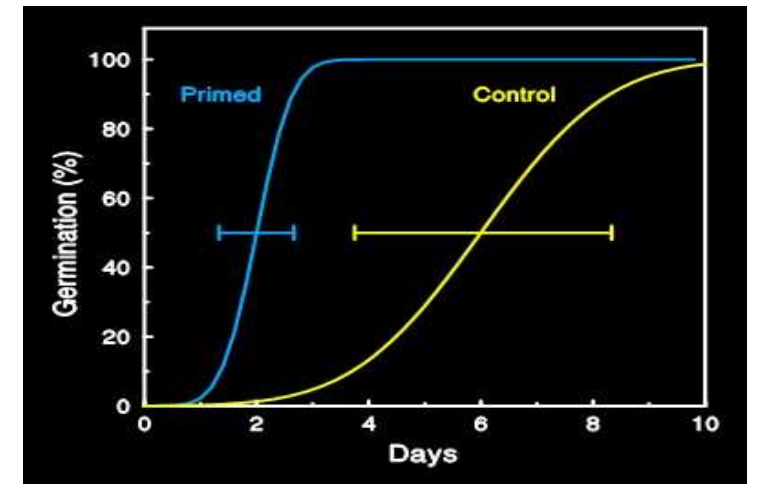
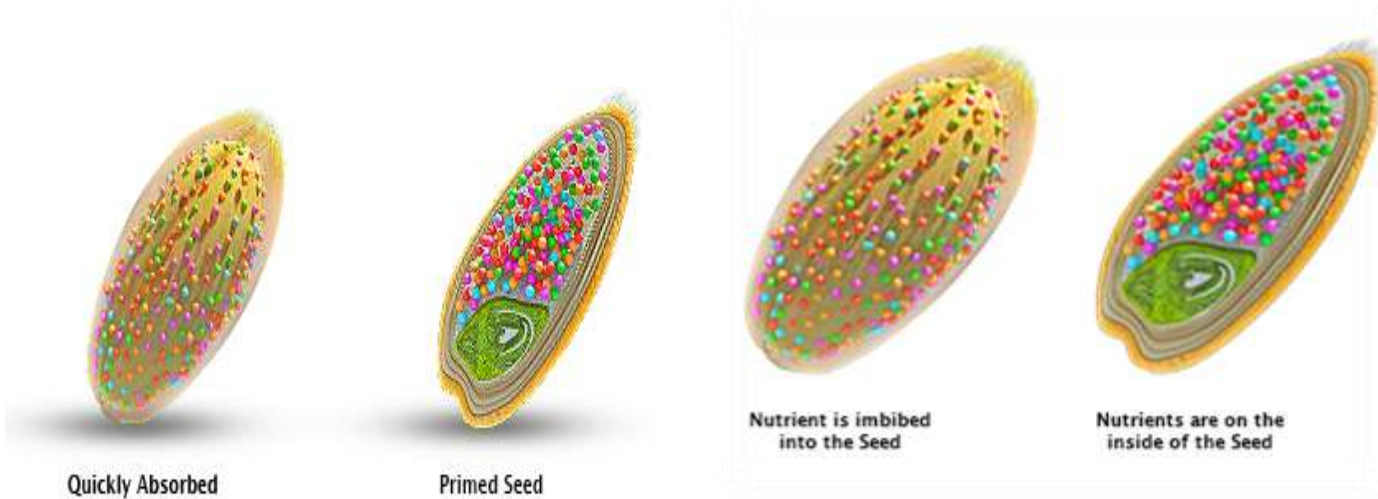




Session 53: Seed priming



Rationale

Environmental pollution, urbanization, biotic and abiotic stresses are major global problems affecting seed germination, emergence and vigor of seedling and ultimately crop yield

Different techniques can be used to enhance crop yield of which, seed priming is the simple and suitable technique to synchronize seed germination, increase emergence and establishment in the farm

Seed priming technique can aid the farmers to reduce the excess use of fertilizers, enhance crop yield by synchronized seed germination, and induce systemic resistance in plants

Introduction

Priming is an approach that involves treating seeds with different organic or inorganic chemicals and or with high or low temperatures

It entails imbibition of seeds in different solutions for a specified duration under controlled conditions, then drying back them to their original moisture content, so that radicle do not emerges before sowing.

