives* Vol. 25, Supplement 1, 2025 pp.474-479 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.063

# EFFICACY OF DIFFERENT SYNTHETIC NANOPARTICLES AGAINST COMMON SCAB OF POTATO CAUSED BY *STREPTOMYCES SCABIES* [(THAXTER) WAKSMAN & HENRICI]

**Shivam Kuma[1], S. K. Biswas[1*], Ravi Kumar[1], Sucharita Mohapatra[2], Kishan Lal[3], Anju Shukla[1], Sandeep Kumar[1], Shenaz S. Ahmed[4], Puskar Shukla[1], H.R. Raghuvanshi[1], and Tanya Rathore[1]**

[1]Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, 208002 (Uttar Pradesh), India
[2]Department of Plant Pathology, Odisha University of Agriculture and Technology, 751003, Odisha, India
[3]Department of Plant Pathology, National P.G. College, Barhalganj, Gorakhpur, 273402 (U.P.), India
[4]Department of Plant Pathology, Assam Agriculture University, Assam, India
*Corresponding author E-mail: biswas.plpath@gmail.com
(Date of Receiving : 21-07-2024; Date of Acceptance : 30-09-2024)

**ABSTRACT**

Potato (*Solanum tuberosum* L.) is a vital and versatile vegetable crop that holds significant global importance. It belonging to the family Solanaceae, which is considered as a 'Kings of Vegetable'. Potato is an important tuberous crop cultivated for vegetable, food and several other processed products. It is a highly popular carbohydrate rich food in many parts of the world, and is used both for table consumption as well as in processed products. Potato is susceptible to several diseases caused by plant pathogenic fungi, bacteria, viruses and nematodes. Among these diseases, the common scab of potato is an economically significant seed-soil borne disease primarily caused by *Streptomyces scabies.* The experimental finding showed that the growth of *S. scabies* bacteria was sharply inhibited by different synthetic nanoparticles over the control. The data showed that the maximum inhibition zone of *S. scabies* was found in $T_7$ treatment (Agritech NPs @ 50, 100, 150, 200 ppm) representing as the value 6.30, 13.45, 21.10, 30.35 mm at 24 h of inoculation, followed by $T_1$ treatment (Ag NPs @ 50, 100, 150, 200 ppm) and $T_4$ treatment (CuO NPs @ 50, 100, 150, 200 ppm), representing as the value 5.25, 12.65, 20.15, 28.35 mm and 4.45, 6.95, 15.20, 23.70 mm at 24 h of inoculation, respectively. The treatments $T_4$ (ZnO NPs @ 50, 100, 150, 200 ppm), $T_3$ (MnO NPs @ 50, 100, 150, 200 ppm) and $T_9$ ($Fe_3O_4$ NPs @ 50, 100, 150, 200 ppm), recorded as the value 3.50, 7.15, 13.80, 20.25 mm, 2.35, 5.85, 11.65, 19.20 mm and 2.15, 5.60, 10.25, 18.95 mm, representing 4$^{th}$, 5$^{th}$, and 6$^{th}$ maximum inhibition zone of *S. scabies* at 24 h of inoculation, respectively.
***Keywords* :** *Streptomyces scabies***,** Common Scab, Potato, Efficacy, Synthetic nanoparticles

## Introduction

Potato (*Solanum tuberosum* L.) is a vital and versatile vegetable crop that holds significant global importance. It belonging to the family Solanaceae, which is considered as a 'Kings of Vegetable'. Potato was the first domesticated vegetable in the region of Southern Peru and North-western Bolivia of Andreas Mountain (South America) between 8,000 B.C. and 5,000 B.C. But the native of Potato is South America (Pushkarnath, 1976). Potato is an important tuberous crop cultivated for vegetable, food and several other processed products. It is a highly popular carbohydrate rich food in many parts of the world, and is used both for table consumption as well as in processed products. Freshly harvested potato tubers contain around 80 % water and 20 % dry matter content (Wichrowska, 2022) and about 60 to 80 per cent of the dry matter is starch. Potato is a temperate crop, growing and yielding well in cool and humid climates or seasons, but it is also cultivated in tropical to sub-polar climatic regions, and represents a major food crop in many

