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Seed Priming Methods: Applications and Future Perspectives

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Introduction

Seed priming is a technique of enhancing seed performance by exposing them to controlled hydration and dehydration cycles before sowing (Ashraf 2005). This process activates the metabolic processes related to germination, but prevents the emergence of the radicle (Bradford 1986). Seed priming can improve seed germination, seedling growth, stress tolerance, and crop yield under various environmental conditions (Osburn and Schroth 1988). Seed priming is an emerging tool for sustainable agriculture that can improve crop productivity and quality with minimal cost and environmental impact.

Seed priming is a technique that enhances the germination and Vigor of seeds by exposing them to a controlled amount of moisture and temperature. This process activates the biochemical reactions that initiate germination, but stops them before the radicle emerges from the seed coat (He decker 1974). Seed priming can improve the uniformity and speed of seedling emergence, especially under unfavourable environmental conditions such as salinity, drought, cold or heavy metal stress. Seed priming can also increase the resistance of seedlings to biotic stress agents such as pathogenic bacteria and fungi (Nouman *et al.* 2014).

Seed priming is an important tool for sustainable agriculture, as it can reduce the need for chemical fertilizers and pesticides, improve crop yield and quality, and conserve natural resources. Seed priming can be done with different types of solutions, such as water, salt, osmotic agents, hormones, nutrients or bio stimulants. The choice of the solution depends on the crop species, the seed quality and the target stress. Seed priming can also induce changes in the seed proteome, which are related to enhanced seed Vigor and stress tolerance (Thakur *et al.* 2019).

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Seed priming is a simple and cost-effective method that can be applied by farmers or seed companies to improve seed performance and crop productivity. However, there are some challenges and limitations associated with seed priming, such as optimal priming duration, storage conditions, seed quality control and environmental variability. Therefore, more research is needed to optimize seed priming protocols for different crops and stress scenarios, and to understand the molecular mechanisms underlying seed priming effects.

Methods of Seed Priming

To invigorate the seeds, accelerate the germination process, and alleviate the environmental stress, different seed priming methods have been developed (Fig. 1) including,

- Hydro-priming
- Osmo-priming
- Halo-priming
- Chemical-priming and
- Hormonal priming.

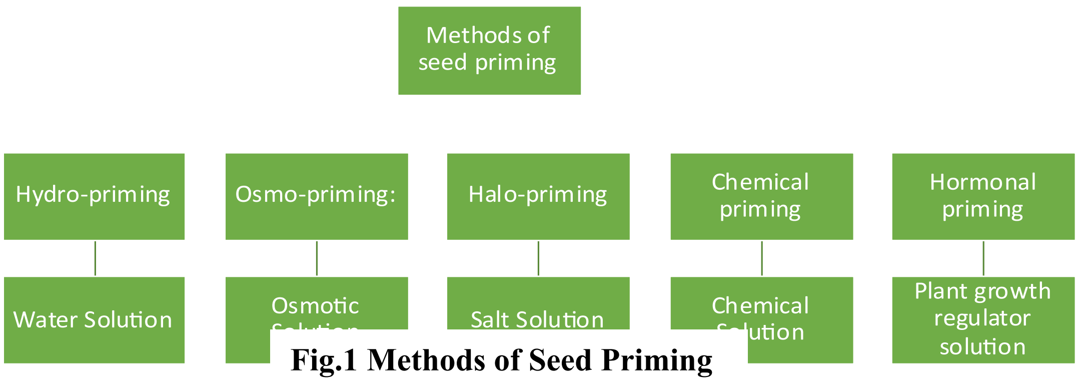

Fig.1 Methods of Seed Priming

There are different types of seed priming, depending on the type of solution or agent used for hydration. Some of the common types are:

Hydro-priming:

This involves soaking seeds in water for a certain period of time and then drying them back to their original moisture content. Pill and Necker (2001) reported that hydro-priming is a pre sowing seed treatment which involves soaking the seeds in water before sowing. These methods allow the seeds to imbibe water and help to obtain the phases of germination in which pre germination metabolic activities are started, while the latter two phases of

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germination are inhibited. This is a simple and low-cost method that can enhance seed vigor and germination uniformity.

Osmo-priming:

This involves soaking seeds in an osmotic solution, such as polyethylene glycol (PEG), mannitol, or sucrose, that creates a water potential gradient between the seed and the solution. This allows controlled water uptake by the seed and prevents leaching of solutes from the seed (McDonald 2000). Osmo-priming can improve seed germination under drought, salinity, and low temperature stress.

Halo-priming:

This involves soaking seeds in a salt solution, such as sodium chloride (NaCl), that induces osmotic stress and enhances salt tolerance in plants (Serafy *et al*. 2021). Halo-priming can also increase antioxidant enzyme activity and membrane stability in seeds.

