



A comparative study of the impact of seed priming on *Vigna radiata* (L). Wilczek, R., And *Cicer arietinum*, L.

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Abstract

A pre-sowing procedure known as "seed priming" permits regulated hydration of seeds so they may absorb water and go through the first stage of germination, but also prevents radical protrusion through the seed coat. This method forces the plant to germinate by improving the metabolic process. This causes a seed to grow more quickly. The purpose of the current study was to investigate how seed priming treatments affected the parameters of seed germination and plant growth in *Vigna radiata* and *Cicer arietinum*. Due to its high seed content of digestible protein (24–27%), the mung bean (*Vigna radiata* L.) is a significant legume crop that is primarily utilized as food for people and animals. One of the key legumes for global production is the chickpea. Because of its low cost of production, broad capacity to fix atmospheric nitrogen and fix in a variety of crop rotations, and abundant tap root system, the chickpea (*Cicer arietinum* L.) is a significant food legume plant in sustainable agriculture systems. The seeds of the above plant species were collected and carefully selected the healthy seeds. The experiment was conducted based on different priming treatments. Halopriming decreased germination at greater concentrations. *Pseudomonas fluorescens* and *Trichoderma viride* biopriming promoted growth and decreased fungal infections. Additionally, glycerol prevented plants from growing. In comparison to the control, distilled water, tap water, and well water offered a moderate growth rate. Since seed priming was found to improve seed performance in the early stages of plant growth, this study concludes.

Keywords: Seed priming, *Vigna radiata*, *Cicer arietinum*, halopriming, biopriming

Introduction

The seed growth can be enhanced by a process named seed priming. Many nations, including China, India, Pakistan and Australia have adopted the seed priming approach and thousands of experiments have been carried out to assess how well it works for various crops. Seed priming is a presowing treatment that allows controlled hydration of seeds to imbibe water and go through the first stage of germination but does not allow radical protrusion through the seed coat. ^[1] This technique enhances the metabolic process and thus forces the plant to germinate. Thus, resulting in the faster growth of a seed. It also helps to reduce the abiotic stresses of the plant. It can be considered as a biotechnological tool that is considered eco-friendly and cost effective. Seed priming can be considered as a green tool for the well maintenance of farming field under adverse conditions. On comparison with a normal seed or unprimed seed, primed seeds have more iron content; as it increases its germinating capability by increasing the efficiency of embryo development. The various types of priming includes-hydropriming, osmotic priming, solid matrix priming and biopriming. Hydropriming involves soak in water and dried back for storage moisture prior to sowing of seeds. Decreases the time that seed spending in seedbed simply imbibes water. Osmotic priming is the method which seeds are soaking in solutions containing chemicals like mannitol, potassium nitrate, potassium chloride, polyethylene glycol, sodium chloride ^[2]. Solid matrix priming including which the incubation of seeds in solid, insoluble matrix, diatomaceous earth or another high water absorbed polymer with limited amount of water allowed to slow imbibition ^[3]. Bio priming is the process

which biological seeds treated by combination of seed hydration and inoculation of seed with beneficial organism to bio-primed seed.

Mung bean (*Vigna radiata* L.) is an important legume crop, which is used mainly as a food for humans and livestock due to high seed content of digestible protein (24 -27%). Chickpea is one of the important legumes for production worldwide. It is the most extensively grown rabi pulse crop in India. Chickpea (*Cicer arietinum* L.) is an important food legume plant in sustainable agriculture system because of its low production cost, wider ability to fix atmospheric nitrogen and fix in various crop rotations and a presence of prolific tap root system ^[4]. Priming is one of the most crucial physiological techniques for enhancing seed performance and achieving more rapid and coordinated germination. The primed seeds produce seedling establishment and growth that is earlier, more consistent, and occasionally better ^[5].