Asian countries, particularly in India (Motalebifard, 2017). Potato production ranked fourth in the world after wheat, rice, and maize (Miyu *et al.,* 2019) and is growing in about 150 countries of the world. The total harvested area of the world in 2022 is about 17,788,408 hectares with a production of 375 million tonnes. The FAOSTAT (updated in late December, 2023), data reveals that approximately 375 million tonnes of potatoes were produced globally in 2022-23, with China (95.5 million tonnes), India (56 million tonnes), Ukraine (20.9 million tonnes), Russian Federation (18.9 million tonnes), USA (17.8 million tonnes), and Germany (10.6 million tonnes), *etc*. India accounted for over 59.72 million tonnes, which was increase of over 3.54 million tonnes from the previous fiscal year as 56.18 million tonnes (Source: Statista, 2024). In India, potato is extensively cultivated in northern state of Uttar Pradesh, which ranks first in potato production in India and contribute alone 32 per cent of the total production in India. With the increasing population pressure in the country, the demand for potatoes is continuously increasing. Therefore, there was an urgent need to enhance the productivity level of potato per unit of cultivated land. The potato crop is challenging both biotic and abiotic factors. One of the significant challenges faced by potato farmers is common scab disease caused by various species of *Streptomyces*, including *Streptomyces scabies*, *S. europaeiscabiei*, *S. acidiscabiei*, *S. turgidiscabiei*, and *S. stelliscabiei*. Amongst the various species, *S. scabies* is considered the most dangerous due to its ability to produce thaxtomin A, a plant phytotoxin (Sarwar *et al*., 2018). *S. scabies* is a gram-positive filamentous bacterium that causes scabby lesions on potato tubers by producing thaxtomin A, which deteriorates cortical and epidermal tissues (Braun *et al*., 2017a, b). This leads to the development of superficial or deep corky stains on the tubers, which can negatively affect their quality. The production of thaxtomin disrupts the outer cells of the tuber, leading to additional layers and skin lesions (Wanner *et al*., 2014). Although the disease does not have a significant impact on potato yield and production, it can result in considerable economic losses due to the rejection of scab-damaged potatoes.

## Materials and Methods

### Experiments site

The present investigation, laboratory experiments on common scab (*Streptomyces scabies*) of potato were carried out during the period 2022-23 in the Plant Bacteriology Lab, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, 208002 (Uttar Pradesh). The details of materials used and the methodology adopted in the present investigation are briefly described below:-

### Equipment's used

Needle, Spreader, Beakers, Conical flasks, Petri plates, Test tubes, Micropipette, Measuring cylinder, Spirit lamp, Wash bottle, Scalpel enamel tray, Nonabsorbent cotton, Glass rods, Hot air oven, Autoclave, Laminar air flow, BOD (Bio-Oxygen Demand) incubator, and Refrigerator were used to conduct the present experiments.

### Cleaning and sterilization of glassware

For studies of laboratory experiment, glassware's were cleaned. The glassware's were kept in cleaning solution containing 60 g of potassium dichromate ($K_2Cr_2O_7$), 60 ml of concentrated Sulphuric acid ($H_2SO_4$) in 1 Liter of water for 24 hours and then washed with soap powder followed by washing in running tap water and then finally rinsed with distilled water and they were further air dried. All the glasswares were sterilized either in an autoclave at 121.6$^0$C at 15 psi for 15-20 minutes or sterilized in hot air oven at 160-180$^0$C for 1.5- 2 hours. Sterilization of culture media was also done by autoclaving at 1.1 Kg/cm$^2$ pressure for 15-20 minutes or at 121.6$^0$C at15 psi for 15-20 minutes.

