

Seed Quality Enhancement Techniques

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Seed is the primary input in agriculture and acts as the foundation of crop production. The use of high-quality seeds results in better germination, uniform plant growth, and higher crop yields. However, seed quality often deteriorates during storage due to environmental factors such as temperature, moisture, and microbial activity. To overcome these challenges, seed enhancement techniques are widely used to improve seed performance before sowing.

Seed enhancement refers to a range of pre-sowing treatments that improve germination, seedling growth, and planting efficiency without altering the genetic makeup of the seed. These techniques are essential for enhancing seed vigour and ensuring successful crop establishment, especially under stress conditions.

Concept of Seed Quality Enhancement

Seed quality enhancement involves improving the physiological and physical characteristics of seeds to maximize their field performance. It focuses on increasing germination rate, seedling vigour, and stress

tolerance. Seed enhancement treatments are generally applied after harvest but before sowing to improve seed performance and facilitate efficient planting.

The main objective is to modify the seed's physiological state and provide additional support such as nutrients or protective coatings to ensure better crop establishment.



Major Seed Quality Enhancement Techniques

1. Seed Priming

Seed priming is one of the most effective and widely used techniques for enhancing seed quality. It involves controlled hydration of seeds to initiate metabolic processes required for germination without allowing radicle emergence. This results in faster and more uniform germination.

Priming techniques such as hydropriming, osmopriming, halopriming, and biopriming significantly improve seedling vigour and stress tolerance. Primed seeds exhibit enhanced enzymatic activity, improved nutrient mobilization, and better performance under adverse environmental conditions. Recent advancements include nanopriming and

hormonal priming, which further enhance germination and stress resistance by improving water uptake and activating biochemical pathways in seeds.

2. Seed Coating and Pelleting

Seed coating and pelleting involve covering seeds with materials such as polymers, nutrients, or protective agents. These techniques improve seed size, shape, and handling, making them suitable for precision sowing.

In addition, coating allows the delivery of essential nutrients and beneficial microorganisms directly to the seed, thereby supporting early seedling growth and establishment. Studies have shown that coated seeds enhance sustainability and improve crop performance under various environmental conditions.

3. Seed Fortification

Seed fortification involves soaking seeds in nutrient solutions containing micronutrients such as zinc, boron, or iron. This process enhances nutrient availability during the early stages of growth and improves germination and seedling development.

Fortified seeds are particularly beneficial in nutrient-deficient soils, as they ensure better crop establishment and productivity.

4. Seed Hardening

Seed hardening is a pre-sowing treatment in which seeds are soaked and then dried before sowing. This technique improves the seed's ability to withstand environmental stresses such as drought and temperature fluctuations.

Studies have shown that hardening treatments enhance seedling survival and improve crop performance under stress conditions.

5. Seed Grading and Sorting

Seed grading involves separating seeds based on size, weight, and density to ensure uniformity. High-quality seeds selected through grading show better germination and produce uniform crop stands.

Advanced sorting techniques, including density separation and optical sorting, are used to remove weak or damaged seeds and improve overall seed quality.

6. Seed Drying and Storage

Proper seed drying and storage are essential for maintaining seed viability and longevity. Reducing seed moisture content prevents fungal growth and seed deterioration.

Maintaining optimal storage conditions such as low temperature and humidity significantly enhances seed lifespan and preserves quality over time.

7. Use of Growth Regulators

Plant growth regulators such as gibberellic acid (GA_3), auxins, and cytokinins are used to improve germination and seedling growth. These substances help break seed dormancy and enhance metabolic activities within the seed.

Hormonal priming activates enzymes responsible for germination and improves overall seed performance.

8. Biotechnological and Advanced Techniques

Modern seed enhancement technologies include nanotechnology, plasma treatment, and magneto-priming. These techniques improve seed vigour by enhancing water uptake, enzyme activity, and stress tolerance.

For example, nanoprimering improves seed metabolism and increases resistance to environmental stress, while

plasma treatments enhance water absorption and germination speed.

Advantages of Seed Quality Enhancement

Seed enhancement techniques significantly improve germination, seedling vigour, and crop establishment. They enhance tolerance to abiotic stresses such as drought and salinity and reduce the requirement for higher seed rates. These techniques also contribute to higher crop yields and improved resource-use efficiency.

Challenges and Limitations

Despite their benefits, seed enhancement techniques face certain challenges. High costs, lack of awareness among farmers, and the need for technical expertise

limit their widespread adoption. Additionally, improper application of treatments may negatively affect seed viability.

Conclusion

Seed quality enhancement techniques are essential tools in modern agriculture for improving crop productivity and sustainability. From traditional methods such as priming and coating to advanced technologies like nanoprimering and plasma treatments, these techniques help achieve better germination, vigour, and stress tolerance. Promoting awareness and adoption of these practices among farmers can significantly contribute to food security and sustainable agricultural development.

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