Biopriming: Concept For Crops Improvement Leading to Sustainable Development of Rural Community

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Abstract

The overuse and indiscriminate application of agrochemicals to crops have resulted in soil contamination and environmental hazards, which have become major concerns for modern agriculture. Additionally, a strict regulatory system governing the use of synthetic chemicals in agriculture has been established as a result of the risk to human health. The most practical environmentally friendly solution to these problems has emerged as bio-inoculants, which have gained significant consumer popularity since their initial release. By boosting the supply or availability of essential nutrients to the host plant, bioagents, which are chemicals containing living microorganisms, encourage plant growth and preserve the health of the soil and crops. A potentially popular strategy for causing significant changes in plant features and promoting the establishment of desirable traits in plants that are connected with fungal and bacterium coats is called biopriming. In biopriming, biological elements such as fungi and bacteria are used. This review focuses on the techniques utilised for biopriming, as well as the function this technology plays in enhancing agricultural productivity and stress tolerance. The comparison of approaches is also addressed, and biopriming is suggested as a possible strategy for applying advantageous bacteria to the seeds. Hence, biopriming methods help in enhancing crop yields by enhancing nitrogen trapping, with enhanced crop yield income generation will be enhanced.

Keywords: Biological agents • Bio-priming • Crop growth improvement

Scope of Future Research:

In the future, Biopriming will have an important contribution to Sustainable development programs of agriculture in rural communities due to changes in climatic conditions and environmental factors. By giving plants resistance to diverse challenges, nano-priming is a cutting-edge seed priming method that helps to increase seed germination, seed growth, and yield. Taking into account their current state and prospective uses, the usage of nano-based fertiliser and insecticides as efficient materials in nano-priming and plant growth development was also covered. Numerous techniques, including soil application, seed inoculation, root dipping, foliar application, and seed coating or

covering, have been used. However, growing worries about the survival of microbes on seed surfaces and a focus on endophytes have prompted researchers to look into potential techniques for guaranteeing the survival and colonisation of the seed by the necessary microorganisms. Researchers have developed the technique of seed priming, which employs activating physiological processes prior to sowing, and which employs activating physiological processes before sowing, which has some advantages, to solve the issues of lack of consistency in seed emergence and low seedling vigour and establishment.

Research Outcomes:

Applications of biopriming are flourishing today; they are the future. This study will be helpful to find out the best protocol for Crops Grown in India. It will also help to find out the possible way to Mitigate Stress effects on Crops. In Near Future, the Development of a New Technique of Bio-priming help toward Improved Crop Performance, Nutritional Security, and Agricultural Sustainability for Smallholder Farmers. In the forthcoming, With the application of Bio-priming, we can Shorten the Time between Seed Sowing and Seedling Emergence. Modern seed treatment techniques like "bio-priming" enable plants to thrive under any circumstances. Along with higher production, the bio-innovative system will function as a growth promoter, illness controller, and quality maintainer (Deepranjan Sarkar et al. 2017).

Introduction

The term "bio-priming of seeds" refers to a common strategy for introducing disease resistance through the use of biocontrol agents. Initially, methods for seed priming were proposed to lessen plant environmental stressors. Hydropriming, osmopriming, hormopriming, thermopriming, nutripriming, chemical priming, and biopriming are only a few of the priming techniques that have been documented (Heydecker et al. 1973; Lutts et al. 2016). "Biopriming" has been proposed as the term for the method of combining seed hydration and microbial inoculation utilising advantageous microorganisms. According to Afzal et al. (2016) and Lutts et al. (2016), it is crucial for boosting seed viability, germination, and plant growth as well as reducing other pressures on the plant. Compared to other known approaches, seed priming with beneficial microbes and biocontrol agents is more effective at managing diseases and pests. A biological seed treatment method known as "bio-priming" combines hydration of the seed (a physiological component of disease management) with inoculation of the seed with a helpful organism (a biological component of disease control) in order to preserve the seed. The concept of bio-priming, which involves treating seeds with both biocontrol and priming chemicals, has become a popular method for managing many-infections and illnesses that are soil- and seed-borne. Induce systemic resistance in treated crops against abiotic and biotic challenges using the relatively new and emerging seed and/or seedling treatment method known as bio-priming (Rakshit et al. 2014).

Bio-priming of seeds denotes a standard tactic for the introduction of disease resistance and immunity via biological control agents. Priming of seeds with helpful microorganisms and bio-control means has been testified more efficient for the management of diseases and pests as equated to other available methodologies. Crops are exposed to a wide range of abiotic stresses like drought,

high temperatures, salinity, cold, alkalinity, ultraviolet light, and mineral toxicity and deficiency. The productivity of crops is frequently impacted by these abiotic stresses. Recently, it has been employed as an alternative technique for eradicating numerous soil- and seed-borne diseases. Bio-priming methods using PGPR inoculants are becoming more common and relevant in modern agriculture as an alternative to chemical treatments. They are more environmentally sustainable and safer for future agriculture and our generation apart from improving plants and soil health. Most often, endophytic microorganisms (bacteria or fungus) or plant growth-promoting rhizosphere are utilised as microbial inoculants. This approach, like other seed priming methods, has been shown to be crucial for enhancing seed quality and performance as well as for fostering plant growth (Aliye et al. 2008; Rajkumar et al. 2010, 2012).