### Disinfection of the laminar air flow chamber

The bench of laminar air flow chamber was illuminated with UV light for 20 min followed by wiping with cotton swab dipped in alcohol. All the laboratory experiments viz. isolation, sub-culturing and other *in-vitro* studies were conducted under aseptic condition in the laminar air flow chamber. The material used for studies were decontaminated by swabbing with alcohol. The blades, forceps, inoculation loop *etc.* were sterilized by dipping in alcohol and heating over the flame to red hot using a Bunsen's burner.

### Preparation of Yeast Malt Agar (YMA) media for *Streptomyces scabies*

The ingredients of culture media *viz.,* Peptic digest of animal tissue (5 g), Yeast extract (3 g), Malt extract (3 g), Dextrose (10 g), Agar-agar (20 g) were added in 1000 ml distilled water and maintain pH value 6.2 ± 0.2. Shake well & heat to dissolve the media completely. Sterilize by autoclaving the agar and broth media at 15 psi at 121$^\circ$C for 15-20 minutes.

### Effective concentration of different synthetic nanoparticles against *Streptomyces scabies* under *in vitro* condition

The inhibitory potential of different synthetic nanoparticles like as Ag NPs, $SiO_2$ NPs, MnO NPs, MgO NPs, ZnO NPs, CuO NPs, Se NPs, Agritech NPs, $TiO_2$ NPs, $Fe_3O_4$ NPs, Ni NPs, and $Al_2O_3$ NPs were determined in four different concentration (50, 100, 150, 200ppm) of each nanoparticles against *Streptomyces scabies* inhibition zone at 2$^{nd}$ days of interval on Yeast Malt Agar (YMA) under *in vitro* condition. The best and effective concentration of each commercial nanoparticles are biosynthesized from pathogenic (*Xanthomonas citri, Xanthomonas oryzae*) and non-pathogenic (*Pseudomonas fluorescens, Bacillus subtilis*) bacteria.

## Results and Discussion

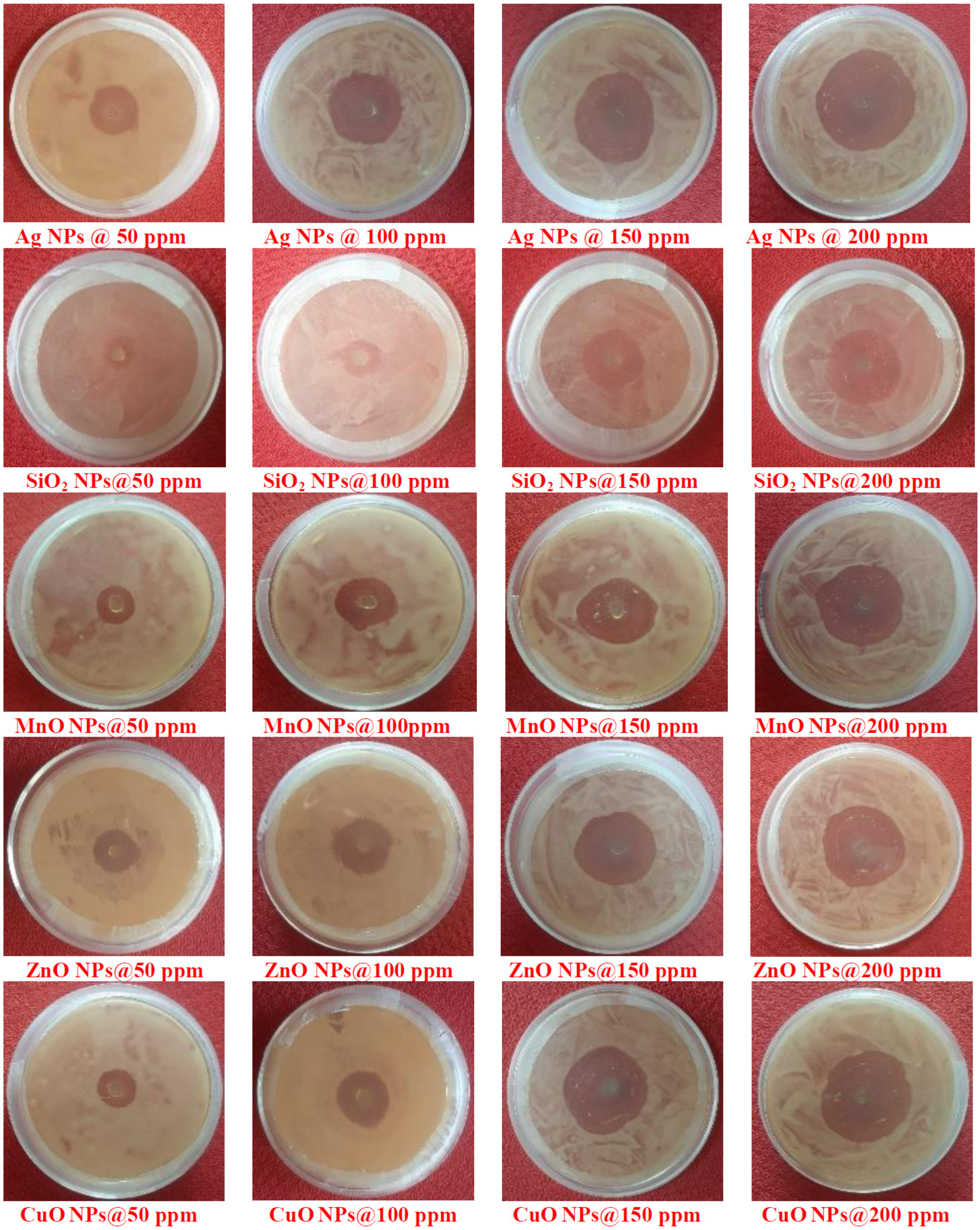
### Evaluation of different synthetic nanoparticles on inhibition zone of *Streptomyces scabies* at various concentrations under *in vitro* conditions

