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SEED PRIMING: A COST EFFECTIVE STRESS MITIGATION STRATEGY

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Abiotic stresses and environmental pollutions are the main problems of seed germination, emergence and vigour of seedling, which ultimately reduce crop yield. These unfavourable conditions affect plant growth and crop yield by delaying the start of germination and reducing its growth rate. Less availability of nutrients is one of the prime constraints of crop yield. There are a lot of techniques which can be used for enhancing crop yield. Seed priming is one of the suitable techniques to enhance seed germination and emergence. "Seed priming is a pre-sowing treatment which leads to a physiological state that enables the seed to germinate more efficiently". Basically, the metabolic processes necessary for germination are allowed by priming.

Mechanisms of Seed Priming

Generally, the germination of seeds takes three phases. (1) Phase I: seed imbibition phase, in which quick water uptake involves in apoplastic spaces through forces driven by seed. (2) Phase II: Activation phase, in which re-establishment of metabolic activities (protein synthesis takes place) and repairing process and (3) Phase III: Germination phase, where cell elongation and radical emergence occurs. Hydration remains stable in phase II. In the case of priming, I and II phase occurs but not allowing seeds to enter phase III. Before ending of phase II germination remains a reversible process because seeds may be dried again and remain alive during storage which re-initiate germination under suitable conditions.

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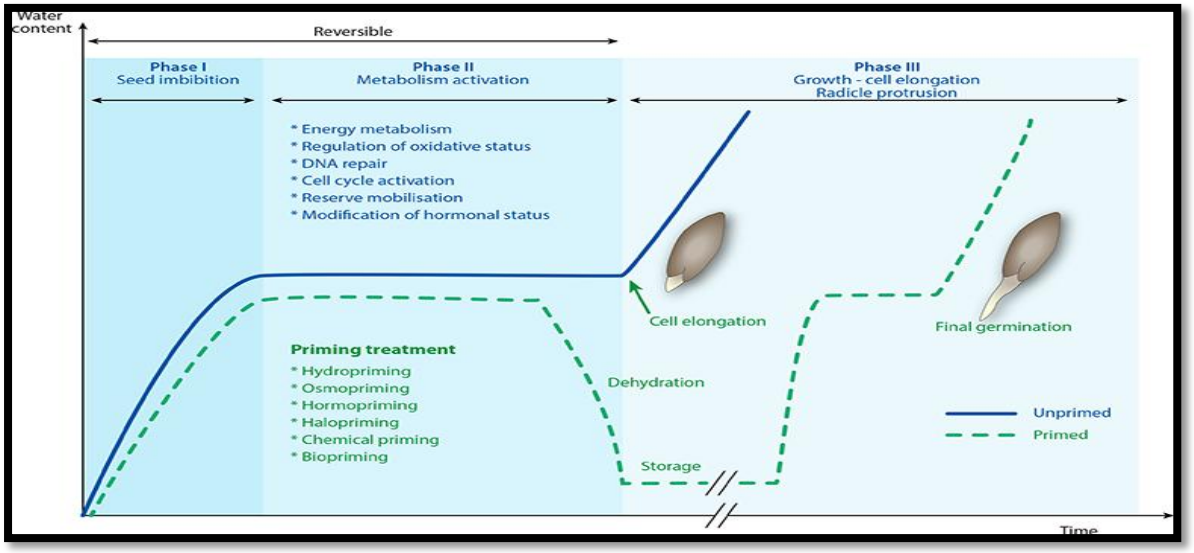
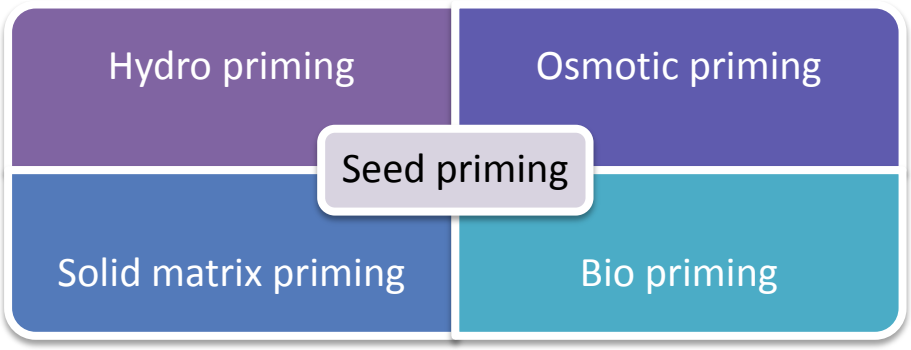


Fig-1 Seed hydration curves and germinating phases in un-primed and primed seeds.

