Seed priming have greater influence in seed quality enhancement in low vigor seed lots compared to high vigor seed lots. The response of chemicals influencing the quality enhancement may vary upon the initial quality of the seed. Nevertheless, seed priming have positive influence on seed quality enhancement. Seed priming has been used to improve germination, reduce seedling emergence time, improve yield. Seed priming best solution of germination related problems, especially when crops are grown under unfavorable conditions. Many priming techniques have been evolved, which are being utilized in many crops now days. It can enhance rates and percentage of germination and seedling emergence, which ensure proper stand establishment under a wide range of environmental conditions. Farmers and researchers have recognized that poor crop establishment is one of the major bottlenecks for crop production. Seed priming has been offered as a solution to this problem that will maximize the probability of obtaining high quality seeds and leads obtain a good stand of healthy and vigorous plants. It is rational to propose that seed priming has low cost and low risk that would be appropriate for all farmers, and it is a key technology to improve the livelihood of resource-poor farmers in the marginal environments. Therefore, priming can step-up the economical benefit of crop growing farmers by improving seed quality parameters of most crops.

**Keywords**: Seed priming, seed quality, seedling growth

**INTRODUCTION**

**Background of the review**

Seed priming is the major option for improving the seed quality of most types of crops. It is performed with the use of substances that contribute to the expression of the seed physiological potential. Seed priming may promote more balanced germination rates and higher germination speed, in addition to faster seedling growth under adverse conditions, for case in point, under abiotic stress conditions (Arif, 2014). Seed priming can increase emergence rate, early seedling growth and stand establishment in many crop species. There are a number of priming methods including hydro priming, solid matrix priming and osmotic priming that have been used to improve emergence and seedling growth (Hacisalihoglu et al., 2018).

Hydro priming involves soaking of seeds in water for a specified period, often overnight, where the priming solution does not control water uptake. Osmotic priming incubates seeds in solutions that contain osmotically active compounds such as salts, sugars, or polyethylene glycol (PEG). The concentrations of the osmolytes in the priming solution determine the water potential between the solution and the seed and regulate water uptake. Similarly, solid matrix priming uses chemically inert solid carriers with negative water potential to regulate water uptake. Both solid matrix and osmotic priming slow the rate of imbibitions as compared to hydro priming and allow for additional time to repair cellular membranes and cellular damage and have been shown to improve the emergence of seeds (Hacisalihoglu et al., 2018).

Seed priming is one of the techniques to obtain higher yield of cereal crops like rice by producing quality seedlings. It can improve seed performance under the stress conditions such as drought on newly harvested or aged seeds, which might fail to germinate (Binang et al., 2019). Yarnia et al. (2012) reported that seed priming has been found a double technology to enhance rapid and uniform emergence and to achieve high vigor and better yields in vegetables and floriculture crops. The success of seed
priming depends on a number of factors, including plant species, water potential of primer, duration, temperature, seed vigor, dehydration, and storage conditions for primed seeds (Hussain et al., 2014). Sarika et al. (2013) conducted an experiment to study various physiological and biochemical changes of seed though priming in French bean. They reported that chemo priming with GA and Ethrel improved the seed quality and showed improved seedling length, seedling dry weight which in turn improved higher seedling vigor index, germination speed and mean germination time. Rehman et al. (2014) also experimented to study the seed priming influence on early crop growth, phonological development and yield performance of Linola. Seeds were treated with 50 mm/L salicylic acid, 2.2% CaCl and 3.3 % Moringa Leaf extract ,including untreated dry and hydro-priming control and results showed that osmo-priming with CaCl2reduced emergence time and produced the highest seedling fresh and dry weights. It also reduced crop branching and flowering and maturity time and had the maximum plant height, number of branches, tillers, pods and seeds per pod followed by MLE. It also increases in seed weight, biological and seed yields were 9.30, 34.16 and 39.49 %, harvest index (4.12%) and oil content (13.39%) with CaCl2osmopriming. Finally he concludes that seed osmo-priming with CaCl and MLE can play significant role in improving early crop growth and seed yield of linola. Therefore reviewing and gathering information based on the previous research finding, as well as identifying the knowledge and research gaps under the role of seed priming on seed quality, is very important.

Objective of the review

➢ To review the role of seed priming on seed quality

REVIEW OF LITERATURE AND DISCUSSIONS

Definition of terms

Seed: It is defined as a complex biological structure consisting of a plant in miniature and food reserves protected by covering coats. A miniature plant is possessing a remarkable capacity to ensure that the new individual starts life in the right place at the right time (McDonald and Copeland, 1998)

Seed quality: Seed quality is judged by different end users such as farmers and industries. For instance, farmers expect to obtain high quality seeds that are able to germinate and produce normal seedlings under field conditions (Khan et al., 2012)

Seed priming: Seed priming could be defined as controlling the hydration level within seeds so that the metabolic activity necessary for germination can occur, but radical emergence is banned. Different physiological activities within the seed occur at different moisture levels (Taylor et al., 1998).