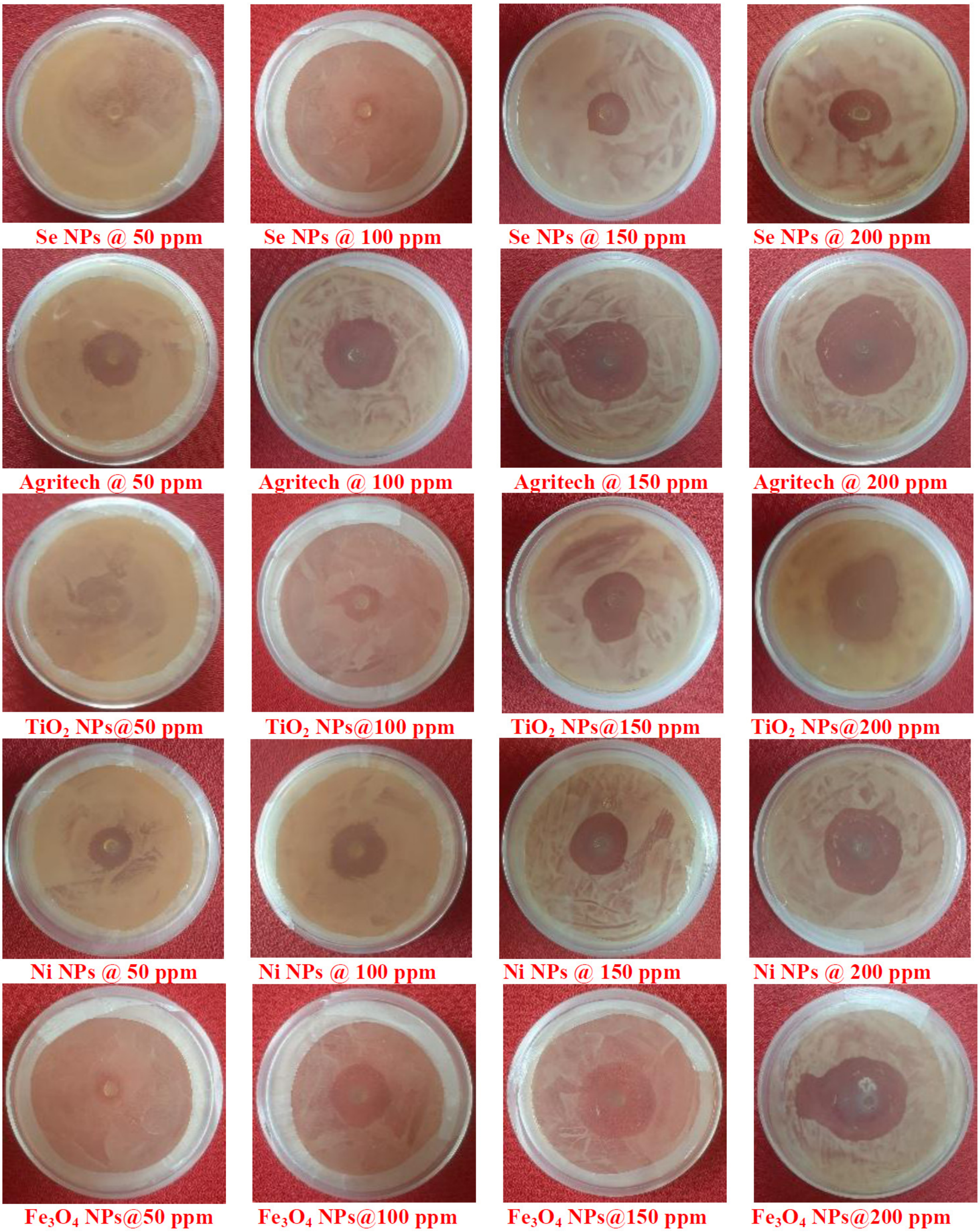
The preliminary research works were conducted to find out the best effective concentration of commercial nanoparticles on inhibition zone of *Streptomyces scabies*. The experimental finding showed that the growth of *S. scabies* bacteria was sharply inhibited by different synthetic nanoparticles over the control. The data illustrated in table-1 & plate-1, showed that the maximum inhibition zone of *S. scabies* was recorded in $T_7$ treatment (Agritech NPs @ 50, 100, 150, 200 ppm) representing as the value 6.30, 13.45, 21.10, 30.35 mm inhibition zone at 24 h of inoculation, followed by $T_1$ treatment (Ag NPs @ 50, 100, 150, 200 ppm) and $T_4$ treatment (CuO NPs @ 50, 100, 150, 200 ppm), representing as the value 5.25, 12.65, 20.15, 28.35 mm and 4.45, 6.95, 15.20, 23.70 mm at 24 h of inoculation, respectively. The treatments $T_4$ (ZnO NPs @ 50, 100, 150, 200 ppm), $T_3$ (MnO NPs @ 50, 100, 150, 200 ppm) and $T_9$ ($Fe_3O_4$ NPs @ 50, 100, 150, 200 ppm), recorded as the value 3.50, 7.15, 13.80, 20.25 mm, 2.35, 5.85, 11.65, 19.20 mm and 2.15, 5.60, 10.25, 18.95 mm, representing $4^{th}$, $5^{th}$, and $6^{th}$ maximum inhibition zone of *S. scabies* at 24 h of inoculation, respectively. The minimum inhibition zone of *S. scabies* at 24 h of inoculation was recorded in $T_{12}$ treatment (MgO NPs @ 50, 100, 150, 200 ppm), representing as 0.00, 2.45, 4.75, 6.95 mm, respectively. On the basis of inhibition zone of *S. scabies* formed due to effect of nanoparticle agents, selected best five nanoparticles *viz.,* Ag NPs, CuO NPs, ZnO NPs, MnO NPs and $Fe_3O_4$ NPs for further studies. The green synthesized AgNPs using leaf and fruit extracts of oak (*Quercus infectoria*) tree showed antibacterial activity against the plant pathogenic bacteria *viz., Pectobacterium carotovorum, Ralstonia solanacearum, Erwinia amylovora* and *X. citri* (Chahardooli *et al*., 2014). Mala and Sivasankari (2012) reported bactericidal activity of silver nanoparticles against various phytopathogens viz. *Pseudomonas solanocearum, Pseudomonas syringae, Xanthomonas malvacearum* and *Xanthomonas campestris.