This stimulates various metabolic processes that improve germination and emergence of several seed species, particularly seeds of vegetables, small seeded grasses and ornamental species

Seed priming is considered to be an easy, highly effective, low cost and low risk technique

Phases of seed germination

Phase I: Imbibitions' phase involves quick water uptake through forces driven by seeds. In this phase, there are changes occurring such as metabolic activities and translation process takes place whereas DNA and mitochondria are repaired

Phase II: Lag phase/Activation phase where there is less water uptake resulting in minor increase in fresh weight of seeds. This phase is highly active physiologically and metabolically. It helps in maturation of mitochondria (causing ATP synthesis), protein synthesis from new mRNAs and mobilizing stored macromolecules into molecules required for radicle outgrowth

Phase III: Germination phase completed germination and seedling growth starts by recommencement of radicle and quick water uptake

Mechanism of priming

In priming, first and second phase occurs, not allowing seeds to enter phase III

Phase II initially occurs for longer time for performing processes and prevents phase III. So, in primed seeds lag phase is reduced as preparation for phase III is not required, which is already done.

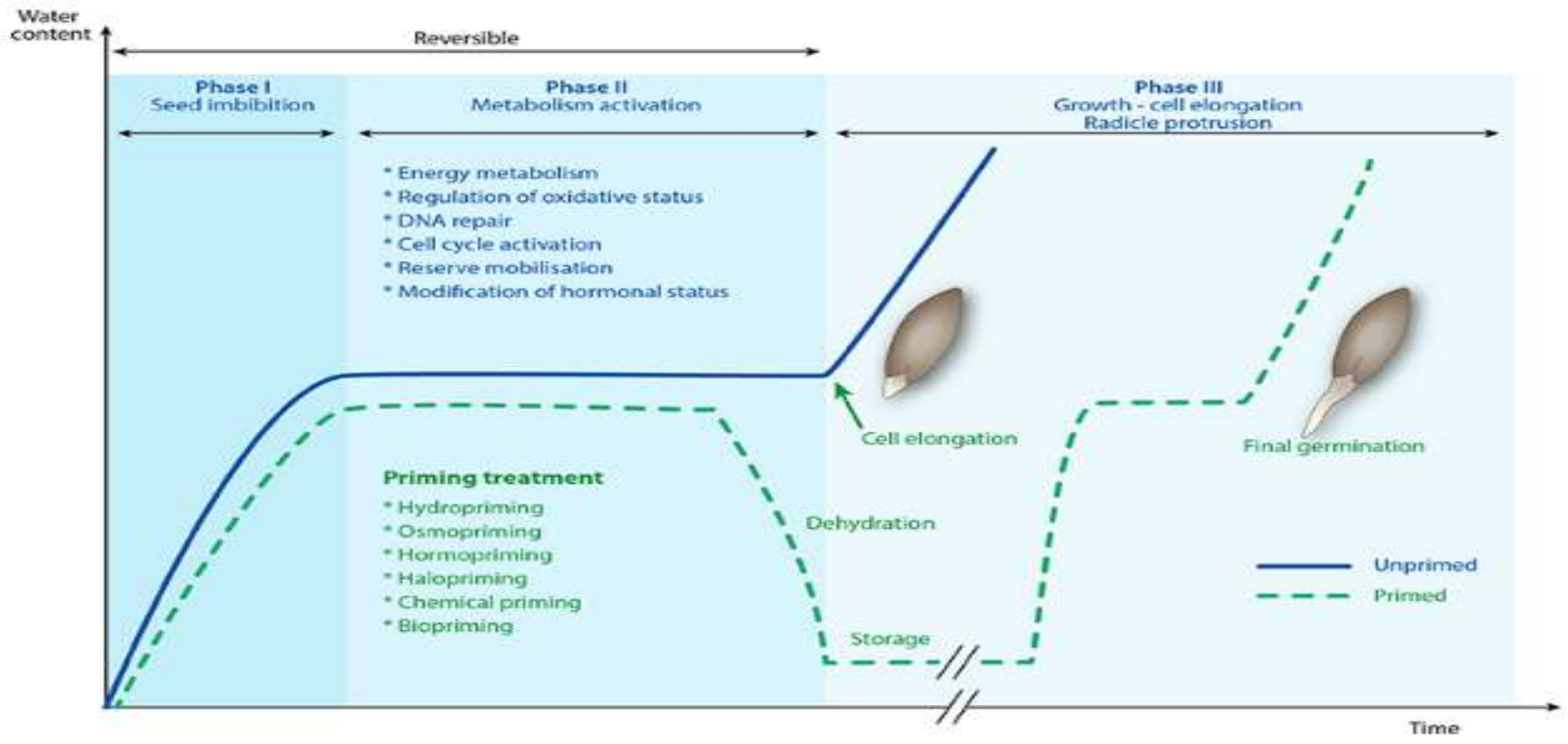
Due to this, different benefits are imposed in seeds such as synchronization of radicle emergence, increase in growth rate and enhancing large number of seeds to germinate