The current study was designed to examine the effect of seed priming treatments on plant growth and seed germination parameters in *Vigna radiata* and *Cicer arietinum*

Materials and Methods

The plants selected for the present study is *Vigna radiata* (L). R Wilczek and *Cicer arietinum* L. Mung bean (*Vigna radiata*) is a plant species of Fabaceae and is also known as green gram. Green gram is an annual vine with yellow flowers and fuzzy brown pods. The type of germination is epigeal in which the hypocotyl elongates, carrying the cotyledons above the ground. It has a well-developed root system. As a legume plant is in symbiotic association with

rhizobia which enables it to fix atmospheric nitrogen fixation. The mung bean is mainly cultivated in East, south East and South Asia. The chickpea (*Cicer arietinum*) is an annual legume of the family Fabaceae. It is cultivated for its edible seeds. Chickpeas are a type of pulse, with one seed pod containing two or three peas. The type of germination is hypogeal, in which the cotyledons store nutrients for the developing seedling, and as the main shoot emerges from the soil the cotyledons stay in the underground. the seeds of the above plant species were collected and carefully selected the healthy seeds.

The germination tray and the other equipments were surface sterilised using 98 % ethanol to avoid contamination. The experiment was conducted based on different priming treatments which is shown in Table 1.

The primed seeds after 6 hrs were removed and left to dry for 12 hours in a Petri dish with blotting paper until the moisture they had absorbed had decreased to roughly their initial weight. The primed seeds were placed in a substrate with briquettes and allowed to germinate and the germination parameters are observed and recorded accordingly.

Treatment	Priming Agent
T1	No priming - Control
T2	Tap Water
T3	Distilled Water
T4	Well Water
T5	<i>Trichoderma viride</i>
T6	<i>Pseudomonas fluorescens</i>
T7	Glycerol (2%)
T8	NaCl (2%)

Root Length, Shoot Length and Seedling Length

Using a measuring scale, the root and shoot lengths of fifteen sample plants from each experimental unit were determined on the 12th day, the last day of the experiment. By summing the lengths of the roots and shoots, the length of the seedling was determined.

Fresh Weight and Dry Weight

The same fifteen sample plants from each experimental unit were placed in a hot air oven set at 90°C for 12 hours after their seedling weight was determined using a weighing machine [6]. They were removed from the oven after 12 hours and weighed once more to determine the dry weight of the seedlings.

Different seed germination parameters were considered.

- Germination percentage was calculated by using the following formula [7]
Germination (%) = Total number of normal seedlings

$$\frac{\text{germinated}}{\text{Total Number of seeds sown}} \times 100\%$$

- Germination Energy was calculated by using following formula; [8]
Germination Energy (GE) = Number of seeds germinated over day

$$\frac{3 \text{ or } 5 \text{ or } 7}{\text{Total number of seeds sown}} \times 100\%$$

- Germination rate was the average number of seeds that germinate over 5 days [9]

$$\text{Germination rate} = \frac{\text{Number of seeds germinated over day 5}}{5}$$

- Germination rate index (GRI) was calculated by following formula [10]

$$\text{GRI} = (G1/1) + (G2/2) + (G3/3) + \dots + (G12/12) + \dots + (Gn/n)$$

It means sum of no. of seed germinated on day 1 divided by 1, no. of seed germinated on day 2 divided by 2 likewise no. of seed germinated over day 12 divided by 12 upto n days.

- Speed of germination was calculated by using the formula; [11]

$$\text{Speed of germination} = \frac{\text{Number of seeds germinated over day 3} \times 100\%}{\text{Number of seeds germinated over day 7}}$$

- Mean Germination Time was calculated by using formula; [12]

$$\text{MGT} = \frac{\sum FX}{\sum [(F1*1) + (F2*2) + (F3*3) + \dots + (Fn*Xn)]}$$

- Seedling Vigour Index There are different formula for calculating seedling vigour. In our experiment we calculated seedling vigour by using following formula

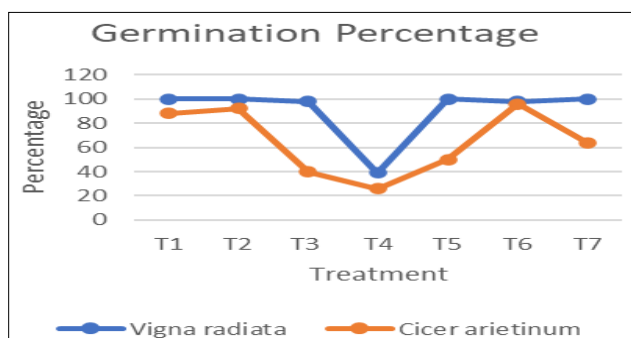
$$\text{Seedling Vigor Index} = \text{Seedling length} \times \text{Germination (\%)}$$

Results and Discussion

Numerous studies have indicated that different seed priming techniques promote seed germination. By triggering metabolism before germination, such as DNA repair and antioxidant enzymes, it guarantees seedlings optimal emergence and growth [13]. Primed seeds germinate more evenly, produce more robust seedlings, and are more resistant to abiotic stress than unprimed seeds.

