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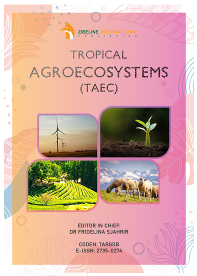

RESEARCH ARTICLE

SIGNIFICANCE OF SEED PRIMING IN AGRICULTURE AND FOR SUSTAINABLE FARMING

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ABSTRACT

This paper focuses on the significance and method of priming which is of present and essential need. The need for following seed priming is due to their multiple benefits in agriculture and crop production like rapid germination, good seed vigor, drought, and heat tolerant, abiotic and biotic stress tolerance behavior are seen in primed crops. However, the method of priming for optimum yield differs from crops to crops which are discussed in detail in findings. For sustainable and eco-friendly farming seed priming is also one of the determinants and influencing factors.

KEYWORDS

Bio-priming, Annual crops, Bio-fertilization, Disease resistance, Halo-priming, Abiotic stress tolerance.

1. INTRODUCTION

Rapid and uniform field emergence is very much necessary to increase yield quality and, sure profit in annual crops. This has a major impact on final yield and quality on direct-seeded crops. Germination and emergence of seedlings are affected by different stresses like drought, salinity, temperature, heavy metals, and others. These constraints limit plant growth and productivity. It reduces average yields for most crop plants by more than 50 % (Varshney and Tuberosa, 2013). Several methods are experimented and applied to increase the productivity and stress tolerance of crop plants. Of the various methods, seed priming is popular because of its key effects on the germination and growth of various plant species. It is the controlled hydration of seed that permits pre-germinative physiological and biochemical changes to occur but restricts germination (Choudhary et al., 2008). It looks simple but a successful solution for improved crop production (Agawane and Parhe, 2015; Nawaz et al., 2013). Seed priming is the best option to increase the early emergence of an early establishment of principles crops i.e. wheat, rice, maize, sorghum, chickpea, and soybean (Chiduza, 1996). It can increase the rate of emergence, seedling vigor, advance flowering, early maturity, and increase productivity (Harris, 2006; Howarth et al., 1996). Water priming was done on rice cultivars in west Africa and result, it takes 50% less germination time compared to unprimed seed (Harris, 1997). It has the potential to improve the germination process under salinity conditions (da Silva Oliveira and Steiner, 2017). There are different methods of priming that are being followed in the field level by farmers. Hydro priming, Osmo priming, chemo priming, Hormo priming are some methods of priming which are practiced by farmers for crop improvement. Also, seed priming signifies to nullify the effects on crop establishment and crop yield seen in late sown wheat by biopriming (Giri and Schillinger, 2003a; Thapa et al., 2020). This paper focuses on the significance of primed seed in agriculture and its role in sustainable farming.

2. METHODOLOGY

The latest research papers and review papers relevant to seed priming research are collected through different national and international open access journals. Also, articles of Scopus and Pub-med indexed journals were reviewed for more relevant and quality information on seed priming. All of the findings present in this paper is secondary information drawn from the above-mentioned sources.

3. FINDINGS

3.1 Physiological and biochemical changes in primed seeds

Priming leads to various physiological and biological variations on seeds. It minimizes the lag time required for imbibition, initiates enzymes, catalysis, or metabolizes inhibitors, transportation of reserved food materials, and promotes outgrowth of embryonic tissue (Nawaz et al., 2013). Starch metabolism has a great role in the seed which affects seedling vigor under pressure. Starch metabolism is carried out by α-amylases which hydrolyzes the reserved food material i.e. starch into sugars provides energy to the developing embryo.

The activity of α-amylases in primed barley seeds is raised by 2.8 times, whereas in primed wheat seeds α-amylase activity was raised by 2.7 times compared to unprimed seed. This could have enhanced germination activities in primed seeds. Seed priming also assists in malate synthase and Isocitrate lyase which converts lipids into carbohydrates. Thus, covering the seeds from lipid peroxidation and oxidative damage of membrane phospholipids contributing seed longevity (de Oliveira, Gomes-Filho et al., 2012). Priming assists in the synthesis of alpha and beta-tubulin subunits which balances cell division and structure (cytoskeleton) (Varier et al., 2010). Priming also is shown in inducing nuclear DNA synthesis in the radical tip cells in tomato, including maize (Zea mays L.) (Liu et al., 1997; Gracia et al., 1995).

