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Seed priming - one small step for farmer, one giant leap for food security: I application and exploration

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Abstract

Crops under field condition face multiple abiotic and biotic stresses that reduce productivity and threaten world food security. Recent works suggests seed priming can optimise seed vigour through genetic repairing and optimising plant physiological process. Priming seeds not only produce robust seedling but also makes the plant ready to face multiple probable stresses in the field more efficiently. We review here factors influencing seed priming and promising methods such as hydro priming, halo priming, osmo-priming, osmo-hardening, hormonal priming, matrix priming, nutri priming and bio-priming that can potentially confer enhanced tolerance when plants are exposed to multiple stresses. The crop specific use of different agents along with its challenges, opportunities and explorative evidences of chemical priming with Selenium and nano Zinc are addressed, with the aim to boost future research towards effective application in crop stress management.

Keywords: Robust seedling, stress, selenium, nano zinc

Introduction

Plants are continuously exposed to a broad range of environmental stresses in the field due to their sessile lifestyle. Abiotic stresses such as salinity, drought, flooding, heat, cold, freezing, nutrient, excess light, UV radiation, heavy metal toxicity and anaerobic stresses as well as biotic stresses such as weed, insect, pathogens (including bacteria, fungi, viruses and nematodes) have a devastating impact on plant growth and yield under field conditions (Savvides *et al*., 2016) [1]. Plants exposed to these stresses sequentially or simultaneously may act synergistically or additively affecting germination, establishment, growth, plant stand, resource utilisation and ultimately, yield. Anthropogenic contribution due to unbridled and imbalanced industrialisation, urbanisation (Nagajyoti *et al*., 2010) [2] and climate change also aggravate the situation affecting global food security. Considerable research work has done towards enhancing plant tolerance to different stresses (Suzuki *et al*., 2014) [3].

Conventional breeding approach to mitigate this multiple stress is time consuming and modern breeding approach involving plant genetic modification is also controversial and currently unacceptable in many countries. Exploring and exploiting physiological phenomenon like priming may an alternative where plants can be 'prepared' to more successfully tolerate future biotic and abiotic stress conditions.

Seed priming may be defined as controlled hydration of seeds to a level that allow pre-germination metabolic activity to continue, but interrupts actual emergence of the radical. Here, we are going to discuss the factors determining the process-efficacy, methods and agents used thereof as well as modern trends.

Factors

There are several biotic and abiotic factors influencing seed priming technology as discussed below.

Priming technique

The priming techniques involved plays an important role in this regard. Each technique has its own advantage and disadvantages. One of the famous seed priming technique is hydro priming. Not only the methods, agents used in those processes also plays a significant role. As for example PEG simulated stress is more beneficial among the NaCl salt and Poly Ethylene Glycol (PEG) simulated stress mentioned by Murillo-Amador *et al*., (2002) [4] in Cowpea.

Temperature

Temperature plays an important role in germination as well as in seed priming. Every crop requires optimum temperature for germination. Optimum temperature for priming and germination of tomato seeds was 27–28 °C (Ozbingol *et al*., 1998) [5], Seed priming is the situation physiologically same as germination.

Oxygen availability

Most seeds can germinate in an atmosphere that is composed of about 20% of oxygen, seed priming decreases the seed's sensitivity to lower oxygen levels. Seeds require a sufficient amount of oxygen (more than 10%) during seed priming (Farooq *et al*., 2012) [6].

Osmotic potential and solution

Osmotic potential plays an important role during germination and seed priming. Water moves from higher potential seed priming solution to lower potential seeds. The movement of water is highly dependable upon seed size, reproductive structure permeableness and hydratable substrate content of the seed (Bewley *et al*., 2013) [7]. Thus seed priming solution concentration and water potential are one of the important factors that determine the effectiveness of seed priming.

Treatment duration

Duration for the seed priming treatment process is an important factor for a few plants. The saturation of seeds with the priming solution is the key to find out the duration of the seed priming technique (Ghassemi-Golezani and Esmaeilpour, 2008) [8]. Thus seed priming with optimum amount of agents along with optimum duration of treatment is very important.