During priming, seeds already complete first two phases of germination, so on sowing; these seeds have the ability to complete the process faster (imbibition) once it is provided with water. This reduces the time required for cellular activities to take place

DNA content increases due to activation and/or synthesis of enzymes of nucleic acid, ultimately increasing total RNA amount and proteins

It also heals the damage caused to cell membrane during storage/drying

Seed hydration curves and germinating phases in unprimed and primed seeds



Techniques of seed priming

1. **Hydro-priming**
2. **Halo-priming**
3. **Osmo-priming**
4. **Matrix priming**
5. **Osmohardening**
6. **On farm priming**
7. **Hormonal priming**
8. **Micronutrient seed priming (Nutri-priming)**
9. **Bio-priming or seed treatment with micro-organisms, e.g. *Pseudomonas aureofaciens*, *Trichoderma spp.* etc.**
10. **Nanoparticle priming or coating seeds with nanoparticles (NPs)**

Techniques of seed priming

1. Hydro-priming: uses water to soak seeds, drying it for dehydration to storage moisture prior to sowing of the seeds (Harris et al., 1991)

It decrease the time that seed spends in the seedbed simply imbibing water (Halmer, 2006)

it synchronizes germination after breaking dormancy, diminishes the lag time required for imbibitions, hydrolyses inhibitors, activates enzymes, mobilises reserved food and enhances embryonic tissue outgrowth



Effect of Hydro-priming on Wheat Seed

❖ Hydro-priming of Wheat seed improves:

- 1) Vigor
- 2) Germination percentage
- 3) Seedlings Establishments
- 4) Uniform Growth
- 5) Water use efficiency
- 6) Grain yield

(Raj Pal Meena, Sendhil R, S. C. Tripathi, 2013)



Limitation of hydro-priming

-Not suitable for some plant species, as rapid hydration may causes leakage of essential nutrients. This overcome by seed humidification