Chemical priming:

This involves soaking seeds in a chemical solution, such as potassium nitrate (KNO3), hydrogen peroxide (H2O2), or calcium chloride (CaCl2), that modulates various physiological and biochemical processes in seeds. Chemical priming can improve seed germination under adverse conditions, such as high temperature, heavy metal toxicity, and disease infection.

Hormonal priming:

This involves soaking seeds in a plant growth regulator solution, such as gibberellic acid (GA3), abscisic acid (ABA), or salicylic acid (SA), that regulates various hormonal pathways in seeds. Hormonal priming can enhance seed germination and seedling vigor by affecting cell division, elongation, differentiation, and dormancy.

Factors Affecting on Seed Priming

Some of the factors that affect seed priming are:

Priming agent: -The type and concentration of the solution used to soak the seeds can have different effects on the seed metabolism, membrane stability, enzyme activity, and gene expression. Different priming agents, such as water, salts, sugars, hormones, or bio stimulants, can be used depending on the crop species, seed quality, and stress conditions (Shaheen *et al.* 2016).

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Priming duration: - The length of time that seeds are soaked in the priming solution can determine the extent of metabolic activation and physiological changes in the seeds. If the priming duration is too short, the seeds may not benefit from the treatment. If the priming duration is too long, the seeds may suffer from leaching of nutrients, deterioration of membranes, or premature germination. The effect of duration of priming on pepper seed performance was demonstrated by (Cantliffe1988) with seeds primed in PEG solution for 4, 5, or 6 days. Seeds primed for 6 days had the fastest germination, but they produced almost 60% abnormal seedlings com- pared to 14% or 0% of seeds primed for 5 or 4 days, respectively. In tomato, one week of priming in PEG 6000 solution was the ideal seed priming period to increase germination rate (Wolfe and Sims 1982).

Priming temperature: -The temperature at which seeds are primed can influence the rate of water uptake, metabolic reactions, and biochemical adjustments in the seeds. Optimal priming temperatures may vary depending on the crop species and their optimal germination temperature. Generally, higher temperatures can accelerate the priming effects but also increase the risk of seed damage.

Priming aeration: -The availability of oxygen during priming can affect the respiration and energy status of the seeds. Adequate aeration can provide oxygen for aerobic respiration and ATP production, which are essential for seed germination and vigor. However, excessive aeration can also cause oxidative stress and lipid peroxidation in the seeds. Onion seeds primed in an aerated PEG solution, using enriched oxygen, had greater percent germination after treatment compared to seeds primed in nonaerated solution (Bujalski *et al.* 1989). Similarly, Heydecker and Coolbear (1977) reported lower germination percent of onion seeds after priming in nonaerated PEG solution. No differences in final germination of lettuce were observed after seed priming in aerated or nonaerated solutions of K_3PO_4.

Seed condition: -The initial quality and characteristics of the seeds can influence their response to priming. Factors such as seed size, seed maturity, seed moisture content, seed dormancy, seed vigor, and seed health can affect the water uptake, metabolic activation, and physiological changes in the primed seeds. Therefore, seed priming is a complex process that requires careful optimization of various factors to achieve the desired outcomes. Seed priming can be a valuable tool for enhancing seed performance and crop productivity if applied properly and according to specific conditions.

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Future prospects of seed Priming and its limitations

Seed priming is a technique that improves the germination and seedling growth of plants under various environmental conditions. It involves the partial hydration of seeds to a certain level that activates the metabolic processes related to germination, followed by drying them back to their original moisture content. Seed priming can enhance the performance of plants by increasing their tolerance to abiotic and biotic stresses, such as salinity, drought, cold, heavy metals, pathogens and pests. Seed priming can also reduce the time required for seedling emergence and increase the uniformity and synchrony of germination.

Although seed priming has emerged as an effective seed treating tool for many crops but treating conditions and methods differ from crop to crop. However, the existing seed primingmethods have some disadvantages. Forinstance, prolonged seed treatment duringprimingmay cause loss of seed tolerance todesiccation (Sliwinska*et al.* 2002) and some priming treatment candetermine contamination with fungi and bacteria. Another noticeable problem is that thelongevity of primed seeds is reduced, comparedto non-primed seeds (Wright *et al*. 2003). Besides, seed primingwith advanced methods such as priming withnanoparticles may have deleterious effects onplant, human health as well as on theenvironment, it is crucial to select specificpriming protocols and techniques which arebeneficial to plants and environment. Though,seed priming has some disadvantage it remainsan environmentally safe and effective technologywhich can be easily adopted by not onlyresource-poor farmers but also different plantresearcher to mitigate abiotic stress (Srivastava *et al.* 2021).