Seed quality

Seed Quality is the key factor for the seed priming process. Seed priming is gaining importance for converting such bad seeds to quality seeds for better crop yield. In order to achieve maximum viability and vigor of seeds, seeds should be harvested close to the physiological maturity stage (Kazemi and Eskandari, 2012) [9].

Light

Light or radiation may be necessary for certain photoblastic seeds to germinate. So the use of light as an initial dormancy breaker is a year old practise. Khan *et al*., (1978) [10] used light for breaking dormancy in lettuce and celery.

Dehydration after priming

Dehydration after priming is an important process for packing and storage of the primed seeds. It has some beneficial aspects which should be carefully performed as excess dehydration may lead to production of dormant seeds. However, Schwember and Bradford, (2005) [11] found that the fast or slow drying-back after priming lettuce seeds had lower seed longevity than nonprime seeds.

Storage condition

Seeds stored after priming have an impact of the storage condition to their future performances. According to Hussain *et al*., (2015) [12] achieved lowest seed germination and growth seedling attributes from the rice seeds stored at 25 °C while no significant reduction was observed from the seeds stored at −4 °C.

Methods and seed priming agents

Seed priming is an ancient process. Now-a-days several priming techniques are developing to provide better seed quality such as

Hydro priming

In hydropriming, the seeds are normally soaked in water before sowing for a particular period depending upon the radical protrusion time of every plant species. It is a very simple, cheap technology as normal water is used in this priming technique. Hydropriming improves seed germination, seed plant emergence, and productivity of field crops (Nagar *et al*., 1998) [13].

Halo priming (Veda)

Halo priming is a technique which involves submerging of seeds in the solutions of inorganic salts *viz*. sodium chloride, potassium chloride etc. The priming of seeds with these soluble salts makes the seeds more seasoned to tolerate stressed alkaline and salt affected soils (Bajehbaj, 2010) [14].

Osmo-priming

Osmo-priming involves soaking of seeds in solution of osmotic priming material for a certain period followed by air-drying before sowing. Osmotic solutions used are of less water potential so that water uptake is restricted. Tavili *et al*., (2011) [15] show that seeds primed with PEG 6000 improved germination and produced longer roots as compared with hydro-priming and unprimed seeds.

Osmo-hardening

Osmo-hardening is the process involves soaking seeds in tap water for 24 hrs, followed by dipping the re-dried seeds in CaCl2 and KCl solutions for hardening. Rehman *et al*., (2011) [16] reported that osmo-hardening with CaCl2 proved to be better followed by KCl.

Hormonal priming

Hormonal priming involves the hydration of seeds in an aerated solute medium of various plant growth promoting hormones such as abscisic acid, kinetin, SA (salicylic acid), GA3 and ascorbate (Zheng *et al*., 2016) [17].

Matrix priming

Matrix priming, also called as the solid matric conditioning. In solid matrix priming (SMP), the matrix potential of the priming solution is controlled during seed imbibition with the addition of solid matrix substance that produce matrix forces to hold water and slowdown the solute uptake by seeds (Selvarani and Umarani, 2011) [18].

Nutripriming

Nutrient priming has been proposed as a novel technique that combines the dual benefits of seed priming with an improved nutrient supply. It involves priming of seeds in solution of nutrients to improve seed quality by increasing nutrient content of the seeds. Micronutrients play a vital role for plant growth through two important process namely photosynthesis and respiration, hence becomes essential for overall growth and grain yield (Farooq *et al*., 2012) [6].

Bio priming

Biopriming or biological seed treatment is the use of beneficial microbes in seed–plant–soil system to induce plant productivity and simultaneously maintain the environmental balance. The priming agent help to promote plant growth by adding nutrients to crops, improve biotic and abiotic stress tolerant ability of plants and also improved soil diversity (Singh, 2015) [19].

Recent trends in seed priming

Researchers are in continuously searching for new priming agents having multiple stress tolerance and other secondary beneficial effect to mankind. In this direction, experimentations are going on possibility of using Selenium and nano zinc ether as sole or in combination in this regard.