Due to their toxicity, persistence, and accumulation in human bodies, fluoride pollution in groundwater has received a lot of attention in recent years. Multiple environmental sources of fluoride and various entry points into drinking water resources are to blame for any potential negative effects on human health and agriculture sustainability. Crops are increasingly being put under a range of fluoride stress as a result of environmental pollution, which has become a severe global issue in many states of India in recent years. The Indian states with the highest fluoride contamination levels are West Bengal, Rajasthan, Andhra Pradesh, Telangana, Tamil Nadu, and Gujarat (Indrani Mukherjee et al. 2018). According to a WHO estimate, 20% of the villages worldwide that are fluoride-affected are in India. Rajasthan has 16,560 villages, or more than 51%, of the country's 33,211 fluoride-affected villages. We might deduce from these numbers that Rajasthan alone contains close to 10% of the world's fluoride-affected habitation. Rajasthan is a classic case of falling water tables and increasing incidence of fluoride in water.

Biologic and abiotic variables including poor soil fertility, drought, and severe temperatures are frequently encountered among these pressures. And with that, low-input farming systems have become more popular in the current environment as a result of growing concern for the preservation of natural resources, a reduction in environmental degradation, and an increase in the cost of inorganic fertilisers. For many crops and agroecological settings, conventional farming methods with reduced fertiliser and pesticide use have been developed and refined. Additionally, scientific and technological advancements have made it possible for us to use the potential of biological diversity for pollution reduction, a practise known as bioresource management. It is anticipated that better microorganism control in agriculture will enable a significant decrease in the amount of minerals utilised without productivity losses and enable a more sustainable production system. This review focuses on the techniques utilised for biopriming, as well as the function this technology plays in enhancing agricultural productivity and stress tolerance (Panda and Khan, 2009).

Biopriming a New Concept:

Over the past few years, Bio-priming has attracted a lot of attention. Recently, it is used as an alternate method for controlling seed and soil-borne pathogens. Bio-priming of seeds denotes a standard tactic for the introduction of disease resistance and immunity via biological control agents. Priming of seeds with helpful microorganisms and bio-control means has been testified more efficient for the management of diseases and pests as equated to other available methodologies. seed biopriming is a cutting-edge method of a seed treatment that involves applying a helpful microbe to the surface of the seed and then hydrating it.

A natural alternative to chemical therapy for the many soils- and seed-borne diseases is seed biopriming. By promoting seed germination and offering protection prior to seedling emergence, seed biopriming improves the first stage of plant development. The role of biopriming has been investigated in a variety of crops utilising various PGPR. Many studies have been done on the role of biopriming in coping with salinity stress, and encouraging findings have been made.

Types of Biopriming:

Several seed priming techniques, including hydro priming, Osmo priming, solid matrix priming, hormo-priming, chemo-priming, nutri-priming, and bio-priming, are effective at promoting seed germination, boosting seedling vigour, and reducing abiotic stress. In addition to these benefits, only the biopriming method of priming offers the additional benefit of biotic stress management, garnering special attention.

Bio-priming of seeds with PGPR is one of the inexpensive and eco-friendly solutions to increase growth in the early or primary stages of its growth. It is affordable for small farmers and rural areas.

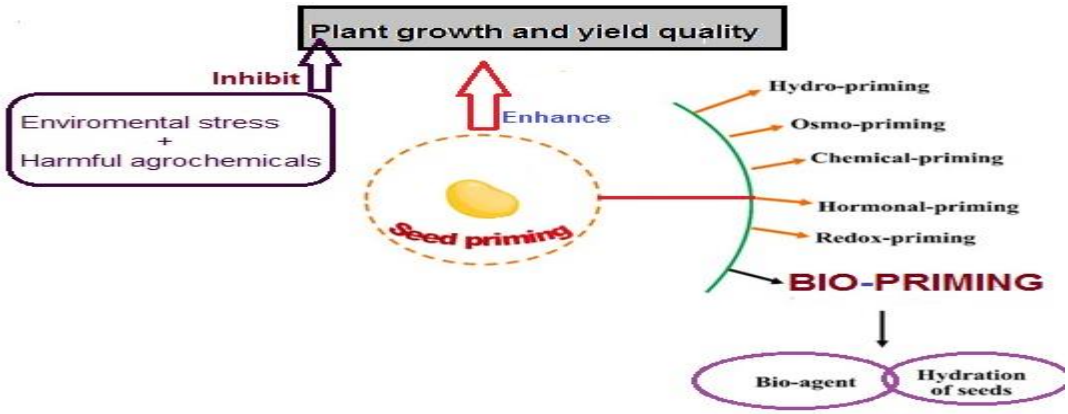

Fig. 1. Seed priming methods for better enhancement of seed germination and plant development.

