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Popular Article

Mitigation of Environmental Stress by Seed Priming

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Introduction

Abiotic & biotic stresses and environmental pollutions are the main constraints of seed germination, radicle emergence and vigour of seedling, which ultimately reduce crop yield and productivity. These unfavorable conditions affect plant growth and crop yield by delaying the start of germination, reducing its growth rate and reducing availability of nutrients from soil. There exist a lot of techniques which can be used for enhancing crop yield under different stress conditions. Among those Seed priming is one of the sustainable techniques to enhance seed germination and emergence. Seed priming is a pre-sowing treatment which leads to a physiological state that enables seed to germinate more efficiently. Seed priming is an alternative, low cost, and feasible technique, which can improve various abiotic & biotic stress tolerances through enhanced and advanced seed production.

Environmental stress and its effect on crop growth and development

Stress mainly of two types-

A) Abiotic stress: It includes heat, drought, salinity, alkalinity, cold etc.

B) Biotic stress: It includes attack of pest, pathogen, insect, weed etc. These effect crop growth as following ways-

- Drought induces stomatal closure and also limits the size of individual leaves and leaf number. Therefore, reduces photosynthesis, growth and yield in a number of plant species (Atta et al., 2022).
- Excessive wilting during drought causes a change in the amount of membrane lipids and this may result in increased electrolyte leakage and cell damage.
- The salinity of soil reduces water availability of plant root via negative (low) osmotic potential as well as decrease of germination dynamics of plant seeds by ionic toxicity of Na^+ and Cl^- (Atta et al., 2021).

- Due to heat stress, various physiological injuries have been observed in plants such as scorching of leaves and stems, leaf abscission and senescence and root and shoot growth inhibition or fruit rot, which as a result lead to decreased plant productivity.
- The stress effects mostly on reproductive stages than on vegetative stages, flower droppings & the pollen infertility occurs under high temperature in many crop species, reducing the seed set and crop yield.
- Various plant pathogens and insect attack crop plants at various critical growth stages and causing necrosis, seed discoloration, leaf curling, rolling, stem rot, wilt etc. and ultimately reduce crop yield.

Different types of seed priming methods:

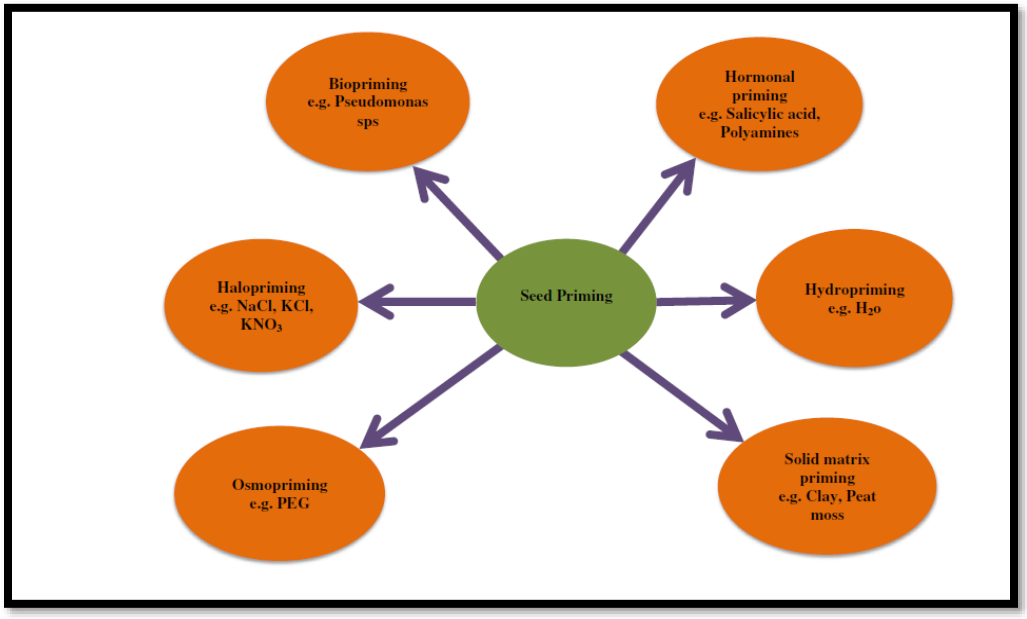

Fig 1: Types of seed priming techniques; Source: Chakraborty and Dwivedi (2021).

