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The Impact of Seed Priming on Various Millets' Seeds Germination Rates

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Abstract:

A pre-sowing procedure called "Seed priming" improves seed performance by starting the physiological process that result in germination. Seed priming is the procedure which given to the seeds before sowing to enhance the good and healthy crop yield. The purpose of this study how to different seed priming methods affect the germination rate of three millet varieties i.e. Foxtail Millet(*Setaria italica*), Finger Millet (*Eleusine coracana*) and Pearl Millet (*Pennisetum glaucum*). The effects of the four priming methods i.e. Hydropriming, Osmo-priming, Biopriming and halopriming on the germination parameters were studied. When compared to untreated controls, the result showed that osmo-priming considerably increased germination rates for all millet varieties. The Pearl Millet show the highest germination rate compare to the other varieties. After the priming with different treatment the result show that the appropriate seed priming can be an effective strategy to improve the germination rate in millet cultivation, to get the better crop establishment and yield.

Keywords: *Seed Priming, Germination Rate, Millet Varieties, Hydropriming, Osmo-priming, Biopriming, Halopriming.*

Introduction

A group of small-seeded grasses identified as millets are cultivation for food and feed. Grains of millets are more nutritious ,gluten free and easily grow in semi-arid ,dry climates with inadequate water availability. Iron, calcium, magnesium, fiber, proteins, and vitamins are all high in millets. In addition, they are recognized for containing an extremely low sugar content, beneficial for people with diabetes . Millets have wide adaptability and high yield potential but are mostly grown in hilly, marginal and sub-marginal soil conditions where major cereals fail. Uniform and rapid germination and emergence of seedlings is essential for successful crop establishment and is of primary importance for optimizing field production of any crop plants in arid and semi-arid regions. Seed priming is an effective technique to enhance rapid and uniform emergence and achieve higher seedling vigour, leading to better stand establishment and yield under adverse climatic conditions. This technique has shown promising biological and physiological improvements for suitable seeds with excellent physiological and agronomic performance in crop plants under adverse environmental conditions. Physical seed priming accelerates the germination process and increases the seedling emergence rate even under extreme climatic conditions and problematic soils. Seed priming is classified into different types, such as hydro-priming, osmo-priming, halopriming, hormonal priming and biopriming, and offers wide crop benefits. Seed priming technique can deal with harmful conditions such as drought, heat stress, salinity, nutrient stress and multiple environmental stresses in fragile lands. Improving millet germination rates is essential for maximizing crop establishment, especially in settings where yield results are directly impacted by seedling vigor. The initial slow growth phase of finger millet can be used to produce short-duration pulses. Additionally, intercropping with fast-growing pulses will benefit in controlling weeds (Reddy *et al.*, 2021). Priming improves stand establishment, speeds up the time it takes for seedlings to emerge and increases germination. Although they show that regrowth was faster under normal or stress conditions, the overall purpose of seed priming is to slightly hydrate the seed to the point where the germination process begins (Singh *et al*., 2015). Seed priming enhances metabolic processes, prevents seed spoilage, breaks dormancy, and induces systemic resistance to biotic and abiotic stresses (Pawar and LaVere, 2018). Seed priming, due to its efficiency and lack of need for expensive equipment and chemicals, can be used as a simple method to overcome problems associated with poor germination and seedling establishment, thereby aiding in agricultural sustainability and being cost-effective, economical, non-toxic and environmentally friendly (Mishra *et al*., 2017).In order to improve stress tolerance and speed up germination, a practice known as "seed priming" involves preparing seeds prior to sowing. Small millets exhibit the ability to adapt to diverse climates and soils, making them a valuable resource for sustainable agriculture (Kheya *et al*., 2023). Small millets, in particular, stand out as a rich source of antioxidants, which boost immunity and provide protection against infections and diseases (Kaur *et al*., 2019). Finger millet, scientifically known as Eleusine coracana, is a member of the Poaceae family. An annual herbaceous plant grown as a cereal crop in arid and semi-arid places of Africa and Asia (Kayastha *et al.,* 2024). With differing degrees of effectiveness, several priming techniques have been tested in various crops, including hydropriming, osmo-priming, biopriming, and halopriming. The objective of this study is to determine the rate at which three well-known millet varieties—Pearl Millet, Finger Millet, and Foxtail Millet germinate when seeded through different seed priming methods. Agricultural economists can suggest unique methods to increase millet production by analyzing how such varieties react significantly to priming treatments.