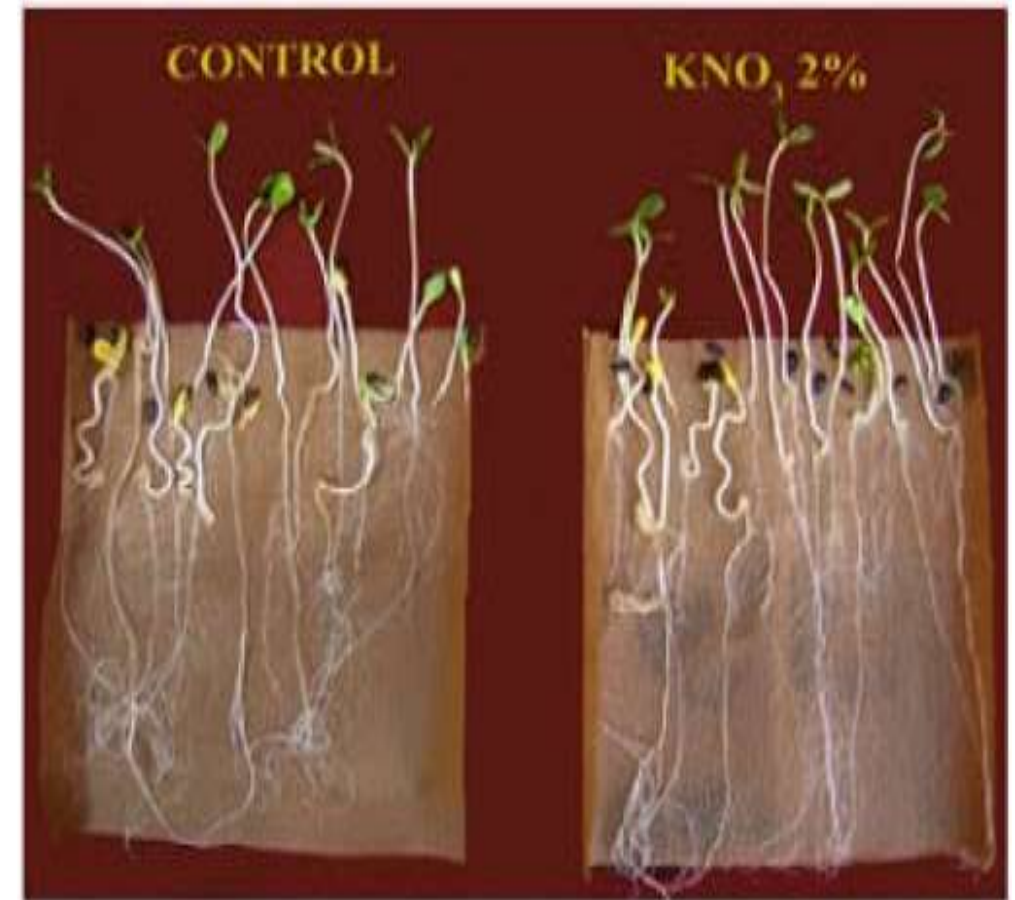
-May result in uneven hydration and non-uniform germination

Techniques of seed priming

2. Halo-priming: refers to submerging seeds in solution of inorganic salts viz., sodium chloride (NaCl), potassium chloride (KCl), potassium nitrate (KNO₃), calcium chloride (CaCl₂) etc.

It improve seed germination, seedling emergence and establishment, and final crop yield in salt affected soil in response to halopriming

Bajehbaj (2010) evaluated the response of germination in four cultivars of safflower seeds and seedling growth on priming with NaCl and KNO₃ in alkaline environment and found that primed seeds increased seed germination, sturdy seedling and produced large quantity of plant per unit area



Techniques of seed priming

3. Osmo-priming:

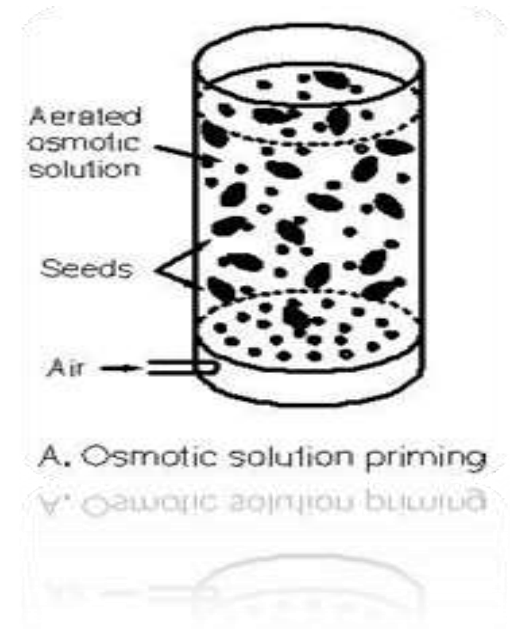
-Also known as seed conditioning.

-Involves soaking seeds in solution of osmotic priming materials such as sugar, polyethylene glycol (PEG), glycerol, manitol, sorbitol and specialized vermiculate compounds for a certain period followed by air drying before sowing.