Future prospects of seed priming include the development of new methods and materials for priming, such as endophytes, bio stimulants, nanoparticles and biochar (Sher *et al*. 2019). These novel approaches can offer additional benefits to plants, such as improved nutrient uptake, disease resistance, growth promotion and soil health. Moreover, seed priming can be integrated with other agronomic practices, such as crop rotation, intercropping and organic farming, to achieve sustainable agriculture and food security. However, seed priming also faces some limitations and challenges, such as the optimal conditions and duration of priming, the stability and quality of primed seeds during storage and transportation, and the cost-effectiveness and feasibility of priming for different crops and regions. Therefore, more research is needed to address these issues and to optimize the seed priming technique for various crops and environments.

Conclusion

The conclusion of seed priming is that it is an effective and sustainable tool for improving seed quality and crop performance. Seed priming can help farmers overcome the challenges of climate change, soil degradation, and biotic and abiotic stresses that affect crop production. Seed priming can also reduce the need for chemical inputs and enhance the nutritional value of crops. Seed priming is a simple and low-cost method that can be applied to various crops and seeds, with different types of solutions and durations. Seed priming has been shown to have positive effects on many horticultural and broadacre crops, such as vegetables, flowers, cereals, oilseeds, and sugar beet.

REFERENCES

Ashraf, M. and Foolad, M.R., 2005. Pre-sowing seed treatment—A shotgun approach to improve germination, plant growth, and crop yield under saline and non-saline conditions. *Advances in agronomy*, *88*, pp.223-271.

Bujalski, W., Nienow, A.W. and Gray, D., 1989. Establishing the large-scale osmotic priming of onion seeds by using enriched air. *Annals of Applied Biology*, *115*(1), pp.171-176.

Cantliffe, D.J., 1988, July. Stand establishment. In *Research and Development Conference on Vegetables, the Market and the Producer 247* (pp. 175-179).

Carpenter, W.J., 1989. Salvia splendens seed pregermination and priming for rapid and uniform plant emergence. *Journal of the American Society for Horticultural Science*, *114*(2), pp.247-250.

El-Serafy, R.S., El-Sheshtawy, A.N.A., Atteya, A.K., Al-Hashimi, A., Abbasi, A.M. and Al-Ashkar, I., 2021. Seed priming with silicon as a potential to increase salt stress tolerance in Lathyrus odoratus. *Plants*, *10*(10), p.2140.

Heydecker, W., 1974. Germination of an idea: the priming of seeds. *Rep Sch Agric Univ Nottingham*.

Heydecker, W. and Coolbear, P., 1977. Seed treatments for improved performance survey and attempted prognosis. *Seed science and technology*.

Nouman, W., Basra, S.M.A., Yasmeen, A., Gull, T., Hussain, S.B., Zubair, M. and Gul, R., 2014. Seed priming improves the emergence potential, growth and antioxidant system of Moringa oleifera under saline conditions. *Plant growth regulation*, *73*, pp.267-278.

McDonald, M.B., 2000. Seed priming. *Seed technology and its biological basis*, *287*, p.325.

Osburn, R.M. and Schroth, M.N., 1988. Effect of osmopriming sugar beet seed on exudation and subsequent damping-off caused by Pythium ultimum. *Phytopathology*, *78*(9), pp.1246-1250.

Pill, W.G., 2001. The effects of seed treatments on germination and establishment of Kentucky bluegrass. *Seed Sci. & Technol.*, *29*, pp.65-72.

Sher, A., Sarwar, T., Nawaz, A., Ijaz, M., Sattar, A. and Ahmad, S., 2019. Methods of seed priming. *Priming and Pretreatment of Seeds and Seedlings: Implication in Plant Stress Tolerance and Enhancing Productivity in Crop Plants*, pp.1-10.

Shaheen, H.L., Iqbal, M., Azeem, M., Shahbaz, M. and Shehzadi, M., 2016. K-priming positively modulates growth and nutrient status of salt-stressed cotton (Gossypium hirsutum) seedlings. *Archives of Agronomy and Soil Science*, *62*(6), pp.759-768.

Sliwinska, E. and Jendrzejczak, E., 2002. Sugar-beet seed quality and DNA synthesis in the embryo in relation to hydration-dehydration cycles. *Seed Science and Technology*, *30*(3), pp.597-608.

Srivastava, A.K., Suresh Kumar, J. and Suprasanna, P., 2021. Seed 'primeomics': plants memorize their germination under stress. *Biological Reviews*, *96*(5), pp.1723-1743.

Thakur, M., Sharma, P. and Anand, A., 2019. Seed priming-induced early vigor in crops: an alternate strategy for abiotic stress tolerance. *Priming and Pretreatment of Seeds and Seedlings: Implication in Plant Stress Tolerance and Enhancing Productivity in Crop Plants*, pp.163-180.

Wright, B., Rowse, H.R. and Whipps, J.M., 2003. Application of beneficial microorganisms to seeds during drum priming. *Biocontrol Science and Technology*, *13*(6), pp.599-614.

Wolfe, D.W. and Sims, W.L., 1982. Effects of Osmoconditioning and Fluid Drilling of Tomato Seed on Emergence Rate and Final Yield1. *HortScience*, *17*(6), pp.936-937.