Factors affecting seed priming process:

- **Aeration:** Aeration helps in seed respiration, seed viability and contributes to uniform radicle emergence. The effects of aeration during priming varies according to species.
- **Duration**: If Seeds are primed for optimal duration (12 hr.), it shows early emergence and seed maturation; but if primed for more duration (36-48 hrs.) this may cause inhibition of germination due to lack of oxygen supplied to embryo.
- **Temperature:** If temperature is reduced during priming, it results in slower imbibition of seeds, because of increasing the duration of phase II of the triphasic pattern of imbibition's.

- **Concentration:** Concentration of priming liquid effects the seed germination & growth. e.g. Seed priming with 1% sodium molybdate reduced the seed germination due to toxic effect on physiological and biochemical processes within the cell (Renugadevi *et al*., 2008).
- **Light:** Light effects seed priming in various ways according to crop species. some species show enhanced germination when seeds primed in illuminating conditions (Celery), others may show better germination in dark (Lettuce).

Role of seed priming in mitigating various types of stress:

Primed seeds have the potential to ameliorate different stresses in field condition. It alleviates stress by following ways—

- Seed priming causes early germination, rapid radicle emergence, uniform germination, &seedling growth and healthy crop stand and provides better growth attributes.
- Osmopriming induces thermo-tolerance by exhibiting upregulation of ABA and downregulation of GA in thermo-inhibition-sensitive genotypes (Toh *et al*., 2008), while reverse was noted in osmo-primed seeds of thermo-inhibition-tolerant (Schwember and Bradford 2010).

Fig. 2 (a) Non uniformity in seed germination due to stress conditions; (b) Uniformity in prime seeds. Source: Choudhury and Atta (2020).

- Seed priming also activates certain antioxidant enzymes like superoxide dismutase (SOD), peroxidase (POD), catalase (CAT) and also other useful osmoprotectants like proline, soluble sugar, soluble proteins, etc. which strengthen the stress tolerance capacity inside the seeds as well as growing plant.

- Osmoprimed seeds impart resistance to fungal, bacterial, viral disease etc. for example - in Tomato, Brassica and pearl millet it provides resistance to *Fusarium oxysporum*, viral disease and downy mildew, respectively (Anup *et al*., 2015).
- Seed priming with PEG leads to enhance and accumulate more LEAs during seed maturation programme and provide better desiccation tolerance during late embryogenesis, which protect seeds against dehydration, salinity, cold, drought and heat stress.