Selenium as a seed-priming agent

Berzelius discovered selenium in 1817. In recent days importance of Se in food chain is gradually increasing that's why scientists are paying more attention to incorporate Selenium into crop plants. So we have to incorporate Selenium in crops without any detrimental effects on them. Hence, introduction of Selenium through Seed Priming technology can play a significant role.

As for example, seeds primed with Selenium at different doses resulted in early emergence of seedlings, which triggered seedling growth, yield and seed quality (Khaliq *et al*., 2015 [20]; Boghdady *et al*., 2017) [21]. Prime with selenium higher the vitamin C concentration, antioxidant properties with an increase in the leaf area and fresh and dry weights of the seedlings. Selenium pre-treatment boosted the metabolite and antioxidative defence system under drought stress conditions and improved quality with higher levels of amylose, phenolic compounds, and flavonoid and oil contents with remarked reduction in grain water uptake during cooking. (Emam *et al*., 2014) [22].

Nano zinc

Uses of Nano-fertilizers can improve crop yield. Contented and reactivity of phytohormones are main index of plant physiology. CeO2 NPs improve the biochemical aspects like amino acids, non-reducing sugar, fatty acids, and phenolic complex in numerous plants. Nano-fertilizers increase nutrient productivity and provide the nutrient according to the need of crops. Many studies depicted that chemical fertilizers are less efficient compare to nano fertilizers. Seed prime with Nanoparticle (Zn NP) was very effective in improving seed germination, radicle and plumule length in rice seedling and increased RWC, dry mass and significant improved chlorophyll content, total soluble sugar, leaf protein, shoot length, root length, root area, (Tarafdar *et al*., 2014 [23]; Upadhyaya *et al*., 2018) [24].

Conclusion

The action of priming agents such as water, Calcium chloride, Manganese, Selenium, Salicylic acid, kinetin, potassium chloride, moringa leaf extract, Pseudomonas fluorescens, Bacillus sp. Etc. as stress signalling molecules and priming agents against different crops has been established. However, few studies have tested the crop specific application of appropriate methods and use of specific priming agent thereon. Considering factors of priming, specific methods can potentially be used through exploitation of early vigour for effective mitigation of futuristic multiple abiotic stress phenomena that may occur in the field. Selenium and nano Zinc, the promising agent candidates are also explored on the basis of germination, emergence, establishment, stress mitigation and crop yield performance. However, further knowledge of the complex mode of action in crop stress tolerance, pharmacological research and time-series studies in combination with proteomics, transcriptomics, and metabolomics are needed. Mode of application, the integration of different priming in crop management practices for higher productivity, and the possible environmental impacts of priming also need to be considered.

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Disclosure statement

No potential conflict of interest was reported by the authors.

References

1. Savvides A, Ali S, Tester M, Fotopoulos V. Chemical priming of plants against multiple abiotic stresses: mission possible? Trends in Plant Science 2016;21(4):329-340.
2. Nagajyoti PC, Lee KD, Sreekanth TV. Heavy metals, occurrence and toxicity for plants: a review. Environmental Chemistry Letters 2010;8(3):199-216.
3. Suzuki N, Rivero RM, Shulaev V, Blumwald E, Mittler R. Abiotic and biotic stress combinations. New Phytologist 2014;203(1):32-43.
4. Murillo-Amador B, López-Aguilar R, Kaya C, Larrinaga-Mayoral J, Flores-Hernández A. Comparative effects of NaCl and polyethylene glycol on germination, emergence and seedling growth of cowpea. Journal of Agronomy and Crop Science 2002;188(4):235-247.
5. Ozbingol N, Corbineau F, Côme D. Responses of tomato seeds to osmoconditioning as related to temperature and oxygen. Seed Science Research 1998;8(3):377-384.
6. Farooq M, Wahid A, Siddique KH. Micronutrient application through seed treatments: a review. Journal of soil science and plant nutrition 2012;12(1):125-142.
7. Bewley JD, Bradford KJ, Hilhorst HWM, Nonogaki H. Seeds: physiology of development, germination and dormancy, 3rd edn. Springer, New York 2013.
8. Ghassemi-Golezani K, Esmaeilpour B. The effect of salt priming on the performance of differentially matured cucumber (*Cucumis sativus*) seeds. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 2008;36(2):67-70.
9. Kazemi K, Eskandari H. Does priming improve seed performance under salt and drought stress. Journal of Basic and Applied Scientific Research 2012;2(4):3503-3507.
10. Khan AA, Tao KL, Knypl JS, Borkowska B, Powell LE. Osmotic conditioning of seeds: physiological and biochemical changes. In Symposium on Seed Problems in Horticulture 1977, P267-278.
11. Schwember AR, Bradford KJ. Drying rates following priming affect temperature sensitivity of germination and longevity of lettuce seeds. Hort Science 2005;40(3):778-781.
12. Hussain S, Zheng M, Khan F, Khaliq A, Fahad S, Peng S, Huang J, Cui K, Nie L. Benefits of rice seed priming are offset permanently by prolonged storage and the storage conditions. Scientific Reports 2015;5(1):1-2.
13. Nagar RP, Dadlani M, Sharma SP. Effect of hydropriming on field emergence and crop growth of maize genotypes. Seed Research 1998;26:1-5.