The most popular technique for applying small doses of active ingredients to seeds is seed dressing [Cakmak, I.; Horst, W.J, 1991]. Although there are many different types of coating equipment, the rotary coater is the one that is most frequently utilized. Seeds spinning inside a metal cylinder are covered with liquid and atomized before being ejected after being freshly treated. This technique can be used to apply a wide variety of active ingredients, particularly chemical plant protectants. Typically, liquid seed treatment formulations are dosed between 0.05 and 1.0% by weight. Finishing powders or fluency powders are used right away following the liquid application of greater loading rates of chemical seed treatment, particularly insecticides, to absorb excess liquid [Mhadhbi, H.;

Fotopoulos,2009]. The dry finishing powders can be applied directly downstream using the dry seed coating apparatus or placed into the rotary coater while it is running.

The most suitable living organisms for the biopriming method are those that exhibit a variety of multi-functional activities, such as the production of plant growth regulators like auxins, cytokinins, abscisic acid, and gibberellins, as well as the secretion of effector molecules and secondary metabolites through modulation of various pathways/cascades (Singh et al., 2020).

Importance of Biopriming in Current Scenario:

Bio-priming of seeds with microorganisms is regarded to be a long-term and synergistic way to deal with biotic and abiotic stress in crop production. Almost all types of crops can benefit from seed biopriming, which is a less harmful alternative to chemical fungicides. Biopriming is the term used to describe the employment of helpful microorganisms, particularly plant growth-promoting bacteria (PGPB) that can endure a variety of challenging environmental circumstances. Modern and sophisticated priming methods like nanoparticles, gamma, magnetic, and UV irradiation are being developed and applied to a variety of field crops. According to Siddiqui et al. (2011) and Ghafari et al. (2013), seed priming with UV radiation and nanoparticles can enhance seed germination and seedling development. There is an urgent need for improved crop cultivars along with mitigating strategies to prevent disruption of the ecological balance in order to meet the rising food demand for an ever-increasing global population due to the frequent occurrence of extreme environmental events and their detrimental effects on sustainable agriculture (Goswami et al., 2016; Seufert et al., 2012). Thus, plant scientists or agricultural experts are constantly working to develop strategies that will efficiently maintain agricultural productivity even in challenging circumstances. Most likely, a variety of techniques have been used to increase crop yield and improve stress tolerance, including crop breeding to create better cultivars, the most recent CRISPR/Cas9-based genome editing tools to create transgenic plants, and non-genetic but chemical-based techniques using exogenous application of plant growth regulators (PGRs).

Future Prospectus of Biopriming Practices:

Climate change has a negative impact on the system of agricultural production. The sustainability of food production in a changing environment depends on improved seed quality. Instead of just lowering input prices or the demand on natural resources, adopting environmentally friendly practices like biopriming is necessary to maintain sustainable food production. The adoption of this technique by farmers should be encouraged because it can enhance soil quality, support crop development, offer greater defense against various abiotic stresses, and also increase yield without posing any hazards to the environment or human health. Under both normal and stressful conditions, biopriming with plant-beneficial fungi and bacteria or with other organic compounds can dramatically improve seed germination and emergence, seedling establishment, crop development, and yield characteristics. By producing a variety of metabolites like phytohormones, exopolysaccharides, volatile organic chemicals, siderophores, or antioxidative enzymes, different

microbial strains have been shown to lessen the negative effects of abiotic stress. This improves the plant's stress response, which leads to increased crop productivity even in harsh environmental conditions.

Incorporating plant growth-promoting microorganisms into seed priming is a successful method that is considered to be a crucial part of a comprehensive stress management approach. But there is an urgent need for research on the bacteria that help plants grow in terms of their viability, presence, mode of operation, and gene expression on the primed seed. Finding accessible and affordable biostimulants that can aid in stress relief is also of the utmost significance. For the development of management strategies to improve the use of biostimulants and monitoring techniques for efficacy, a deeper understanding of the molecular mechanisms of biostimulants during seed germination and seedling growth under abiotic stress conditions is also required (Hartmann et al., 2021). Although it is now widely acknowledged that controlling the signals in plant microbiomes is the key to interspecies and even interkingdom communication, questions regarding how microbiomes form, how their compositions may change over time, or how QS affects the composition and function of consortia remain unanswered (Stephens and Bentley, 2020). Additionally, research into the epigenetics of bio-primed would reveal the gap between the mechanisms behind priming effects and stress memory (Conrath et al., 2015). Therefore, the future of priming-mediated agricultural productivity requires the convergence of seed biopriming and stress-memory-related research.

Conclusions

Environmental, economic, and sustainable agriculture are essential due to the public's growing worries about environmental and human health risks. Bio-priming is a straightforward technique that even novice farmers may use. These kinds of interventions will increase the efficiency with which crops use nutrients while also reducing the amount of fertiliser applied. Agrochemical use is also unprofitable, which causes ecological problems. In the present day, pre-treating seeds with microorganisms has immense potential. The use of particular microorganisms for particular reasons can also produce excellent outcomes. In order to obtain sustainable yields in agriculture, bio-priming must be incorporated into the already-existing technology of integrated nutrient management. Bio-priming is emerging as a common method of inoculation as soil application requires a higher proportion of bio-inoculants contradicting the economic profitability of the farming systems.

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