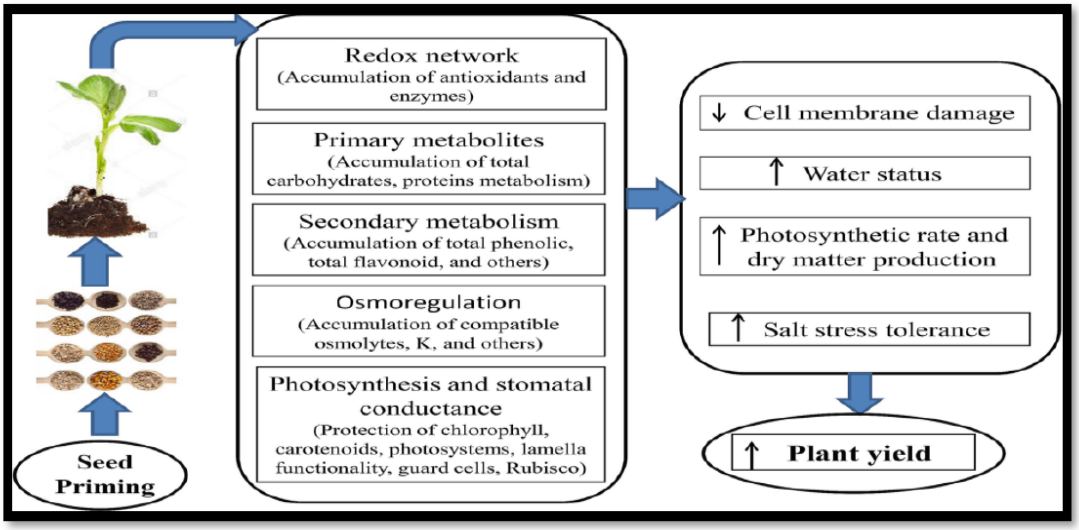

Fig 3: Mechanism of stress mitigation by seed priming; Source: Abdelhamid *et al*., (2019).

Conclusion

Seed priming emerges as an excellent technology for combating detrimental effects of abiotic & biotic stress in crops without much influencing its fitness and vigor. Seed priming technique is innovative, cheap and easy to apply at farmer's field conditions. 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. But some biological priming techniques are used in combination with physical &chemical priming method for mitigating stress.

Reference

Abdelhamid, M.T., Raafat, M.E., Darwish, M.T. *et al.* (2019). Mechanisms of Seed Priming Involved in Salt Stress Amelioration. In: Hasanuzzaman M., Fotopoulos V. (eds). Priming and Pretreatment of Seeds and Seedlings. Springer, Singapore. https://doi.org/10.1007/978-981-13-8625-1_11

Anup CP, Melvin P, Shilpa N, Gandhi MN, Jadhav M, Ali H, Kini KR (2015). Proteomic analysis of elicitation of downy mildew disease resistance in pearl millet by seed priming with β-aminobutyric acid and *Pseudomonas fluorescens*. J Proteome 120:58–74.

Atta, K., Pal, A.K. and Jana, K. (2021). Effects of salinity, drought and heavy metal stress during seed germination stage in ricebean [*Vigna umbellata* (Thunb.) Ohwi and Ohashi], *Plant Physiology Reports*, 26(1), 109-115. https://doi.org/10.1007/s40502-020-00542-4.

Atta, K., Singh, A. P., Adhikary, S., Mondal, S., & Dewanjee, S. (2022). Drought Stress: Manifestation and Mechanisms of Alleviation in Plants. In A. P. M. Eyvaz, A. Albahnasawi, M. M. Tekbaş, & M. E. Gürbulak (Eds.), Drought. *IntechOpen*. https://doi.org/10.5772/intechopen.102780.

Chakraborty, P. and Dwivedi, P. (2021). Seed priming and its role in mitigating heat stress response in crop response. Jounal of Soil Science and Plant Nutrition. 21:1718-1734. https://doi.org/10.1007/s42729-021-00474-4.

Choudhury, A. and Atta, K. (2020). Seed Priming: A Cost Effective Stress Mitigation Strategy, Agriallis, 2(10): 30-36.

Renugadevi J, Natarajan N, Srimathi P. (2008). Efficacy of botanicals in improving the seeds and seedling quality characteristics of cluster bean. Legume Research—An International Journal. 31:164-168.

Schwember AR, Bradford KJ (2010). Agenetic locus and gene expression patterns associated with the priming effect on lettuce seed germination at elevated temperatures. Plant Mol. Biol. 73:105–118.

Toh S, Imamura A, Watanabe A, Nakabayashi K, Okamoto M, Jikumaru Y, Hanada A, Aso Y, Ishiyama K, Tamura N, Iuchi S (2008). High temperature-induced abscisic acid biosynthesis and its role in the inhibition of gibberellin action in Arabidopsis seeds. Plant Physiol. 146:1368–1385.


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