* Kala *et al.* (2016) successfully synthesized CuNPs using leaf aqueous extract of *Datura innoxia* from copper sulphate and reported antibacterial activity of the synthesized CuNPs against *Xanthom onas oryzae* pv. *oryzae.* Vinay *et al.* (2018) synthesized Zn nanoparticles by using *Pseudomonas flourescens* and were evaluated against bacterial blight of rice (*Xanthomonas oryzae* pv. *oryzae,* Xoo) and bacterial blight of pomegranate (*Xanthomonas axonopodis* pv. *punicae,* Xap) under *in vitro* condition. Devatha *et al.* (2018) performed antibacterial activity of synthesized iron nanoparticles from *Azadirachta indica* (AI) leaf extract on bacteria (*Escherichia coli, Pseudomonas aeruginosa*, and *Staphylococcus aureus*) was accomplished by well diffusion method. Biogenic synthesize ZnO, MnO, and MgO nanoparticle showed substantial significant inhibition effects against *Xanthomonas oryzae* pv.*oryzae* (Bacterial leaf blight) at a concentration of 16 ppm, for which the antagonized area was 17mm (Ogunyemi *et al.,* 2020). Imada *et al.* (2016) studied the effect of magnesium oxide nanoparticles (MgO NPs) on disease resistance and antibacterial activity against *Ralstonia solanacearum* in tomato plants. Boroumand *et al.,* (2019), concerns on the green synthesis of selenium nanoparticles (Se-NPs) through chemical reduction method using ascorbic acid (Vitamin C) as a reluctant and polyvinyl alcohol (PVA) or chitosan (CS) as stabilizers and determined the antibacterial activity of Se-NPs against the gram-negative bacteria *Escherichia coli*, and the gram positive bacteria *Staphylococcus aureus*. The green synthesis of NiO nanoparticles (NiO NPs) by using the leaf extract of *Tagetes erecta,* as the bio-reductor and found to be effective against Gram-positive and Gram-negative bacteria (Likasari *et al.,* 2021). Manikandan *et al.* (2019), reported that biosynthesized $Al_2O_3$ NPs at pH = 7 was found to have effective antibacterial activity against gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli.*