The magic behind seed priming improves seed germination and emergence

The last physiological activity in the seed germination process is radical emergence. The initiation of radical emergence requires high seed water content. Once sown, seeds spend significant amounts of time just for absorbing water from the soil. By reducing this time to a minimum, seeds can be made to germinate and seedlings emerge within a shorter time (Mamun and Ali, 2018). Priming also causes physiological and biochemical changes in seed during the seed treatments and metabolic activities increase alpha-amylose activity, thus indicating higher vigor index and well-developed shoot and root (Lee and Kim, 2000). Moreover, vigor index of the seedling is related to germination ability of seeds and nutritional level and those are affected by factors such as moisture, temperature, light, nutrition, pathogen etc. In the seeds of a certain crop type, priming occurs in three stages. Stage I includes mitochondrial DNA repair and protein synthesis by using the existing RNA, in which seeds absorb a large amount of water. Mitochondria and proteins are synthesized during stage II, when supplies, such as proteins, fats and lipids, turn into compounds necessary for germination, and seeds absorb small amounts of water. Stage III involves the completion of the germination process and seedling growth, accompanied by a sudden increase in water absorption (Hussain et al., 2014).

Meena et al. (2013) conducted an experiment with seed priming treatments i.e. is dry seed, hydro-priming, and pre-germinated seeds) in subplots. The results of the experiment showed that priming with plain water and pre-germinated seeds improved germination indices, seedling growth and crop establishment. Furthermore, seed priming with GA has been demonstrated to be a useful tool for activating metabolic germination processes and facilitating increments in physiological processes during seed germination. This means that seed priming using GA3 at appropriate concentrations leads to high germination rates and better seedling growth; however, the beneficial concentration differs among plant species. Similarly Brar et al. (2019) follow that exogenous application of GA3 lead to activation of such genes in seeds, thus improving germination. Increased vigour characteristics elevated peroxide scavenging enzymes activities and declined in lipid per oxidation some of the possible reasons behind enhanced seed germination. Higher metabolic activity in primed seeds causes efficient food mobilization during early hours of germination, which leads to increased shoot and root lengths.

Hussain et al. (2014), Guan et al. (2009) and Rahimi (2013) reported that Vitamin C priming can increase growth parameters of seedlings. According to Mamun and Ali (2018) finding vitamin C priming and Osmo hardening were found superior compared to other priming treatments. Seed germination and seedling growth parameters, particularly germination percentages,
germination energy, vigor index, shoot and root lengths were increased. In addition, seed priming improves emergence, stand establishment, tillering, allometry, grain and straw yields, and harvest index (Faroq et al., 2008). The increase in seed germination percentage upon priming may be due to increased vigor characteristics, increased peroxide scavenging enzymatic activities and decreased lipid per oxidation. Further, an increase in mean seedling dry weight upon priming may be due to increased shoot and root lengths because of higher metabolic activity that leads to the better mobilization efficiency of stored food during the early hours of germination that might have contributed for the better growth of seedlings (Manjunatha, 2018). The effect of priming on spinach with various sources and soaking durations. Four priming sources i.e. is Distilled water, DAP, SSP, SSP+N2CO) and soaking durations of 4 hour interval 4 hour to 24 hour along with control were studied. Number of days to emergence, germination percentage, survival percentage, leaf area (cm2), leaf yield (tons/ha) and 100 number seeds weight (g) were significantly affected by priming sources and durations. SSP+N2CO solution proved the best in most of the parameters while distilled water (control) showed comparatively poor performance (Sharma, et al., 2017).

Role of seed priming on seed quality parameters

Yalew et al. (2012) reported that, seed priming can improve vigor, speed of germination and germination percentage of sesame. Primed seeds with water alone improve the percentage and speed of germination. The root length, shoot length and vigor index of bread wheat was higher due to priming. Primed seed with water was found to be promising for early emergence. For this reason, It is recommended that seed priming in water because it performed better than all treatments and enhancing emergence and better seedling growth. Hacisalihoglu et al. (2018) conducted two laboratory and greenhouse experiments to evaluate effect of seed priming with potassium nitrate on germination and emergence traits of two soybean cultivars cv. Gorgan 3 and cv. Sahar. They reported that seed priming with KNO caused a significant increase in germination and emergence percentage, radical and plumule length, seedling dry weight, plant height, plant leaf area and plant dry weight. Seed priming led to significant increase of leaf area per plant and leaf area of non-primed seeds was decreased by 78%.

Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops, particularly vegetables and small seeded grasses. Sharma et al. (2017) Due to priming treatments, germination percentage at 3rd and 7 day, speed of germination (%) and germination energy (%) varied widely. The highest germination percentage on 3 and 7 day, speed of germination (%) and germination energy (%) was found in Vitamin C priming and it was 91.9%, 97.7% 98.2% and 96.0% respectively and followed by Osmo priming (NaCl). Other priming treatments performed similarly to the control. Yarnia et al. (2012) Concluded that suitable priming of wheat seeds for 12 h in low concentration PEG 6000ml or KH2PO4 at the temperature of in higher germination percentage and seed vigor. Similarly, Yarnia et al. (2012) determined the effect of hormonal treatments i.e., IAA, GA3 and kinetin on germination and seedling growth of onion. Of these priming treatments, GA3 and IAA led to improved attributes such as germination, seedling length, root length, seedling dry weight etc. Helaly et al. (2016) also reported highest germination, seed yield and weight of thousand seeds in GA3 (1000 ppm) primed onion seeds. In case of shallots also GA3 priming significantly enhances the germination, speed of germination, seedling vigour and rate of seedling emergence Agung et al. (2016).

Hydro-priming plus KNO and osmo priming by PEG4000 could speed up seed germination. Barley seeds were primed with hydro-priming plus KNO at 5 mg/ml for 12 hours had significantly high seed germination and low mean germination time (MET). Seed priming enhanced barley seed quality in terms of malt quality especially speed of germination. Priming technique can shorten malting process for 64.81%. Priming of fresh and aged onion seed with GA3 (50 ppm) resulted in favorable impact on the germination ability and seed vigour. Also the aged seed was more responsive to priming as compared to the fresh seed Muruli et al. (2016).

Sharma et al. (2014) reported that in okra significantly higher vigor index was observed in the hydro primed (2044.0) and solid matrix (SM) primed seeds with calcium aluminum silicate (2121.0) for 24 h in comparison to other treatment, Osmopriming (1821.0) and Halo priming (1402.0)] as well as non primed seeds (983.5). Moreover Brar et al. (2019) reported that the standard germination, vigour indices and EC tests could be used as reliable predictors of seed quality because of easiness, quickness and accuracy in their execution. Further, various seed priming treatments can be used for enhancing seed quality of marginal seed lot. GA3 (50 ppm) was found to be best priming treatment for improving the seed quality followed by biofertilizer (Azotobacter), hydro priming and dry dressing with Thiram (2 g/kg), KH 2 PO 4 (0.5%) and KNO 3 (0.5%), respectively.

Overall, the priming technology was found useful and beneficial for enhancing the physiological, biochemical and storage potential of crop seeds like onion seed. Indeed, in the case of these onion seed varieties, we recommend the priming treatment for getting a plentiful harvest. Sharma et al. (2017) showed that, osmopriming with KNO3 for different durations were superior than unprimed treatments in terms of seed germination, emergence, plant height, and dry matter accumulation at 3 weeks after sowing. Seeds of cowpea could be primed (both hydro and osmopriming) for increased performance. However, osmopriming with KNO salt (soaked in 1%
KNO₃ salt solution and dried before sowing) for 6 hours could result in greater seed germination and seedling height than hydro priming Yalew et al. (2012). Correspondingly, Sharma et al. (2017) conducted an experiment to study the effect of osmo priming duration on germination, emergence and early growth of cowpea. Treatment consisted three osmo priming duration (soaking in 1 % KNO₃ salt for 6, 8 and 10 hrs) and one hydro-primed control (10hr) and the result showed that osmo-priming with KNO₃ for different durations were superior to unprimed treatment in term of seed germination, emergence, plant height and dry matter accumulation in cowpea. However, osmo-priming with KNO₃ salt (soaked in 1 % KNO₃ salt solution and dried before sowing) for 6 hours could result in greater seed germination and seedling height than hydro-priming.

