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# Nano Priming Efficient Instrument for Horticultural Crops to Withstand Stresses

**Shipra Singh Parmar [1] and Divya Pandey[2]**
[1]Department of Vegetable Science,[2]Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.)

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## Introduction

Seeds, a fundamental element in the realm of agriculture, serve as the foundational building blocks for the natural development of crops. The genetic underpinnings of variability are intrinsic to seeds, thereby playing a substantial role in overall production outcomes. Hence, the seed constitutes a fundamental element of each nation's strategy for ensuring food security. In order to optimize seed germination, enhance horticultural productivity, and ensure economic stability in the field of commercial agriculture, it is imperative to maximize the efficient allocation of production resources. Seed priming has emerged as a scientific technique that enhances the speed of seed germination and subsequent growth. To enhance metabolic activity and increase germination rate lacking radicle emergence via the seed coat, a viable pre-sowing technique known as "seed priming" entails subjecting seeds to a specific solution and subsequently ingesting them.

## Classification of Seed Priming

The various forms of priming currently employed include halo-priming, hydro-priming, solid matrix-priming, bio-priming and osmo-priming. The agents employed in various forms of priming include water in hydro-priming, osmotic agents in osmo-priming, salt solution in halo-priming, beneficial microorganisms in bio-priming and a solution containing solid particles in solid matrix-priming. The process of seed priming has been observed to have an impact on the activity of enzymes involved in the degradation of macromolecules into smaller components, which plays a crucial role in the whole development of the embryo. This, in turn, leads to accelerated growth and establishment of seedlings. Scientists have recently investigated the resiliency of seeds that have been treated with nanoparticles containing high levels of nutrients. Primers in the form of nano particles have been demonstrated to be more successful for achieving workable yields than standard priming approaches.

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**Seed nano-priming**

In order to encourage their usage in horticulture, scientists have investigated how nanomaterials affect plant germination and growth. This is because nanotechnology has evolved across numerous sectors. Without a doubt, nanotechnology plays a significant role in the revolution of food and agricultural production, with the potential to propel the farming industry forward. The application of nano priming has been observed to augment the permeability of the seed coat, leading to increased uptake of water, oxygen, and nutrients. Consequently, this phenomenon results in an elevated rate of germination and seedling growth. Studies have demonstrated the efficacy of various types of nanomaterials, such as metallic, biogenic metallic, and polymeric nanoparticles, in the process of seed nano-priming. This phenomenon induces modified genetic transcription, thereby expediting the proliferation of shoots and roots while disrupting metabolic pathways such as hormone biosynthesis. Seed priming induces a notable enhancement in the antioxidant activity and enzymatic activities within the defence system of plants. Consequently, this leads to an increased resistance of plants against pests, as well as other biotic and abiotic stimuli present in their environment.

**The utilization of different nanoparticles in seed priming**

| SN | Nanoparticle | Usage |
|---|---|---|
| 1 | **Copper nanoparticles (Cu-NPs)** | Copper (Cu) is an essential element for the metabolic processes and overall growth of plants. Cu-NPs from many items may affect humans and ecosystems. |
| 2 | **Iron nanoparticles (Fe-NPs)** | Nanoparticles of iron oxide (FeO), play a key role in the germination, growth, and increased productivity of plants. FeO-NPs are used as nano-fertilizers to increase plant iron availability, height, biomass, root length, and hormone and antioxidant enzyme activity. |
| 3 | **Silica nanoparticles (Si-NPs)** | Silica NPs may enter plant cells with DNA and other things. Nanosilica improves germination speed, seed radicle height, and dry weight. |
| 4 | **Silver nanoparticles (Ag-NPs)** | Ag-NPs protect seedlings from bacterial and fungal infection, making them useful in horticulture and other |

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| | | |
|---|---|---|
| | | agricultural operations. |
| 5 | **Zinc nanoparticles (ZnO-NPs)** | Zinc nanoparticles alter plant morphology and physiology, making them popular in agriculture. ZnO controls many enzymes, including superoxide dismutase, dehydrogenases, and phytohormone metabolism. |

**Effect of nano priming on stress**

The application of seed nano priming technological advances is employed to mitigate both abiotic and biotic stresses. Nanoparticles exhibit antibacterial and antifungal properties, thereby enhancing the processes of germination and development. The application of a nano-selenium solution at a concentration of 50 ppm for seed priming resulted in a significant reduction in the occurrence of damping off in citrus seedlings, as well as a decrease in the percentage of albino seedlings. Nanoparticles possess the capacity to actively counteract infections and alter seed and plant metabolism, thereby enhancing the inherent immune system, modifying hormone synthesis, and augmenting plant resilience against diseases and abiotic stressors. The utilization of nanopriming enhances the development of substantial root and shoot biomass under elevated abiotic stress conditions due to the accumulation of a heightened level of dehydrogenase enzymes within cells. This enzymatic buildup facilitates cell elongation in the rhizome and expedites the growth of the root system, resulting in the production of abundant biomass. Research findings have provided evidence that the application of seed nano-priming techniques enhances root development and promotes the production of essential enzymes involved in nutrient absorption. Consequently, this enables a decrease in the amount of fertilizer required for agricultural purposes.

**Conclusion**

Nanotechnology possesses the capability to revolutionize conventional agriculture, shifting its reliance on agrochemicals towards a more sustainable approach through the treatment of seeds. When the aforementioned systems are capable of facilitating plant establishment while simultaneously providing protection against biotic and abiotic challenges, there will be a notable increase in productivity and enhancement of food quality. Utilizing nanoparticles for seed priming offers several advantageous features. The utilization of nanoparticle seed priming has the potential to modify crop management strategies, leading to decreased rates of chemical application, diminished risks of contamination, and the adoption

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of more ecologically sustainable horticultural practices for farmers, consumers, as well as the environment.