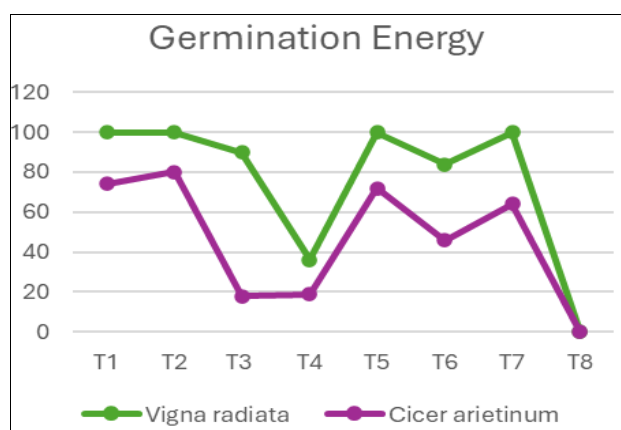
Germination Percentage (%): Germination percentage is an estimate of the viability of a population of seeds. In *Vigna radiata*, highest germination percentage was observed

in control (100%), Tap water (100%), *Trichoderma viride* (100%) and Glycerol (100). On comparison with control, lowest germination percentage was recorded in distilled water (98%), *Pseudomonas fluorescens* (98%), well water (39%), and lowest in NaCl (0%). In the case of *Cicer arietinum*, on comparison with control (88%), highest germination percentage is recorded in *Pseudomonas fluorescens* (96%) and Tap water (92%) and lowest in Glycerol (64), *Trichoderma viride* (50%), Distilled water (40), and NaCl (0).



Graph 1

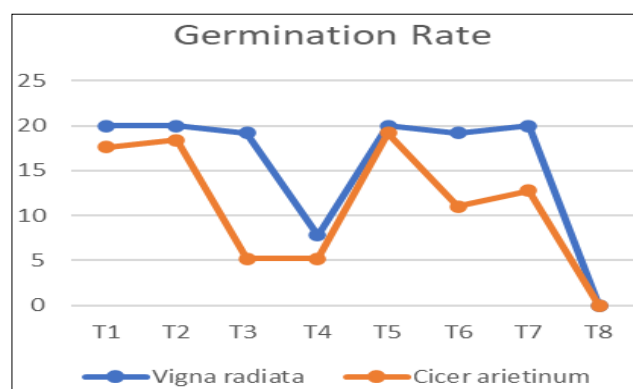
Germination Energy: In the priming done in *Vigna radiata* seeds, it is clear that the germination energy is higher in the seeds treated with tap water, *Trichoderma viride* and glycerol the value is 100. Distilled water and *Pseudomonas fluorescens* the value is 90 and 84 respectively. The lowest value is reported in well water the value is 36. NaCl shows a negative value. The priming done in *Cicer arietinum* it is clear that germination energy is higher in seeds treated in tap water the value is 80. Followed by *Pseudomonas fluorescens* 72, *Trichoderma viride* 46, well water 19 and the lowest value is observed in Distilled water 18. Germination energy is also negative in NaCl treatment. (Graph 2)