Materials and Methods

1. Pearl Millet: *Pennisetum glaucum* : Pearl millet, one of the most popular varieties, is grown throughout Africa, India, and some regions of the Middle East and is resistant to drought. It is often used to make porridge, fermented beverages, and flatbreads. It is also high in iron, calcium, and magnesium.

2. Ragi Finger Millet: *Eleusine coracana:* A popular grain in India and parts of Africa, finger millet is rich in protein and calcium. It is often found in baked products, porridge, and infant formulas. The high nutritional content of finger millet makes it a popular superfood.

3. Foxtail millet: *Setaria italica* : This grain is used in many traditional Asian dishes and is recognizable by its small, rice-like grains. It is perfect for those trying to control their weight and diabetes as it is high in dietary fiber, protein, and antioxidants.

Seed material:

- **Pearl millet (***Pennisetum glaucum***) variety V1**
- **Finger millet (***Eleusine coracana***) variety V2**
- **Foxtail millet (***Setaria italica***) variety V3**

Every seed came from a verified seed bank and was devoid of any obvious pests or diseases.

Treatments for seed priming: Five priming techniques were used:

1. Control(T0**):** seeds that were not treated.

2. (T1): soaking seeds for 12 h at room temperature with lime water.

3. (T2): Priming with Polyethylene Glycol (PEG) solution.

4. (T3): Priming with Gibbrelic acid solution

5. (T4): Priming with urea solution

Experimental Design: The randomized complete block design (RCBD) experiment used three replicates. There were four replicates for each priming treatment and control, with 50 seeds per duplicate.

Evaluation of germination: During 14 days, germination was evaluated in a controlled laboratory setting with a 12 h photoperiod and 25 °C. The following germination parameters were measured:

- **Germination percentage (GP):** proportion of germinated seeds out of 50.
- **Mean germination time (MGT):** the average amount of time required for seeds to germinate.
- **Germination index (GI):** The rate of germination over the time .

Data Analysis: ANOVA was used to evaluate the data, and Duncan's multiple range test (DMRT) was used to identify significant differences between treatments at P < 0.05.

Result:

Germination percentage(GP)%:

Table 1: Showing the different germination percentage of different varieties of millet.

