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Seed Quality Enhancement Techniques

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The foundation of a productive crop begins with a high-quality seed. Modern agriculture faces challenges from climate change, poor soil health, and fluctuating environmental conditions. In this context, seed quality enhancement techniques have emerged as critical interventions that optimize seed performance, reduce input costs, and contribute to sustainable farming. Seed quality is the cornerstone of successful agriculture. Techniques that enhance seed performance not only improve germination and crop establishment but also ensure resilience under biotic and abiotic stresses. This article explores major seed quality enhancement techniques including priming, coating, pelleting, hardening, fortification, and bio-priming highlighting their scientific basis, types, benefits, and applications across crops and farming systems.

Objectives of Seed Quality Enhancement Techniques

- Improve Germination Rate and Uniformity
- Enhance Seedling Vigour
- Protect Seeds from Pathogens and Pests
- Improve Stress Tolerance
- Deliver Nutrients and Growth Promoters

Seed Priming: Preparing Seeds for Rapid and Uniform Germination

Seed priming is a pre-sowing treatment where seeds are partially hydrated to trigger early metabolic activities without actual germination. This technique accelerates and synchronizes germination, improves seedling vigour and stress tolerance, reduces seedling mortality in rainfed conditions. There are different types of priming techniques like hydropriming (water), osmopriming (PEG, mannitol), halopriming (salt solutions), hormonal priming (PGRs like GA₃), biopriming (hydration + beneficial microbes), solid priming, matrix priming (vermiculite, diatomaceous earth or lignaceous shale).

Seed Coating: Protection and Precision

Seed coating applies thin layers of protective or nutritive materials to seeds, enhancing their performance without changing shape significantly. This technique is used in cereals, legumes, vegetables, cotton, sunflower. Different types of coating materials are nutrients, fungicides (for growth and protection). This technique enhances pathogen protection, precise sowing and nutrient delivery, improved seed identification and handling.

Seed Pelleting: Uniformity for Precision Sowing

Seed pelleting transforms seeds into uniformly sized pellets using inert or functional materials, ideal for precision agriculture. This technique enhances sowing accuracy, vigorous seedling establishment and reduces wastage and thinning. Different types of pelleting are inert pelleting (clay, talc), nutrient pelleting (micronutrients), protective pelleting (fungicides/insecticides), bio pelleting (beneficial microbes), multi-component pelleting (All-in-one formulation).

Seed Hardening: Inducing Stress Memory

Seed hardening involves controlled hydration and drying cycles, enhancing seed tolerance to drought and environmental extremes. This technique improves drought resilience, faster germination under field stress, suitable for dryland crops (e.g., sorghum, pigeon pea). Different types of hardening are water hardening, chemical hardening (CaCl_2 , KCl , KH_2PO_4), hormonal/plant extract hardening (GA_3 , neem, aloe)

Seed Fortification: Infusing Vital Nutrients and Hormones

Seed fortification, also known as enrichment, involves soaking seeds in nutrient, hormone, or bioactive solutions to boost early growth. This technique helpful in better nutrient uptake, enhanced enzymatic activity, strong root and shoot growth. Different types of seed fortification are nutrient Fortification (zinc, iron, boron), hormonal fortification (gibberellic acid, cytokinin), bio-fortification (rhizobium, trichoderma), natural extracts (seaweed, moringa, coconut water)

Seed quality enhancement techniques are integral to the future of sustainable and high-efficiency farming. These scientifically proven interventions enable farmers to overcome environmental constraints, reduce input costs, and achieve better yields. Especially in the face of climate change and degraded soils, these techniques offer a resilient and sustainable path forward for agriculture.

Future Thrusts

- ✓ Nanotechnology applications: for targeted nutrient and pesticide delivery, improving seed shelf life.
- ✓ Biopriming and microbial inoculation: using beneficial microbes to enhance seed performance.
- ✓ CRISPR and Genomic interventions: for precise improvement of seed traits.
- ✓ Climate-resilient seed hardening: to increase tolerance to abiotic stresses like drought, salinity, and heat.
- ✓ AI and IoT-based tools: for assessing seed viability, vigor, and health using advanced imaging techniques.

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