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3.2 Methods of seed priming

experiments had been performed. Different techniques are used for seed priming such as Hydro-priming, where the seeds are soaked in water, Osmopriming, where the seeds are soaked in an osmotic solution like Polyethylene glycol (PEG), glycerol or mannitol followed by air-drying for a certain period, Halopriming, where the seeds are soaked in inorganic salt solutions, Hormonal priming is the pre-seed treatment with various kinds of hormones such as kinetin, ascorbate, Gibberellic acid (GA3), etc which induces the proper growth and development of the seedlings (Moradi and Younesi, 2009; Farooq et al., 2005; Nawaz et al., 2013). Seed priming techniques such as hydro-priming, halopriming, osmopriming, hormone priming, Nutri priming, chemical priming, bio-priming are practiced in rice for many environmental stresses (Jisha et al., 2013; Paparella et al., 2015).

3.3 Treatments

3.3.1 Treatment by growing adjusters

Growing adjusters of the plant bring very slight modifications in physiological activities. Two or more materials are enough to develop physiological effects by the simultaneous activities of these materials (Dubinov et al., 2000). The famous adjusters are Cycocel, Ethephon, Gibberellic, Cytokinin, and Indol Acetic Acid (IAA). The growing adjusters in cereals are used for increasing longevity and durability of plants against cold climate (Gusta et al., 1994). Auxins such as IAA (Indole Acetic Acid), IBA (Indole Butyric Acid), NAA (Napthlaneacetic Acid), 2,4-D (2,4-Dichlorophenoxyacetic acid) are commonly used for stimulation and development of healthy roots and also for priming (Decastro et al., 1990). During the initial phase of the barley crop, by using 20 g/mlμ gibberellic acid, increases stalk, the number of spikes, and seed yield (Koranteng and Matthews, 1982). Likewise, a similar result was obtained in the growing stage of barley by using Cycocel and Ethephon (Ma and Smith, 1992). GA3 @50ppm of primed seed lead to substantial of plant life such as improve root length, uniform budding, the vigor of the plant, and pathogen-free (Hoseini et al., 2013).

3.3.2 Treatment by osmotic solutions

When wheat seeds are treated by 2.5% potassium chloride solution for 12 hours before planting, it increased 15% in wheat performance (Misra and Dwivedi, 1980). The germination phenomena would have fastened in cold weather when maize seeds are treated by polyethylene glycol or inorganic salts of potassium like KNO3 and K2HPO4 (Basra et al., 1989). The rate of germination phenomena accelerated when wheat seeds are treated by polyethylene glycol solution (Chiu et al., 2002). The sprouting phenomenon occurs more rapidly and effectively in both land and lab when the seeds are treated by Polyethylene glycol, moreover, treated seeds are much more compatible than unprimed ones (Windauer et al., 1994). Osmopriming or Osmo conditioning in plants has the highest rate of sprouting and solid weight by inorganic potassium salt (Potassium nitrate) (Yildirim and Bahar, 2010).

3.3.3 Treatment by pure water

When seeds are dipped into distilled water, the absorption speed of nitrogen increase by 11 kilograms per hectare. The power of conventional priming (12 hours) on maize seed for two successive years was examined and observed. In both years, it was found that yield results weren't the same though it leads to computable effects on growth, flowering, and ripening time (Murungu et al., 2004). On the other hand, there was more growth, longevity, durability, production, earlier flowering and ripening, and higher performance in the treated seeds of maize (Harris et al., 2001). The soaking seeds of barley in water leads to better performance of seed and straw. The soaking of wheat seeds in water for about 12 hours leads to a better germination process (Giri and Schillinger, 2003b). Priming seed of pea by mannitol and water (4%) for 12 hours at a temperature of about 25°C increases plant knots and biomass numbers (Kaur et al., 2002). Hydro-priming of bean seeds in water for 7-14 hours lead to better functioning and improved performance (Ghassemi-Golezani et al., 2010).

