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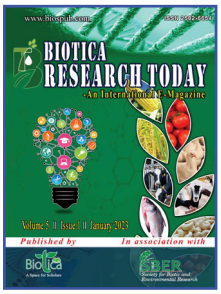

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Mechanism of Silver Nanoparticles against Plant Diseases

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Abstract

Agricultural productions are reduced by every year due to plant diseases is one of the reason. Management of plant diseases by using chemicals it is harmful to environment. So, using of nanoparticles against crop diseases protection offers a great promise in the management of insects and pathogens. Nanoparticles are used by famers to control many plant pathogenic diseases such as fungi, bacterial and viral diseases. Silver (Ag) nanomaterials are commonly used to manage plant diseases, because it has high toxicity and used as antimicrobial agent against various plant pathogens. In this article here discussed by mode of action and mechanism of silver nanoparticles against plant pathogens.

Introduction

The word "nano" is the one billionth of a meter or 10^{-9}. The term nanotechnology was coined by Professor Norio Taniguchi in 1974 who exemplified the accurate manufacturing of materials at the nanoscale level. In green nanotechnology, the nanoparticles are synthesis by using of plants and microorganisms. Microorganismsare capable of combining inorganic material within or outside the cell to form nanoparticles. However, ahuge number of microorganisms are capable of producing metal NPs, and the mechanism of NPs biosynthesis is very important. Due to its broad spectrum, extreme stability, and excellent aqueous solution dispersion, silver nanoparticle (AgNPs) is frequently utilized in crop protection (Prasad *et al*., 2017). Foliar spray of AgNPs used to inhibit the growth of fungi, bacteria, molds, rots and several other plant diseases (Singh *et al*., 2015). Moreover, AgNPs are also used as an excellent plant-growth stimulator. Silver nanoparticles show multiple modes of inhibitory action against bacterial diseases (Aziz *et al*., 2016).

Mode of Action of AgNPs against Microorganisms

AgNPs have the capability to penetrate cells because of its great surface area-to-volume ratio, which also increase their contact with microbes. Silver is effective against bacteria (Gram-positive and Gram-negative) and fungi. Many theories and suggested scenarios have been used to explain the mode of action of AgNPs against microorganisms (Figure 1). Silver nanoparticles can be synthesize from microorganisms like fungi (Table 1) and Plants *etc*. and the mechanism of AgNPs against fungi and bacteria which causing plant diseases based on:

1. Interaction with Cell Wall and Membrane

- Changes in permeability.

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- Disturbance in the administration of phosphates.
- Degradation of the plasma membrane.
- Collapse of the proton motive force.
- Inhibition of the ATP synthesis.

2. Influence on Amino Acids and Enzymes

- Bonding with amino acids (especially to –SH group).
- Inhibition of enzyme activity with bonding to its active center.

3. Obstructions in Energy Recruitment

- Influence on electron movement in the respiratory chain.
- Inhibition of cytochromes.

4. Impact on DNA and RNA

- Breaks in hydrogen bonding.
- Inhibition of synthesis of nitrogen bases.
- Disorders of DNA and RNA synthesis.

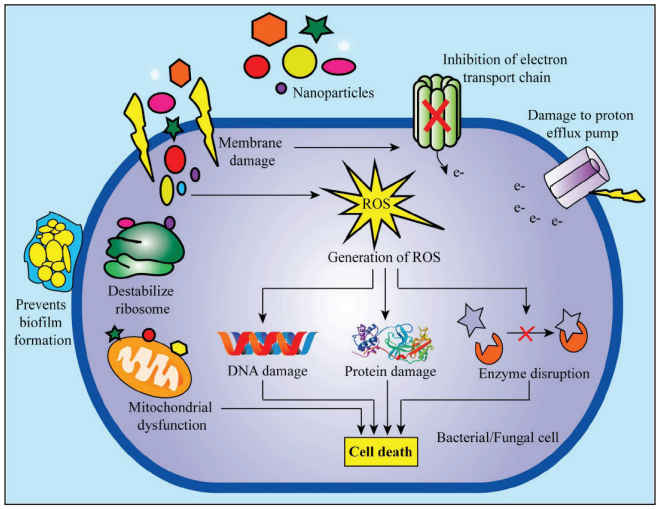

Figure 1: Mechanism of nanoparticles in fungi or bacterial cell (Sharmin *et al*., 2021)

Table 1: Synthesis of AgNPs from fungal microorganisms and its mode of action

Sl. No.	Fungi	Types of nanoparticles	Mode of action
1	*Aspergillus clavatus*	Silver	Antibacterial
2	*Fusarium acuminatum*	Silver	Antibacterial
3	*Fusarium oxysporum*	Silica, Titania	Antifungal
4	*Fusarium oxysporum f. sp. vasinfectum*	Silver	Antibacterial
5	*Penicillium purpurogenum*	Silver	Antibacterial

- Denature ribosomes, inhibiting protein synthesis.

5. Generating Reactive Oxygen Species (ROS)

Conclusion

This chapter concludes, use of silver nanoparticles has been proved to have beneficial and functional role with potent antimicrobial/ antiviral efficiency against plant pathogens; whereas, some nanoparticles have been reported to have a deleterious role regarding reactivity and phytotoxicity in plants. Hence, we are supposed to be very careful during screening and selection of the type of nanomaterial needed to be used regarding their physical, chemical, and accumulation behavior, concentration, and toxicity.

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