Source: https://www.intechopen.com/media/chapter/51934/media/fig1.png.

Priming Methods

Several methods of seed priming have been developed in order to invigorate seeds and overcome environmental stress. There are mainly four common methods utilized for priming of seeds.



1. **Hydro-Priming:** It is one of the major and most common priming processes where seeds are soaked in water and drying back to storage moisture prior to sowing of the seeds. This decreases the time that seed spends in the seedbed simply imbibing water. Hydro-Priming of seed improves:
    a. Germination percentage
    b. Vigour of seed
    c. Uniform growth
    d. Water use efficiency

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e. Grain yield

2. **Osmotic Priming/ Halo Priming:** Osmotic Priming or Halo Priming refers to the soaking of Seeds in a solution of inorganic salts. In Osmotic Priming, seeds are soaked in solutions containing chemicals such as Polyethylene glycol (PEG), Potassium nitrate (KNO3), Sodium chloride (NaCl), Potassium chloride (KCl), Mannitol, Glycerol, Sorbitol. Priming with salt solutions known as Halo priming. Osmotic Priming of seeds helps in the improvement of germination of Seed, Seedling emergence, establishment and final crop yield in salt-affected soils.
3. **Solid matrix priming:** It involves the incubation of seeds in a solid, insoluble matrix, such as vermiculite, another high water-absorbent polymer, with a limited amount of water, allowing for slow imbibition.
4. **Bio- Priming:** Basically a process of biological seed treatment with the combination of seed hydration and inoculation (the biological aspect of disease control) of seed which protects seed by the beneficial organism. It is an ecological approach using selected fungal antagonists against the soil and seed-borne pathogens.

Besides these types of priming methods, there are some other types of priming likely-

- **Hormopriming:** Here, seed imbibition occurs in the presence of plant growth regulators which have a direct effect on seed metabolism. The growth regulators basically used are Kinetin, Ethylene, Auxin, Gibberellic acid, Abscisic acid, Salicyclic acid etc.
- **Nutripriming:** Seeds are soaked with limited nutrient containing solutions instead of pure water. As a result, both nutritional effect and biochemical advantages of priming which improve germination traits, seed quality and seedling establishment. Priming with Zn improved productivity of chickpea and wheat (Arif *et al*, 2007). In cotton, K-priming promotes favourable effect on growth and nutrient status of cotton seedling under saline conditions (Shaheen *et al*, 2015).

Drying of Seeds after Priming

- Seed drying is essential after the priming process. Seed dehydrator is used for seed drying.
- Slow drying at moderate temperature is generally preferable.
- Heat- shock treatment is also used.

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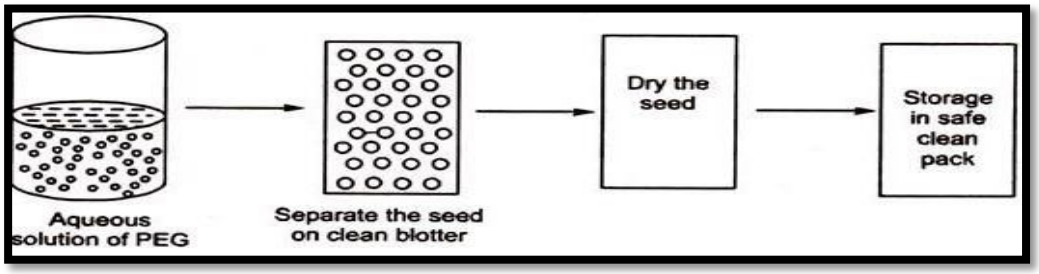

Fig2: Methods of seed drying after priming.