14. Bajehbaj AA. The effects of NaCl priming on salt tolerance in sunflower germination and seedling grown under salinity conditions. African Journal of Biotechnology 2010;9(12).
15. Tavili A, Zare S, Moosavi SA, Enayati A. Effects of seed priming on germination characteristics of Bromus species under salt and drought conditions. American-Eurasian Journal of Agricultural and Environmental Sciences 2011;10(2):163-168.
16. Rehman HU, Basra SM, Farooq M. Field appraisal of seed priming to improve the growth, yield, and quality of direct seeded rice. Turkish Journal of Agriculture and Forestry 2011;35(4):357-65.
17. Zheng M, Tao Y, Hussain S, Jiang Q, Peng S, Huang J, Cui K, Nie L. Seed priming in dry direct-seeded rice: consequences for emergence, seedling growth and associated metabolic events under drought stress. Plant Growth Regulation 2016;78(2):167-178.
18. Selvarani K, Umarani R. Evaluation of seed priming methods to improve seed vigour of onion (*Allium cepa* cv. aggregatum) and carrot (*Daucus carota*). Journal of Agricultural Technology 2011;7(3):857-867.
19. Farooq M, Wahid A, Siddique KH. Micronutrient application through seed treatments: A review. Journal of Soil Science and Plant Nutrition 2012;12(1):125-142.
20. Singh M, Awasthi A, Soni SK, Singh R, Verma RK, Kalra A. Complementarity among plant growth promoting traits in rhizospheric bacterial communities promotes plant growth. Scientific Reports 2015;5:15500.
21. Khaliq A, Aslam F, Matloob A, Hussain S, Geng M, Wahid A, Ur Rehman H. Seed priming with selenium: consequences for emergence, seedling growth, and biochemical attributes of rice. Biological Trace Element Research 2015;166(2):236-244.
22. Boghdady MS, Desoky E, Azoz SN, Abdelaziz DM. Effect of selenium on growth, physiological aspects and productivity of faba bean (*Vicia faba* L.). Egyptian Journal of Agronomy 2017;39(1):83-97.
23. Emam MM, Khattab HE, Helal NM, Deraz AE. Effect of selenium and silicon on yield quality of rice plant grown under drought stress. Australian Journal of Crop Science 2014;8(4):596-605.
24. Tarafdar JC, Raliya R, Mahawar H, Rathore I. Development of zinc nanofertilizer to enhance crop production in pearl millet (*Pennisetum americanum*). Agricultural Research 2014;3(3):257-262.
25. Upadhyaya H, Roy H, Shome S, Tewari S, Bhattacharya MK, Panda SK. Physiological impact of Zinc nanoparticle on germination of rice (*Oryza sativa* L.) seed, Journal of Plant Science and Phytopathology 2017, P2575-0135.