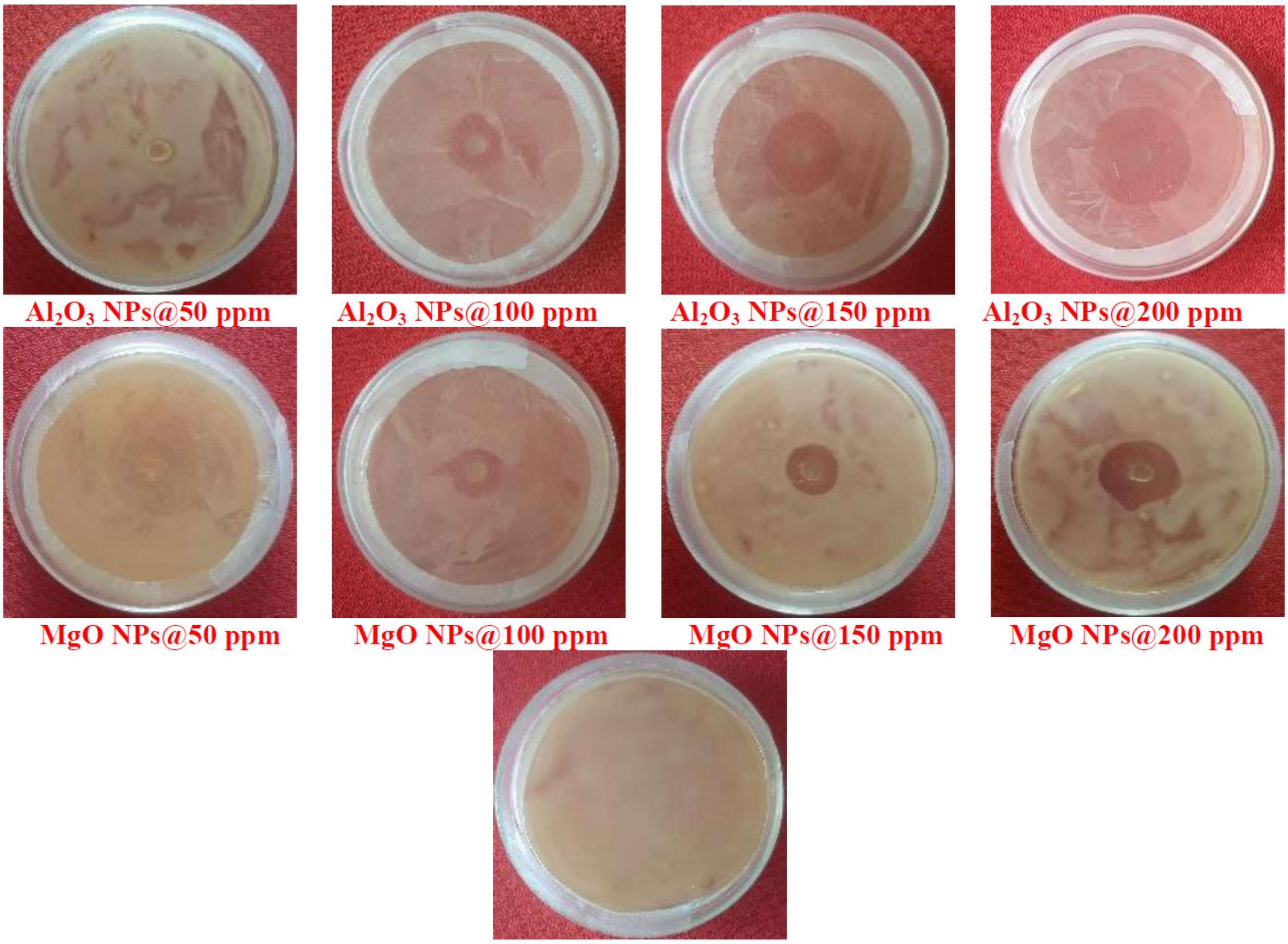
**Table 1:** Evaluation of different synthetic nanoparticles on inhibition zone of *Streptomyces scabies* at various concentration under *in vitro* conditions