Source: http://www.agricultureinindia.net/wpcontent/uploads/2018/05/clip_image002-111.jpg

Advantages of Seed Priming

- ✓ Faster speed of germination.
- ✓ Increases germination rate.
- ✓ Enables seed to germinate and emerge even under adverse agro-climatic conditions i.e. stress conditions.
- ✓ Improves uniformity to optimise harvesting efficiency and enhance yield potential.
- ✓ Seed performance improved under stress conditions.
- ✓ Protect seed from seed-borne fungi.

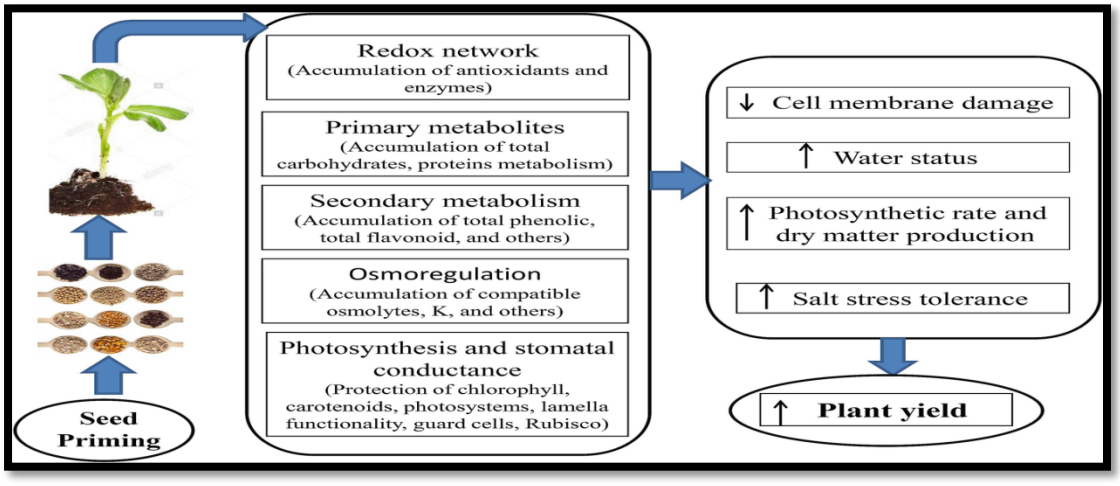

Fig-3 Mitigation of stress by seed priming; Source: Abdelhamid M.T. *et al.* (2019).

Utility of Seed Priming

- ➢ Kaur *et al.* (2002) observed in chickpea that priming increased plant biomass, numbers of branches, flowers, pods and seeds per plant leading to higher seed yield.

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- Several crops like chickpea, maize, rice and wheat under semi-arid conditions reported that yield was increased after seed priming (Harris *et al.* 2001). Major beneficial changes of priming showed in these crops were: faster emergence of crop, better drought tolerance, early flowering and higher grain yield.

Fig-4 Effect of seedling growth in primed and non-primed seeds.

Source: Karthika and vanangamudi (2013).

- Priming at the low and medium concentrations increased the rate of germination of the relatively large chickpea and cowpea seeds compared to an un-primed control.

Fig-5(a) Irregularities in seed germination due to stress conditions. 5(b) Uniformity in prime seeds.

Source: https://www.slideshare.net/GhulamAsghar8/seed-priming-83863812.

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Conclusion

Seed priming is a pre- sowing technique which controlled imbibition of seed followed by dehydration, has become a common trend towards increasing the speed and uniformity of germination and emergence under both stress and normal conditions. The main purpose of priming is to partially hydrate the seed to a point where early phases of germination processes begin, but radicle emergence is prevented, before sowing the Seed (Ahmed *et al*. 2002). Different methods of Priming have advantages and disadvantages and may not all be equally profitable to use in different crops. In general, chemical treatments have been used more often and more effectively than biological treatments. Some biological treatments have also been effectively used in combination with chemical or physical priming treatments to further enhance germination and seedling emergence under non- stress and stress conditions (Haque *et al.* 1995). To determine the effectiveness of different priming techniques, factors such as concentration, a dose of priming agent, the time period for incubation of seed in priming agent, and seed storability must be examined, and the optimal conditions should be determined.

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