-Osmo priming not only improves seeds germination but also enhances general crop performance under non saline and saline conditions

-Osmo-priming of Italian ryegrass and sorghum seeds with 20% PEG8000 for two days at 10°C enhanced germination rate, water stressed, water lodged, cold stress or saline conditions

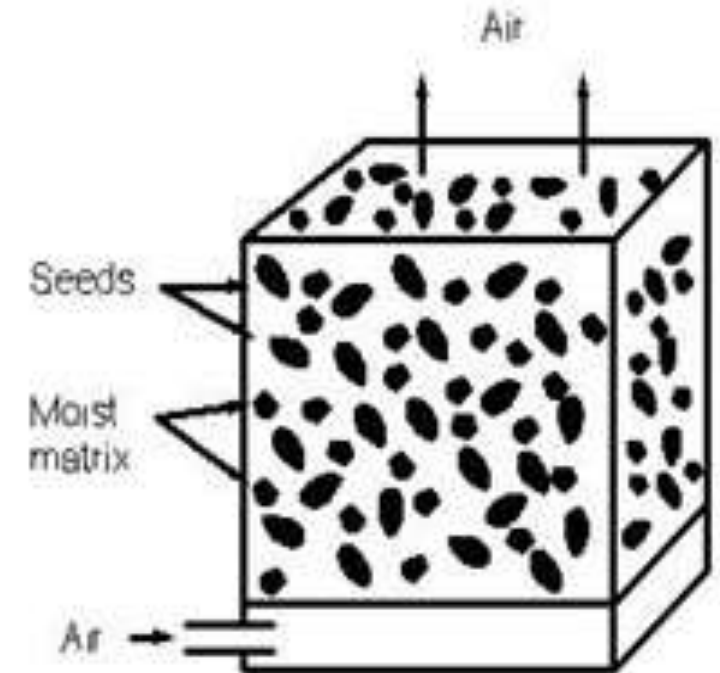
-Tavili *et al.*, (2011) showed that *Bromus* seeds primed with PEG6000 enhanced germination and produced longer roots as compared with hydro-priming and unprimed seeds



Techniques of seed priming

4. Matrix priming: refers to incubating seeds in a solid, insoluble matrix such as vermiculite, diatomaceous earth or another highly water absorbent polymer with restricted amount of water, allowing for slow imbibition (Mc Donald, 2000)

-Sand matrix improved germination parameters up to 50% (Selvarani and Umarani, 2011)



C. Solid matrix priming

Techniques of seed priming

5. Osmo-hardening: involves soaking seeds in tap water for 24 hrs, re-drying the seeds which are followed by hardening seeds with CaCl_2 and KCl solutions

-**Rehman et al., 2011** studied effect of three seed priming (osmo-hardening, hydro-priming and on-farm priming) on direct seeded rice and reported osmo-hardening with CaCl_2 to be better followed by KCl in increasing crop yield due to enhanced growth, large quantity of tillers, enlarged length and yield of kernels, increased content of K, P and Ca, whereas reduction was seen in unproductive kernels and unwanted ineffective spikelets .

Techniques of seed priming

6. On farm priming:-Farmer can prime their own seeds

-Seeds are soaked in clean water usually overnight (about 8 -12 hrs)

-After soaking, the water is drained off and the seeds are surface dried by placing them on cloth or plastic sheet on the ground for 15-30 minutes