| Treatments | Inhibition zone of *S. scabies* (mm) at 50 ppm | Inhibition zone of *S. scabies* (mm) at 100 ppm | Inhibition zone of *S. scabies* (mm) at 150 ppm | Inhibition zone of *S. scabies* (mm) at 200 ppm |
|---|---|---|---|---|
| $T_1$ = Ag NPs | 5.25 | 12.65 | 20.15 | 28.35 |
| $T_2$ = $SiO_2$ NPs | 1.75 | 2.85 | 5.45 | 8.85 |
| $T_3$ = MnO NPs | 2.35 | 5.85 | 11.65 | 19.20 |
| $T_4$ = ZnO NPs | 3.50 | 7.15 | 13.80 | 20.25 |
| $T_5$ = CuO NPs | 4.45 | 6.95 | 15.20 | 23.70 |
| $T_6$ = Se NPs | 0.00 | 1.55 | 3.35 | 7.65 |
| $T_7$ = Agritech NP | 6.30 | 13.45 | 21.10 | 30.35 |
| $T_8$ = $TiO_2$ NPs | 0.00 | 2.25 | 7.95 | 11.50 |
| $T_9$ = $Fe_3O_4$ NPs | 2.15 | 5.60 | 10.25 | 18.95 |
| $T_{10}$ = Ni NPs | 1.15 | 4.85 | 10.65 | 17.95 |
| $T_{11}$ = $Al_2O_3$ NPs | 0.00 | 2.55 | 6.20 | 10.15 |
| $T_{12}$ = MgO NPs | 0.00 | 2.45 | 4.75 | 6.95 |
| $T_{13}$ = Control | 0.00 | 0.00 | 0.00 | 0.00 |