S. No.	Treatment	V1 (%)	V2 (%)	V3 (%)
1	T0	68	65	70
2	T1	74	70	76
3	T2	85*	82*	88*
4	T3	80	75	81
5	T4	78	72	77

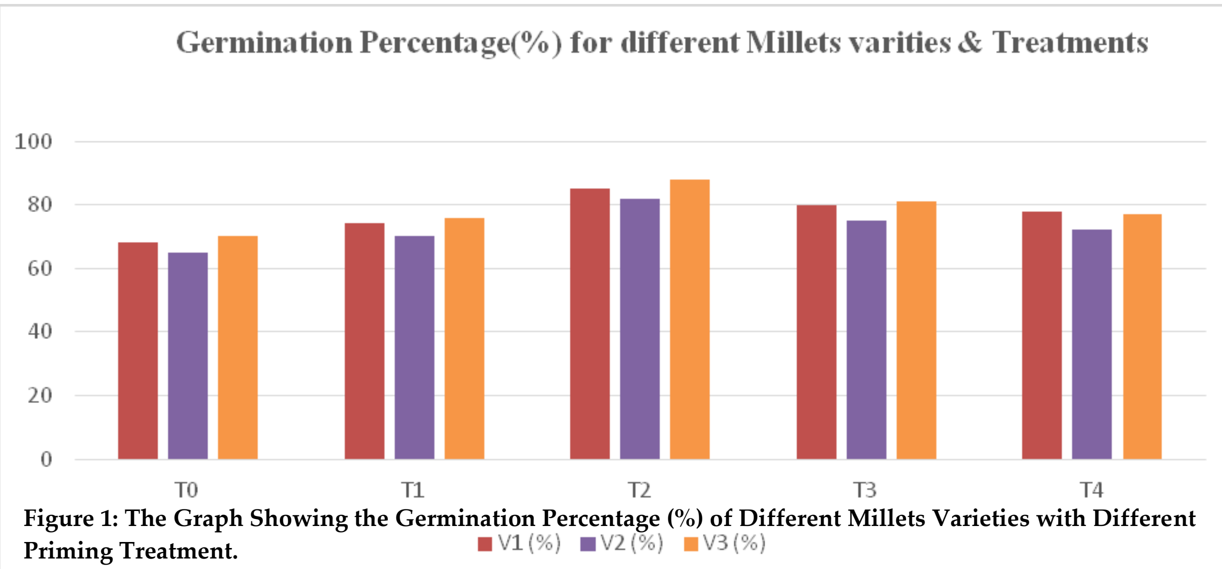


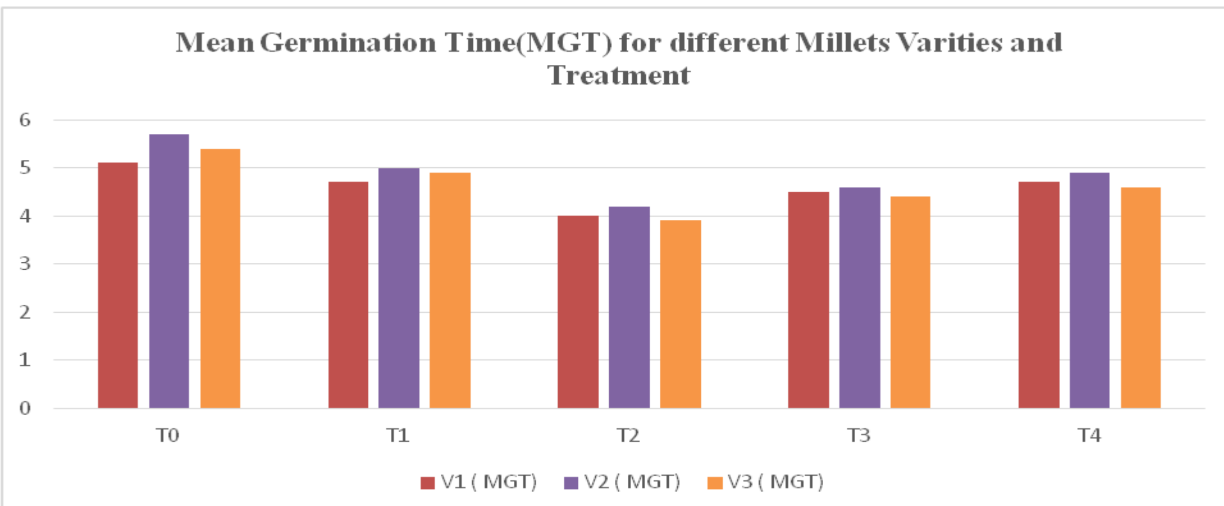
Figure 1: The Graph Showing the Germination Percentage (%) of Different Millets Varieties with Different Priming Treatment.

Mean Germination Time (MGT):

Table 2: Showing the different Mean Germination Time of different Millet varities With different priming Treatment.

S. No.	Treatment	V1 (MGT)	V2 (MGT)	V3 (MGT)
1	T0	5.1*	5.7*	5.4*
2	T1	4.7	5.0	4.9
3	T2	4.0	4.2	3.9
4	T3	4.5	4.6	4.4
5	T4	4.7	4.9	4.6

Figure 2: The Graph Showing the Mean Germination Time (MGT) of Different Millets Varities with Different Priming Treatment.



Germination Index:

Table 3: Showing germination index with different seed treatment in different Millet Varieties.

