

## In Vitro Evaluation of Green-Synthesized Silver Nanoparticles (AgNPs) for the Management of *Xanthomonas citri* and *Tylenchulus semipenetrans*

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Citrus production faces major threats from *Xanthomonas citri* subsp. *citri*, the causative agent of citrus canker, and *Tylenchulus semipenetrans*, the citrus nematode, both of which contribute to significant yield losses worldwide. Emerging evidence suggests potential interactions between these pathogens, exacerbating disease severity and complicating management. Conventional control methods, including chemical pesticides and antibiotics, pose environmental risks, contribute to antimicrobial resistance, and may negatively impact non-target organisms. Therefore, there is an urgent need for sustainable and eco-friendly management strategies. This study will investigate the efficacy of green-synthesized silver nanoparticles (AgNPs) in controlling *X. citri* and *T. semipenetrans* through in vitro assays. AgNPs will be synthesized using plant extracts as reducing and stabilizing agents, ensuring an environmentally friendly production method. Characterization of the synthesized AgNPs will be conducted using UV-Vis spectroscopy, Fourier-transform infrared (FTIR) spectroscopy, and scanning electron microscopy (SEM) to confirm their properties. The antibacterial activity against *X. citri* will be assessed using agar well diffusion and minimum inhibitory concentration (MIC) assays, while the nematocidal effect on *T. semipenetrans* will be evaluated through motility inhibition and mortality tests. Additionally, co-inoculation studies will be performed to investigate possible interactions between the bacterium and the nematode in vitro and assess whether AgNPs can disrupt these interactions. By developing a green nanotechnology-based alternative, this research aims to promote an environmentally sustainable and innovative approach to citrus disease management. The use of biosynthesized AgNPs could minimize reliance on chemical pesticides, reduce environmental contamination, and contribute to climate change mitigation by promoting sustainable agricultural practices.

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