3.3.4 Solid Matrix priming

This treatment is carried out by mixing the seeds with a high-power capacity of solid substances such as Vermiculite, peat moss, Ground Leonardite Shale, charcoal, sand, and clay. In this treatment, the water-absorbing capacity of seed is guided by physical and chemical properties (Hartz et al., 1997). This priming is applied on turfgrass species Seed priming treatment technique has been practiced in many countries including India, China, Pakistan, Australia and more than thousands of furthermore, performed farm examinations, evaluation and finishing budding judgment (Yamamoto et al., 1997).

3.3.5 Priming methods recommended as per crops

Generally, methods of priming differ from crops to crops and sometimes between cultivars too (table 1). however, the method of priming is of utmost importance to indirectly influence yield and crop performance.

3.4 Seed priming as a tool for sustainable agriculture

The use of higher chemical toxin containing priming techniques tend to get hazardous for the people as they have a direct bad effect on the human health. In this respect, different types of seed priming like osmo-priming, matrix priming hydro-priming, bio priming and halo-priming can be adopted. In regard bio-priming is to be considered a boon for seed priming. Bio priming over the time has helped to reduce majority of the plant disease and pathogen related problems. Biopriming treatment is able to inflict changes in plant characteristics and bring about uniform seed germination and development associated with micro-organism immunization. Seed priming and osmo-priming are primly being used in lots of horticultural crops to increase and promote the growth and uniformity of germination. However, it may be used alone or in combination with biocontrol agents to fasten the rate of seed emergence and minimize soil borne diseases. Besides, few of the biocontrol agents can be used to be able to colonize the rhizosphere, they help the seed to resist the abiotic stresses like drought, heavy metal stress, drought and salinity etc.

They are used as seed dressers (Govindasamy et al., 2011). Therefore, biopriming has become a viable option than using inorganic chemicals leaving the residue (Govindasamy et al., 2011). Hence bio priming can prove to be a crucial step towards the sustainable agriculture it will help solve major problems regarding many pathogens so it is very useful as the bio residues left on plants will not have any side effects like the fungicides, insecticides that chemically leave the residue on the plants. Yellow mosaic virus of mung bean and downy mildew of pearl millet, Collar rot (Sclerotium rolfsii) in chickpeas, are found to decrease with the use of hydro-primed seeds. The use of Trichoderma as a form of bio priming has helped to solve the cowpea root rot pathogens problems (Thapa et al., 2020). Salicylic acid solely or in combination with magnesium nitrate (Mg (NO3) 2) can produce the ability of resistance in groundnut and mustard plants against Alternaria alternate and Alternaria brassicae (Haque et al., 2012).

3.5 Seed priming enhances crop growth and yield

Seed priming had a significant effect on crop growth enhancement. In barley, the grain was increased as a result of seed priming. The highest improvement in grain yield per unit area (32%) was achieved by hydro priming over control (Abdulrahmani, et al., 2007). The rice yields with bio fertilization were 6310 kg/ha whereas without bio fertilization i.e. control was 5912 kg/ha. The primed rice had a 7% higher yield in comparison with control. In black gram, plant height significantly differed among the varied level of seed priming at all the crop growth stages. The priming of black gram with NPK 10:26:26@ 10gm lit^{-1} solution had produced a plant with a maximum height at 30, 45, and 60 DAS. Seed priming treatment of black gram has a positive effect on yield attributes like grain yield, plant height, crop growth rate, and periodic no of leaves over no priming i.e. Control (Assunção de Almeida et al., 2018).