S. No.	Treatment	V1 (GI)	V2 (GI)	V3 (GI)
1	T0	34.0	31.0	33.0
2	T1	39.0	36.0	35.0
3	T2	51.0*	47.0*	52.0*
4	T3	44.0	42.0	45.0
5	T4	41.0	38.0	40.0

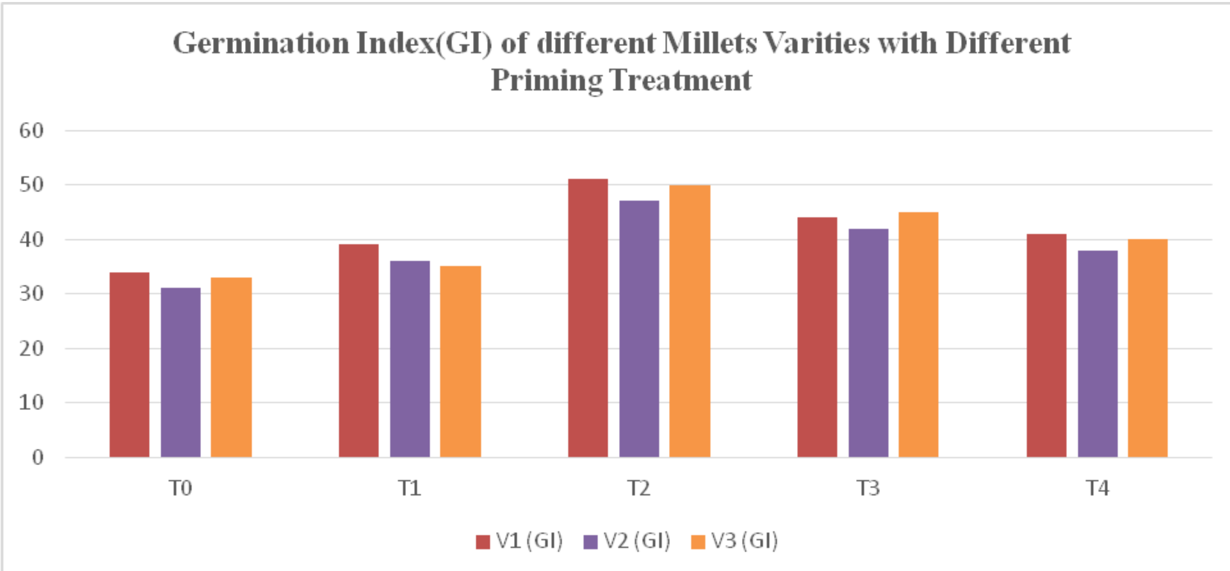


Figure 3 : The Graph Showing the Germination Index of Different Millets Varieties with Different Priming Treatment.

Analysis and comparison of different treatments:: all the millet varieties, osmo-priming consistently yields the highest GI, indicating that it may be the best method to promote germination. all the varieties, the control therapy has the lowest GI, indicating that there may be no treatment better than using it.

Differences between varieties:: Foxtail millet had the highest Germination rate (88.0) after osmo-priming, although Pearl millet also showed significant improvement (85.0). Foxtail millet had the highest GI (51.0) after osmo-priming, although Pearl millet also showed significant improvement (51.0).

Analysis of Statistics: According to ANOVA ($p < 0.05$), priming treatments had significant effects on GP, MGT and GI in all millet types. Osmo-priming consistently decreased MGT, producing the highest GP and GI compared with the other treatments and controls.

Discussion:

The study found that seed priming, particularly osmo-priming, greatly increased the germination rate of millet varieties. Osmo-priming likely promotes water absorption and metabolic activity, leading to more reliable and faster germination. Pearl millet displayed the strongest response, possibly due to its inherent seed characteristics that make it more sensitive to osmotic changes. Both halopriming and biopriming improved germination metrics, although to a lesser degree, indicating that their suitability may vary depending on certain varietal traits. Despite its benefits, hydropriming was less effective than osmo-priming, suggesting that basic water treatments may not create enough osmotic stress to maximize germination potential. Since rapid establishment of germination in the field is important, the reduction of MGT observed in all primed treatments suggests that priming accelerates germination. These findings are consistent with previous research showing that osmo-priming enhances seed performance by promoting cellular processes required for germination and increasing enzyme activity. However, the varying responses across millet varieties highlight how important it is to employ appropriate priming techniques for a particular crop type.

Conclusions:

Seed priming, especially osmo-priming, greatly increases the germination index, reduces the average germination time, and increases the germination rate in several millet species. Osmo-priming as a seed treatment can enhance crop establishment and potentially increase millet yields. To confirm these laboratory findings, other studies should look at how priming affects plant growth and yield in the long term. The technical difficulty of improving seed performance makes it possible to investigate in more detail the physiological and biochemical changes that occur during seed treatment.

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