Ecofarming
e-Magazine for Agriculture and Allied Sciences
http://www.rdagriculture.in
e-ISSN: 2583-0791
Ecofarming Vol. 03(01): 07-09, 2023

Seed priming

for improving seed germination in maize under low temperature conditions

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Received: **Oct 24, 2022; *Revised:* Oct 26, 2022 *Accepted:* Oct 29, 2022**

During seed priming, seeds are permitted to take in enough water to allow for the early processes associated with germination, but not enough to allow for radical emergence. In seed, water absorption follows a triphasic pattern, with an initial fast water uptake phase (Period I) known as imbibition, followed by a lag phase (Phase II), and then an increase in water uptake (Phase III) linked with seedling development. Pre-sowing enhancement treatments increase the pace of field emergence and minimise the period that seedlings are exposed to unfavourable environmental conditions and biotic elements in soil during germination and seedling establishment, resulting in a greater plant stand. Priming creates priming memory in seeds which may be recruited following successive stress exposures and provide increased stress tolerance during germination in primed seed. Priming generates a large activation of antioxidant enzymes during imbibition and early seedling development as compared to the control seedlings and especially to the seedling derived from aged seeds. Plant stand and vigour of corn

seedlings can be improved under unfavourable soil conditions by pre-germinating under near-optimal conditions before planting. It was discovered that pre-germinating maize seed overnight on damp paper reduced the time to emergence while increasing emergence percentage and seedling fresh weight.

Hydropriming is one of the most successful, easy, and economical methods of seed enhancement for early and uniform germination with guaranteed seedling survival under sub-optimal temperature environments. Under suboptimal temperature conditions, pre-sowing hydration with fungicide (Thiram) treatment increased emergence speed, early vegetative development, plant stand and delayed flowering in maize genotypes (Nagar *et al*., 1998). Hydro-priming might enhance degraded low vigour seed performance. Hydro-priming (17h/25°C +Thiram @2.5g/kg) can considerably improve maize seed germination under low temperature circumstances (Pal, 2020).

Pre-sowing seed priming treatments in vermiculite and hot water soaking can also successfully increase seed germination ability under suboptimal temperature conditions. In solid matrix priming, the seeds are combined with an inert solid substance with predetermined quantities of water and seeds are allowed to ingest water up to threshold moisture level that inhibits radical emergence. Hacisalihoglu *et al*., (2018) observed that solid matrix priming improved seedling emergence, reduced mean emergence time and enhanced uniformity in seedling emergence in maize inbred lines on exposure to 10°C.

Heydecker and Coolbear (1977) discovered that osmo-priming was the most effective seed treatment for increasing total germination, synchrony in germination and germination speed in a variety of plant species. Under adverse environmental circumstances, utilising an osmoticum (PEG/salt) as a pre-sowing treatment improved germination, seedling emergence, and uniformity because it increased pre-germinative metabolic activity, leading in improved seed quality. Osmo-priming (PEG 6000) followed by drying of *shrunken*2 sweet corn seeds improves emergence percentage and uniformity with a shorter mean emergence time at sub-optimal temperatures (10, 15, and 20°C), however hydropriming is more successful than osmo-priming because it avoids the anoxia condition (Sung and Chang, 1993).

Biopriming and coating in sweet corn with Pseudomonas fluorescens AB254 prevent the seedling from pre-emergence damping off that successfully enhances plant stand. Sugary sweet corn has no damping off, and biopriming protects *shrunken*2 and sugary enhancer (*se*1) sweet corn from damping off. Khalid *et al*., (2012) investigated the possibility of improved sweet corn seed propagation through transplanting and seed priming to improve emergence and field stand and discovered that the bio-priming treatment had the highest percentage of seeds that germinated among the other priming treatments and the control. Noumavo *et al*., (2013) treated maize seeds with several single and mixed Rhizobacteria solutions, with the combination of *Pseudomonas fluorescens* and *Pseudomonas putida* resulting in the highest germination percentage, the best vigour index, and the greatest number of leaves as well as the leaf area whereas highest underground biomass of maize roots was observed using *Azospirillum lipoferum* treatment.

Under low temperature conditions, salicylic acid-treated seed showed enhanced germination percentage, as well as quicker and synchronous seedling emergence. Farooqi *et al*., found better freezing tolerance, quicker and synchronous maize seedling emergence due to antioxidant activation, maintained water content in tissue, and decreased membrane permeability (2009). *Shrunken*2 sweet corn kernels do not contain enough biologically active GA to stimulate α amylase production. GA_3 treatment increases the amount of mRNA and membrane in

aleurone cells, resulting in α amylase production in *sh*2 kernels. When plant growth regulators, GA_3 (200 and 250 $mgL^{-}1$) were employed, seed vigour and germination were enhanced, and GA_3 treatment boosted seed germination and antioxidant capacity, resulting in sweet corn seedlings with improved growth.

Malondialdehydes (MDA) are formed in seeds during the peroxidation process of polyunsaturated fatty acids inside the membrane. A decrease in MDA levels in primed maize seeds when subjected to cold temperature stress showed that seed priming prevented lipid peroxidation. Li *et al*., (2004) discovered that seed film coating on maize inhibited MDA accumulation. Seed priming helps to restore MDA concentrations and enzymatic activities such as glutathione reductase, peroxidase, and catalase activity in aged seeds. Rehman *et al*., (2015) investigated different priming treatments on maize, including hydro-priming (distilled water), osmo-priming ($CaCl_2$@ 2.2%), osmo-priming (Moringa leaf extracts@ 3.3%), and hormonal priming (salicylic acid@ 50 mg $L^{-}1$) and discovered that hormonal priming and osmo-priming were the most effective treatments in improving early planted maize productivity by stimulating early seedling.

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