

Physiological seed priming techniques in millets

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In recent years, various strategies are being employed in order to induce the abiotic stress tolerance in plants. It is well accepted fact that physiological seed priming fastens the germination time. It is an effective, practical and facile technique to enhance uniform emergence, seedling vigour and yields in millets, particularly under rainfed or less fertile soils. Seed priming is a broad term but in this article, physiological seed priming techniques, viz. hydro-priming, osmo-priming, hormonal priming, nutrient priming and nano-priming have been discussed in detail as these techniques are cost effective, ecofriendly and simple.

Keywords: Nano priming, Seed priming, Small millets

MILLETS are small grained cereals, viz. finger, kodo, foxtail, proso, little and barnyard millets. They are the staple food of millions inhabiting the arid and semi-arid tropics of the world. Small millets are nutritionally superior to rice and wheat. They are rich source of proteins, minerals and vitamins, but are generally grown on marginal land under rainfed conditions. They have wide adaptation and can withstand certain degree of soil acidity and alkalinity. Inherently, they are resilient to moisture and temperature stress.

Millets are having wide adaptability and potential for higher yields, but are mostly grown only in hilly, marginal and sub-marginal conditions of soils where major cereals fail. Uniform and rapid germination, and emergence of seedling are essential for successful crop establishment and it is of primary importance for optimizing field production of any crop plants in arid and semi-arid regions.

Farmers require high-quality seeds with excellent germination and seed health. Seed producers have the responsibility to maintain the seed quality and deliver the seed to farmers at right time. Germination and seedling emergence are the critical stages in the plant life cycle. Insufficient seedling emergence and poor establishment are the main constraints in the production of crops in the regions receiving less rainfall for which seed priming could play an important role.

Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high seedling vigour, leading to better stand establishment

and yield under adverse climatic conditions. This technology has shown promising biological and physiological improvements leading to suitable seeds with excellent physiological and agronomic performance in crop plants under adverse environmental conditions. Physiological seed priming hastens the germination process and enhances the rate of seedling emergence even under extreme climatic conditions and in problem soils. Seed priming is categorized into different types, viz. hydro-priming, osmo-priming, halopriming, hormonal priming, and biopriming, and provides extensive crop benefits. Seed priming techniques can deal with detrimental conditions in fragile lands such as drought, heat stress, salinity, nutrient stress and several environmental stresses.

Hydro-priming

Hydro-priming is a controlled hydration process of the seeds that involves seed soaking in simple water without chemicals. Among the different seed enhancement techniques, hydro-priming could be a suitable treatment for salinity and drought-prone environments. It is a simple and cheap technique, with promising effects. Hydro-primed seeds produce healthy seedlings, uniform crop stand, escape drought and hasten crop maturity.

Osmo-priming

Osmo-priming involves seed hydration in an osmotic solution of low water potential such as polyethylene

glycol or a salt solution under controlled aerated conditions to permit imbibition but prevent radical protrusion. Most commonly used salts for osmo-priming are potassium chloride (KCl), potassium nitrate (KNO₃), sodium chloride (NaCl), magnesium sulphate (MgSO₄), potassium phosphate (K₃PO₄), calcium chloride (CaCl₂) and potassium hydrophosphate (KH₂PO₄). These salts provide nitrogen to the germinating seed which is required for the protein synthesis during the germination process. Osmo-priming induces rapid and uniform germination and decreases mean germination time.

Hormonal priming

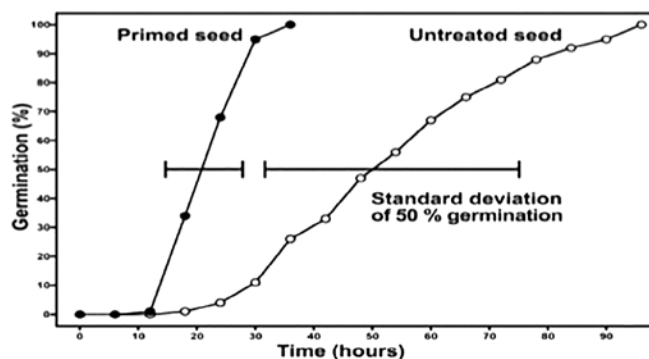
Cytokinins play a vital role in all the phases of plant growth and development starting from seed germination to senescence. Priming with optimum concentration of cytokinins has been reported to increase germination, growth and yield of many crop species. Gibberellic acid (GA₃) is known to break seed dormancy, enhance germination, hypocotyl growth, internodal length, cell division in the cambial zone and increase leaf size. GA has stimulatory effect on hydrolytic enzymes, which speed up the germination and promote seedling elongation by degrading the cells surrounding the radicle in cereal seeds.

Nutrient priming

Seed priming with micronutrients improves stand establishment, growth and yield; furthermore, the enrichment of grain with micronutrients is also reported in most cases. Many researchers proved the potential of nutrient priming in wheat, rice and forage legumes. Micronutrients, viz. Zn, B, Mo, Mn, Cu and Co are commonly used for seed treatment in most of the field crops. Seed treatment with micronutrient is a low-cost way to improve nutritional level of crops. Farmers in South Asia follow nutrient priming by soaking seeds in micronutrient solution overnight which they find very useful and simple. Seed priming with zinc salts is used to increase growth and disease resistance of seedlings.

Nano-priming

Nano-priming is an innovative technology that helps to improve seed germination, seed growth, and yield by imparting resistance to various stresses. Nano-priming is a considerably more effective method compared to all other seed priming methods. The salient features of nanoparticles (NPs) improve electron exchange and enhance surface reaction capabilities associated with various components of plant cells and tissues. The nano-priming is done using, viz. zinc and zinc oxide, iron, titanium oxide and silver. Nano-priming induces the



Effect of seed priming on seed germination

Source: <http://www.seedbiology.de>

formation of nanopores in shoot and helps in the uptake of water absorption and activates reactive oxygen species (ROS)/antioxidant mechanisms in seeds.

Seed priming: A strategy to induce abiotic stress tolerance in millets

In barnyard millet, hormoprimering with GA₃ @10 ppm recorded higher values for germination (100%), shoot length (10.85 cm) and vigour index (2353). Bioprimering of foxtail millet, little millet and proso millet with *Pseudomonas fluorescens* 20% for 8 h showed early germination, higher germination, shoot and root length, increased dry matter production, high vigour index and high seed metabolic efficiency than seeds primed with KH₂PO₄. The priming procedure strengthened the antioxidant activities of POD, CAT, SOD, and APX, increased free amino acid contents, e.g. proline, and reduced MDA accumulation and electrolyte leakage in seedlings which led to the enhancement of drought tolerance in sorghum.

SUMMARY

Seed priming hastens the germination process and enhances the rate of seedling emergence even under extreme climatic conditions and in problem soils. Seed priming has a wide range of commercial applications in improving crop stand by improving germination rate and seedling vigour, and effective crop stress management. Sustainable crop improvement and crop production require the adoption of low-cost and environment-friendly physiological seed priming techniques. Hence, a comprehensive study involving the identification of physiological and biochemical changes in seed and plant stress tolerance mechanisms in millets is needed to address the changing climate scenario, for future climate change sustainability.

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