Similarly priming in Mung bean seed with osmo priming there is earlier emergence and flowering compared to non- primed seeds. The primed seed had greater grain yield (16% more) and Biological yield (15% more) over the control. The bio primed treatment on Sorghum has influenced growth i.e. plant height (196.65 cm), day to 50% flowering (70.0 DAS), and root shoot ratio (0.23). As well as biopriming on sorghum has increased 15.33% mass grain yield over control (Kumar and Nagesh, 2011). In maize, the primed treatment shows the most effective than other treatments which influenced the growth of maize with attained plant height 188.26 cm, days to 50% tasseling 63DAS, days to 50% silking 67.5DAS and root shoot ratio 0.32. The bioprimed treatment on maize has increased 10% kernel yield over the control (Kumar and Nagesh, 2011). The seed priming with sodium molybdate @ 500ppm + seed coating with Trichoderma harzianum @ 15g/kg seed has shown effect treatment for Pea.

Table 1: Recommended priming methods in different economically important crops

Name of crop	Cultivar	Treatment used for priming	Recommended priming	References
Rice	Puita	Priming with Zn, Znic Sulphate solution, boric acid	Stimulate and Zinc sulphate	
	Super basmati Shaheen basmati	Sodium selenite, Hydro priming	Sodium selenate	
	Nerica	On farm priming, hardening, hydropriming, osmo hardening, vitamin-C, control	Vitamin-C priming and osmo-hardening	(Mamun et al., 2018)
	MR219	Hormonal priming and osmo-priming	Hormonal priming and osmo-priming	(Kareem et al., 2019)
Maize				
	DKB390 VTPRO2	Immersion in non-aerated solution and towel paper rolls	Priming using towel paper rolls	(Pallaoro et al.,2016)
	21NS Ht	Hydropriming, Priming with different concentration of KNO3 solution	Priming with 0.5% KNO3	
Wheat	Edwin	Potassium chloride, Polyethylene glycol, Hydropriming	KCL and Hydropriming	(Giri and Schillinger, 2003b)
	Zarin	Polyethylene glycol, KNO3, osmo-priming	Osmopriming	
Barley	Abidar	Hydropriming, osmopriming, Nutrientpriming	Nutrient priming in P solution	(Abdulrahman et al., 2007)
	Bajour and Frontier87	Onfarm seed priming and hydropriming	Onfarm seed priming	
Marigold		Polyethylene glycol 6000	Polyethylene glycol 6000	(Arjenaki et al., 2011)
	Bonanza Gold marigold	Paclobutrazol	Paclobutrazol	
Chickpea	GPF-2	Priming in0.1%mercuric chloride, Osmo priming, hydro priming	Priming with water and mannitol	(Kaur et al., 2002)
	GG-1 GJG-3	KNO3, PEG, Bavistin, Neem oil, Control	KNO3@100PPM	(Patil et al., 2018)
Sorghum	Buhoth70	Gibberellic acid, salicylic acid	Gibberellic acid, salicylic acid	
Millet	Barnyad millet	Hydro priming, Hormopriming, organic priming, botanical priming, halo priming, chemo priming	Hormo priming	
Soyabean	William-82	Hydropriming, Polyethylene glycol, Osmopriming	Osmopriming	(Marwat et al., 2008)
Tomato		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Hydropriming	(Venkatasubramanian and Umarani, 2007)
Egg plant		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Sand matricpriming	(Venkatasubramanian and Umarani, 2007)
Chilli		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Sand matricpriming	(Venkatasubramanian and Umarani, 2007)
Onion		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Sand matricpriming	
Carrot		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Hydropriming	
Okra		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Sand matricpriming	(Nirmala et al., 2008)
Beetroot		Osmopriming, Halopriming, Hydropriming, sand matricpriming	Hydropriming	(Nirmala et al., 2008)
Watermelon		Osmopriming, Halopriming, Hydropriming,	Halopriming	(Maiti and Pramanik, 2013)
Cucumber		Osmopriming, Halopriming, Hydropriming, control	Hydropriming	(Maiti and Pramanik, 2013)
Mustard		Hydropriming, Chemopriming, Hormonal priming	Hydropriming	
Sugarcane		Vitropriming	Vitropriming	(Duarte et al., 2018)