-Huge benefit in crop yield was obtained by using some technique in chickpea

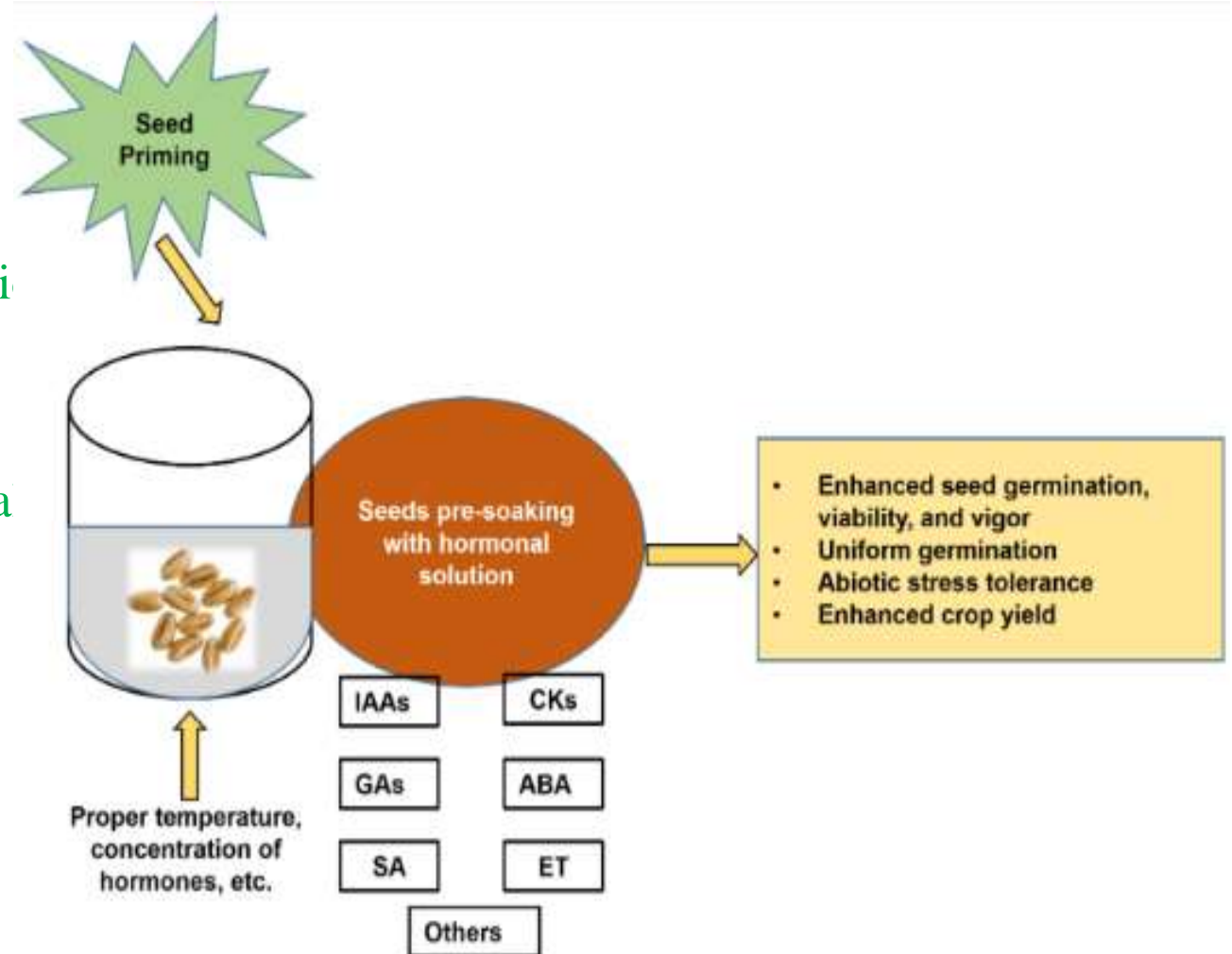
Soaking period

Recommended safe limits tested in over 100 farm trials (with only minor differences depending on variety and country) includes: Rice: 24hrs, Wheat and barley: 12 hrs, Upland rice and maize: 16 – 18 hrs, Sorghum and Pearl millet: 10 hrs and Chickpea and mungbean: 8 hrs

Techniques of seed priming

7. Hormonal priming: refers to treating seeds in hormones such as GA3, salicylic acid, ascorbate, kinetin, jasmonic acid etc which helps in promoting seedling growth

GA3 priming influence on growth and biochemical parameters of chickpea DCP 92-3 cultivar (Mazid, 2014)



Techniques of seed priming

8. Micronutrient seed priming (Nutri-priming)

-Involves priming seeds in solution of nutrients to improve seed quality by increasing nutrient content of seeds