Manjunatha et al. (2018) treated sunflower seeds with priming chemicals 12 hours of soaking with C1: Control, C2: Hydro priming, C3: KH₂PO₄ (1%), C: (400ppm), C5: NaCl (1 %), C6: KCl (2 %), C7: KNO₃(2%), C8: CaCl₂.2H₂O: GA (2%), C: PEG (1Mpa), C10: K₂HPO₄ (1 %). The results of the study showed that among the seed lots L has recorded higher seed quality parameters viz., germination (93.00 %) and seedling length (26.70 cm) compared to L (70.67 % and 19.30 cm). Among the various seed priming treatments KH₂PO₄ (1%) is the suitable priming chemical to improve the marginal quality sunflower seed lots viz., germination (89.67%), speed of germination (19.22), days to 50 % germination (2.15), seedling length (28.83 cm), seedling dry weight (64.44 mg) and seedling growth ratio (1.44) compared to control (81.83 %, 15.91, 2.74, 23 cm 55.03 mg and 1.20 respectively). Moreover Ahmad and Lee (2011) showed that the highest germination percentage of hydro primed sesame seeds for 12 h compared with non-primed seed. Similarly Geraldo et al. (2017) reported that highest germination percentage in chickpea with hydro priming for 12 h was recorded. On the other hand, (8) studied that ascorbic acid priming on chickory seeds have shown the highest germination percentages, fastest germination rates and best seedling development under stress and non-stressed conditions while potassium chloride (KCl) enhanced germination only under non-stress condition.

Among the priming methods, seeds primed with KNO₃ performed well and followed by hydro priming. The possible effect of KNO₃ might be due to its role in influencing the turgidity of membranes, lead to activation of enzymes involved in protein synthesis and carbohydrate metabolism. Besides, the nutrient potassium has a positive effect on keeping quality Pinpinatt et al. (2015). Guan et al. (2009) shows that the chitosan priming increased the chilling tolerance of maize seedlings demonstrated by improving germination speed and shoot and root growth and maintaining membrane integrity and higher activities of ant oxidative enzymes. The 0.50% chitosan seems to be a suitable concentration for seed priming. Fresh seeds of cucumber were artificially aged as per ISTA standards to low vigor seed lots. Both high vigor (unaged) and low vigor (aged) seeds were subjected to seed priming with various chemicals (water, KH₂, K2HPO₄, oxalic acid, gibberellic acid, KNO₃,calcium chloride, salicylic acid) and results were compared to PO4. Changes in physiological (percent germination, total seedling length, total seedling dry weight, seedling vigor index I and II) and biochemical parameters (Electric conductivity, total soluble sugars and proteins, dehydrogenase activity, amylase activity, catalase activity, protein profiles, isozymeProfiles) in relation to enhancement in viability and vigor upon priming were identified. The germination ability of primed seeds was compared with unpruned seeds under various biotic stress conditions (Pratima et al., 2017).

Priming with calcium nitrate leads to greater germination rates under suboptimal temperature conditions, in addition to better seedling emergence, regardless of the seed lot used. Seeds undergoing controlled deterioration have higher germination rates with the use of calcium nitrate plus phenylalanine in seed priming, regardless of the seed lot used (Geraldo et al., 2009). Mamun and Ali (2018) reported that there was a significant effect of seed priming on different rice varieties. However, the priming effect differed with rice varieties. The variety Nerica showed poor performance; whereas the other varieties were found superior. Vitamin C priming and Osmopriming were found superior compared to others priming treatments. Seed germination and seedling growth parameters, particularly germination percentages, germination energy, vigor index, shoot and root lengths were increased by the treatments with Vitamin C priming and Osmo-priming for Nerica. What is more, seed priming with NaCl (1% solution for 36 hours) was found superior among all the different durations of priming treatments. Moreover, priming treatments have more pronounced effect on variety V2 S 22 maintained highest seedling parameters followed by Navodya of tomato seeds. So, we can integrate these treatments in the priming of tomato seeds. The variety of S 22 can be beneficial for the farmer as its germination percentage is good; it may be grown in farmer field so that they can get more production (Rahimi, 2013).

CONCLUSION AND RECOMMENDATION

Conclusion

It is concluded that:

- Seed priming have greater influence in seed quality enhancement in low vigor seed lots as compared to high vigor seed lots.
- The response of chemicals influencing the quality enhancement may vary upon the initial quality of the seed. Nevertheless, seed priming have positive influence on seed quality enhancement.
Seed priming has been used to improve germination, reduce seedling emergence time, improve stand establishment and yield.

The beneficial effects of priming have been demonstrated for many crops. It is the best solution of germination related problems, especially when crops are grown under unfavorable conditions.

Many priming techniques have been evolved, which are being utilized in many crops nowadays. It can enhance rates and percentage of germination and seedling emergence, which ensure proper stand establishment under a wide range of environmental conditions.

RECOMMENDATION

It is recommended:

- Farmers and researchers have recognized that poor crop establishment is one of the major bottlenecks for crop production. Seed priming has been offered as a solution to this problem that will maximize the probability of obtaining high quality seeds and leads obtain a good stand of healthy and vigorous plants.
- It is rational to propose that seed priming has low cost and low risk that would be appropriate for all farmers and it is a key technology to improve the livelihood of resource-poor farmers in the marginal environments. Therefore, priming can step-up the economical benefit of crop growing farmers by improving seed quality parameters of most crops.

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