This treatment shows the highest germination percentage 98.57% Shoot length 42.79 cm Vigorous Index I 5573.23 No. Of pods per plant 27.27 biomass per plant 39.14gm and seed yield per plant 19.84gm. The primed seed increased 35% more seed yield per plant over control (Koutu et al., 2019). Rapeseed Mustard: the seed priming through KH2PO4 significantly fastened the growth of rapeseed Mustard variety and also helped to attain the earliest 50% flower 45.05 days and maturity 103.56 days. Similarly, it also produced the tallest plant at harvest 155.47 cm and maximum primary branches per plant 6.06. The primed sees have seed yield 1788.46 kg/ha. Thus, priming treatment on rapeseed mustard increases 32% seed yield (Das et al., 2015). In soybean, the hormonal priming treatment for 12 hrs has displayed higher germination i.e. 87.75% over control. The highest shoot and root length, Vigorous index were observed in Soyabean. The primed seed attained maximum plant height 47.37 cm, more no. Of branches per plant 6.93 and more no of leaves 71.39 over control. The hormonal priming for 12hrs increases Soyabean yield 21% more than untreated seeds i.e. Control (Agawane and Parhe, 2015). (Table 2.)

Table 2: Effect on growth and yield due to priming of seeds

Crop	Methods	Yield	Reference
Rice	Control Biofertilization	5912 kg/ha 6310 kg/ha	(Assunção de Almeida et al., 2018)
Black gram	Control -0.5 MPa osmotic potential treatment	Grain yield:0.92Mg/ha Biological yield:6.01 Mg/ha Grain yield:1.09Mg/ha Biological yield: 7.01 Mg/ha	
Rapeseed Mustard	Control KH2PO4 @ 0.15 mol per 100 ml of water per 5 g of seeds	1220.21 kg/ha 1788.46 kg/ha	(Das et al., 2015)
Soybean	Control Hydration with 100 ppm GA3 (12hr)	22.88 q/ha 28.86 q/ha	(Kering and Zhang, 2015)
Maize	Control Biopriming	53.09q/ha 58.35 q/ha	(Chaudhary et al., 2019)
Sorghum	Control Biopriming	24.96q/ha 29.48 q/ha	(Chaudhary et al., 2019)
Wheat	Control COCL2 15ug/ml priming for 12 hrs 24hrs	Grain yield of 12 hrs: 32.88 q/ha 24hrs: 35.49 q/ha Grain yield: 39.45 q/ha 39.39 q/ha	(Mahajan et al., 2011)
Pea	Control Seed priming with sodium molybdate @ 500 ppm+ seed coating with Trichoderma harziaxem(@15g/kg seed)	9.12g/ plant 13.94 g/ plant	(Koutu et al., 2019)
Buckwheat	Control (0 hr priming) 18 hr priming 18 hr priming with 45 kg N	1031 kg/ha 1599 kg/ha 1575 kg/ha	(Gairhe et al., 2015)
Barley	Control Hydro priming	1372.7 kg/ha 2072.3 kg/ha	(Abdulrahmani et al., 2007)

4. CONCLUSION

Seed priming are the need of prime importance in agriculture as they not only helps to influence germination but also has multiple attributing benefits. Their role in increasing nutrient content in food and seed is much valuable. Seed priming facilitates in plant growth promotion and influences yield. Despite of these factors, they also have positive impact on decreasing fertilizer rate, influencing nutrient uptake, maintaining plant growth vigor and tolerant to different biotic and abiotic stress. The use of bio-priming has a much significance in sustainable agriculture due to their broad range of scope and opportunities for plant growth promotion, suppressing the activity of pathogenic microorganisms and so on.

DATA AVAILIABILITY STATEMENT

All the information's used in this paper and data used are accessed through from open access journals.

CONFLICT OF INTERESTS

The authors do not have any type of competing interests.

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