**Plate No. 1 Evaluation of different commercial nanoparticles on inhibition zone of *Streptomyces scabies* a various concentration under *in vitro* conditions during 2021-22**




Se NPs @ 50 ppm
Se NPs @ 100 ppm
Se NPs @ 150 ppm
Se NPs @ 200 ppm
Agritech @ 50 ppm
Agritech @ 100 ppm
Agritech @ 150 ppm
Agritech @ 200 ppm
$TiO_2$ NPs@50 ppm
$TiO_2$ NPs@100 ppm
$TiO_2$ NPs@150 ppm
$TiO_2$ NPs@200 ppm
Ni NPs @ 50 ppm
Ni NPs @ 100 ppm
Ni NPs @ 150 ppm
Ni NPs @ 200 ppm
$Fe_3O_4$ NPs@50 ppm
$Fe_3O_4$ NPs@100 ppm
$Fe_3O_4$ NPs@150 ppm
$Fe_3O_4$ NPs@200 ppm




## References

Devathaa, C.P., Jagadeesh, K. and Patil, M. (2018). Effect of green synthesized iron nanoparticles by *Azardirachta indica* in different proportions on antibacterial activity. *Environ. Nanotechnology, Monitoring & Management.* **9**: 85-94.

Kala, A., Soosairaj, S., Mathiyazhagan, S. and Raja, P. (2016). Green synthesis of copper bionanoparticles to control the bacterial leaf blight disease of rice. *Current Science*. **10**: 110-115.

Mala, A.R. and Sivasankari, M. (2012). Synergistic bactericidal activity of silver nanoparticles and ciprofloxacin against phytopathogens. *Journal of Cell and Tissue Research,* **12**(2): 3249-3254.

Miyu, M., Sarma, P., Warade, S.D., Hazarika, B.N., Debnath, P., Ramjan, M. and Ansari, M.T. (2019). Effect of foliar application of micronutrients on potato (*Solanum tuberosum* L.) cv. "Kufri Joyti" for growth, yields & quality attributes. *International Journal Chemistry Studies*, 7(3): 4813-4817.

Motalebifard, R. (2017). Effects of zinc and phosphorus levels on yield, nutrients uptake and Zinc recovery and agronomic efficiency in potato. Journal of Water and Soil (Agricultural Sciences and Technology).

Sarwar, N., Zahid, M.H., Ashfaq, S. and Jamil, F.F. (2018). Induced systemic resistance in chickpea against Ascochyta blight by safe chemicals. *Pak. J. Bot*. **43**(2): 1381-1387.

Vinay, J.U., Nargund, V.B., Jahagirdhar, S., Patil, R.R. and Hegde, R.V. (2018). Green Synthesis of Zinc Nanoparticles using *Pseudomonas fluorescens* Extract and Their Antibacterial Activity against *Xanthomonas* spp. *Int. J. Curr. Microbiol. App. Sci*., 7(10): 1280-1291.

Wanner, L.A. (2014). A patchwork of *Streptomyces species* isolated from potato common scab lesions in North America. *Am. J. Potato Res.,* **86**(4): 247–264.

Wichrowska, D. (2022). Antioxidant Capacity and Nutritional Value of Potato Tubers (*Solanum tuberosum* L.) as a Dependence of Growing Conditions and Long-Term Storage. *Agriculture*, **12**(1): 21.

Thaxter, R., (1891). The potato common scab. *Connecticut Agricultural Experimental Station Report,* **1890**: 81-95.

Waksman, S.A. and Henrici, A.T. (1948). Family II. Actinomycetaceae Buchanan and family *Streptomycetaceae* Waksman and Henrici. *In:* "Bergey's Manual of Determinant Microbiology." R.S. Breed, E. Murray and G.D. Hitchens (eds.), The Williams & Wilkins Co., Baltimore, Maryland, pp.892-980.