-Micronutrients carryout two vital processes in plants namely, photosynthesis and respiration whose limitation can decrease the overall growth and grain yield

-Priming with micronutrients enable seeds to uptake water at a faster rate and encourages it for different metabolic processes

Raj (1987) and Khalid & Malik (1982) reported enhanced number of leaves, plant height, total yield and dry matter, nodule number and leghaemoglobin content on priming pigeonpea and peanut seeds with cobalt nitrate and increased copper, potassium and manganese content in grains and grain yield on priming wheat seeds in copper sulphate or manganese sulphate, respectively

Techniques of seed priming

9. Bio-priming or seed treatment with micro-organisms, e.g. *Pseudomonas aureofaciens*, *Trichoderma spp.* etc.

- Involves treatment of seeds with beneficial micro-organisms. Micro-organisms which protect plants from pathogens and improve their growth are used.
- **Karthikeyan et al., 2009** observed that *Azospirillum brasilense* and *Pseudomonas fluorescens* primed seeds increased plant parameters such as leaf number, length of roots, height and content of ajmalicine in *Catharanthus roseus* varieties compared with control.
- Hirinzadeh et al., 2013** found that barley seeds primed with *Azotobacter*, *Azospirillum* and its combination (*Azotobacter* + *Azospirillum*) could increase plant and spike height, spike number/area, grains/spike, thousand grain yield and weight, especially *Azospirillum* showing appropriate performance compared with others.
- Similar experiment was performed by **Sharifi et al., 2011** on maize hybrids using same organisms where positive effect on growth, yield, kernel number/ear and grain number/ear row was seen with significant performance by *Azotobacter*

Techniques of seed priming

10. Nanoparticle priming or coating seeds with nanoparticles (NPs):

- A new method of seed priming with nanoparticles (NPs) such as zinc oxide, iron oxide, titanium dioxide, silver nanoparticles etc.
- Fertilizers or nutrients applied to plants are not utilized by them as they get drained away or are broken down by exposure to light and water
- Nanoparticulate material/nutrient delivery to plants provide adequate and restricted use of nutrients/macromolecules at a specific site required for enhancing plant growth
- Germination percentage and root-shoot length were enhanced with iron NPs whereas Cu showed inhibitory effect on growth indicating iron to be stimulatory and copper as inhibitory (**Asmeen et al., 2015**)
- Similarly, **Alam et al., 2015** also reported positive and enhanced results of iron NPs on growth of BARI Gom 25 wheat seedlings at 2ppm whereas negative impact was seen at 2.5 ppm, indicating higher dose of iron oxide to be toxic for germination and seedling growth.

Beneficial effects of priming

Priming exhibits uniform and faster germination rate, seedling vigour and crop establishment under adverse conditions.

Priming overcomes thermo dormancy e.g. lettuce seeds

-Seed priming of different crops can alleviate the adverse effects caused by stress (drought and salt) and enhance crop yield

-Priming ameliorates chromosomal damage induced by aging.

-Priming reduces the soil-borne destructive diseases, e.g. seed priming using *S. mukorossi* and *A. Nilotica* leaf extract was effective in controlling infection with root rot fungi like *Macrophomina phaseolina*, *Fusarium spp.* and *Rhizoctonia solani* in okra, sunflower, peanut and chickpea seeds

- Priming also enhances viability of low vigour seeds

Limitation of seed priming

A reduction of seed storage life is the major limitation of priming and the principal constraint to its diffusion, since dehydration to the initial moisture (drying-back) is needed to allow seed storage.

Toxicity of chemicals

Limited O₂ supply

Difficulty in handling large quantity of seed

Conclusion

Seed priming enhances germination, leads to early flowering and maturity, breaks dormancy and makes the crop resistant to abiotic stresses and soil-borne destructive diseases by inducing systemic resistance.

It is clear that use of different priming techniques has been studied on varied crops and found to be beneficial in terms of crop yield. Hence, seed priming can be considered as a better solution against problems related to germination when seeds are grown under unfavourable conditions.



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