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Role of Nanoparticles in Enhancing Postharvest Attributes of Cut Flowers

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SUMMARY

Post-harvest quality in cut flower crops decides their valuable cost in international and national market for trade and consumer acceptance. Produce grown cut flowers with intensive care and management but sometimes fail to perform better after harvest if not managed carefully after harvesting. Flower crop having very perishable nature, so after harvest flowers crops are very sensitive to oxidative damages. So nanotechnology is one of the most important method to reduce the use of chemicals and increasing the inputs use efficiency. Nanotechnology consists of large surface area particles at atomic level ranging from 1-100 nm in diameter. Given such properties, this technology is widely used in various fields of agriculture due to its easy penetration and mobility in plant cells. One of the main functions of nanoparticles is antimicrobial action which makes them an effective preservative solution to enhance the vase life of cut flowers. Apart from inhibiting growth of microorganisms, particularly, bacteria by increasing membrane permeability in vase solution, they also prevent ethylene biosynthesis and increase the activity of antioxidant enzymes.

INTRODUCTION

Nanoparticles (NPs) are a technology involved in modification of a specific material at atomic level in order to obtain unique properties which can be adjusted to accomplish many functions. Nanomaterials/nanoparticles have a wide range of shape, size, dimension, origin and composition based on required features for the desired application. They can be tubular, spherical, hollow, flat, conical, cylindrical or irregular, with sizes ranging from 1-100 nm NPs have novel and size related specific physio-chemical properties that are significantly different from larger matter therefore, nanotechnology is widely used in various industries such as energy, electronics, biomedicine and mechanics. In recent years, NPs and nanotechnology have been used significantly also in the horticulture field for improving plant growth, development, productivity and health in the form of agrochemicals (nano formulation: fertilizers and pesticides), by detecting agrochemical residues in crops through nano sensors; diagnosis of plant diseases by acting as a catalyzing agent, use of nanodevices for genetic engineering of plants; bioremediation of a contaminated soils and improving plant defense systems against oxidative stress. Nanotechnology also helps in the extension of postharvest life of many horticultural products in different ways to minimize horticultural product waste (20-30%), such as production of new innovative packaging materials (nanocomposites), controlling postharvest diseases, protecting stored products from the influence of harmful rays and gases, use of multiple chips (biosensors) for labelling of fresh produce and improving strength and appearance of packaging.

Silver Nanoparticles (SNPs)

With the rapid increase in the use of nanotechnology, silver nanoparticles (SNPs) are new compounds that are widely used for their antimicrobial properties, high electrical and thermal conductivity, non-linear optical behavior, catalytic activity and chemical stability. SNPs are non-toxic, small in size, easy to apply with no side effects and high durability. Due to these advantages, it is considered as more effective as compared to other biocides Approximately 25% of all nanotechnology-based consumer products consist of SNPs. Their application is employed in textiles (silver embedded fabrics), cosmetics (contact lens solutions) and pharmaceuticals (nutritional supplements, anti-inflammatory agents, sanitizers and for wound healing). They are also used for water purification and vegetable disinfection Nano silver (NS) or SNPs are bunches of silver atoms ranging from 1-100 nm in diameter and are one of the most commonly used nanoparticles for controlling microbial growth (bacterial and fungal) SNPs have a specific ability to oxidize substances in surrounding them. A single nanoparticle has a high electric charge and lacks two electrons in its shell which attracts pathogenic microorganisms. By intercepting the missing electron, nanoparticles damage and ultimately destroy the microorganisms. Moreover, they strongly inhibit bacterial proliferation due to their high surface to volume ratio, which makes them an efficient anti-microbial agent in comparison to other oxidation states of silver: Ag0 , Ag+, Ag2+ and Ag3+ SNPs also limit the activity of bacterial species in water by replacing their monovalent silver ions (Ag+) with hydrogen cations (H-) or thiol or sulfhydryl (-SH) groups in surface proteins present in bacterial cell membranes. These groups interact with nucleic acids and organelles (cytoplasmic components), inhibit respiratory enzymes, dissipate the proton motive force (required by bacteria to grow and remain viable), decrease the permeability of the cell membrane and finally cause cell death. In response to silver ion attack, bacterial cells may produce low molecular weight proteins as a defense mechanism which conglomerate/fold the nucleic acids to protect DNA molecules. Furthermore, silver ions interact with the phosphate groups of DNA (main component), and sulphur groups of associated proteins destroy its bases and prevent DNA replication. They also react with thiol groups of many enzymes thus inactivating them and causing death of bacteria.

Role in improving vase life

Usually the main cause of vase life reduction in cut flowers is stem blockage due to microbial infection (bacteria) at the cut end of the stem, vascular occlusion and physiological injuries. Furthermore, water imbalance, depletion of food reserves (carbohydrates) and ethylene biosynthesis also contribute towards reduction in postharvest life. Thus, vase life can be extended by placing cut stems in preservative solution and providing a suitable environment SNPs not only kill the bacteria growing in the vase solution but also enter the cut flower stem through vascular tissues and inhibit bacterial colonization at the cut end. Furthermore, they are translocated into other floral parts and limit ethylene biosynthesis by suppressing the action of ethylene biosynthesis genes (ACO1 and ACS1), thus increasing solution uptake, relative fresh weight, petal water content and ultimately enhancing the cut flower longevity. Formulation of SNPs from different products causes differences in their pH, odor, color and particle size. Therefore, a wide range of SNP concentrations with various application methods and concentrations have different effects in improving or maintaining quality of cut flowers. However, they need to be applied at very high concentrations to get effective results, thus increasing the cost of the treatment as compared to other silver compounds i.e. silver nitrate (AgNO3) and silver thiosulphate.

CONCLUSION

Silver and other metal nanoparticles can have an important role in improving the postharvest characteristics of many cut flowers. Their easy application, non-toxicity, large surface area and durability makes them excellent materials to use as a preservative component. They have been successfully employed to increase the vase life of the cut flowers by reducing bacterial proliferation, preventing ethylene biosynthesis, limiting protein and chlorophyll degradation, and improved antioxidant enzyme activity to mitigate the effects of oxidative stress.

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