Graph 2

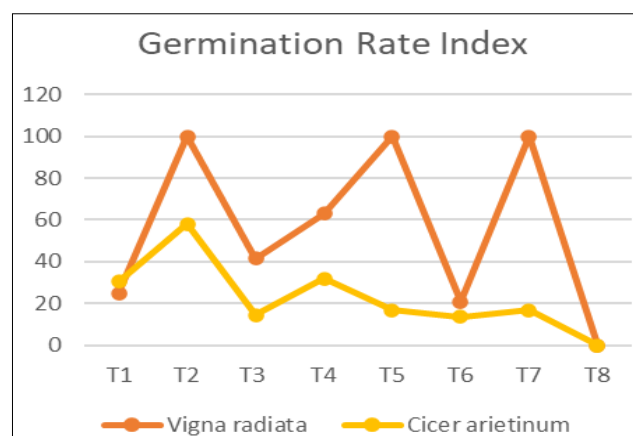
Germination Rate: The priming done in *Vigna radiata* revealed the results that the highest rate of germination was noticed in the seeds treated in tap water, *Trichoderma viride* and glycerol (20) followed by distilled water and *Pseudomonas fluorescens* 19.2 respectively. The lowest value of germination rate is observed in well water 7.8 and in NaCl negative result with null value is obtained. In *Cicer arietinum* the highest value of germination rate is found in *Pseudomonas fluorescens* treatment it shows a greater value

19.2 followed by tap water, glycerol and *Trichoderma viride* the values 18.4, 12.8, 11 respectively the lowest value is reported in well water. (Graph 3)



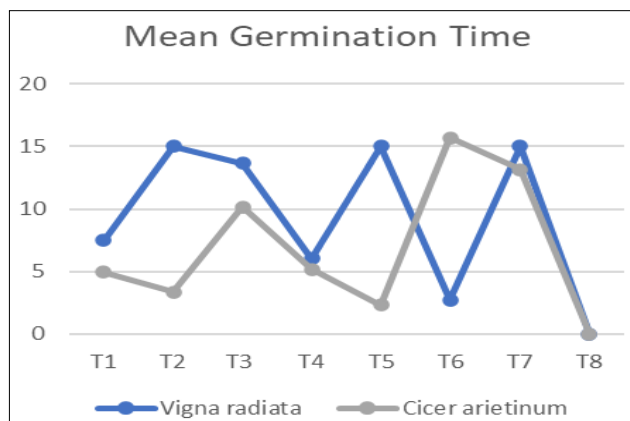
Graph 3

Germination rate index: The priming done in green gram the result that the germination rate is higher in tap water, *Trichoderma viride* and glycerol the value is 100. If you followed by well water, distilled water and *Pseudomonas fluorescens* the values are 63, 41.4 and 21.01 respectively. It showed a negative value in NaCl treatment and a negative value in NaCl treatment. In the case of priming done in *Cicer arietinum* the germination rate is higher in tap water the value 58 followed by well water 31.8. Then *Pseudomonas fluorescens* and glycerol having the value 16.83. The lowest value observed in distilled water, *Trichoderma viride* the values 14.5 and 13.66 respectively. It shows a negative result in NaCl treatment. (Graph 4)



Graph 4

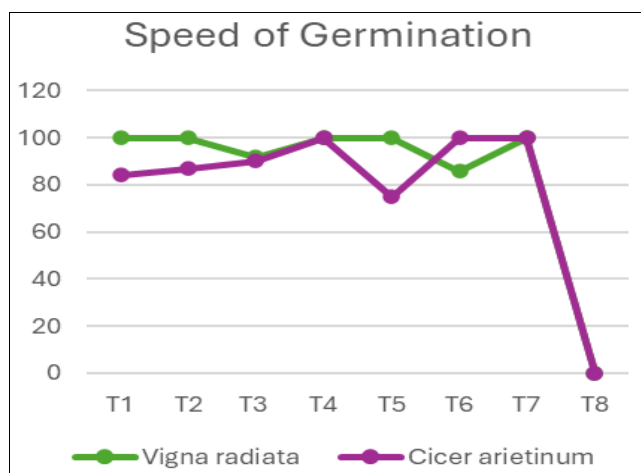
Mean Germination Time (MGT): MGT showed the rapidity of germination; hence lower the value of MGT, the earlier is the germination. The results of *Vigna radiata* shows that MGT of different treatment lowest in *Pseudomonas fluorescens* ie, 2.72 and highest in glycerol 15, followed by *Trichoderma viride* and tap water. Distilled water followed by the value (13.67) and control have (7.5). Mean germination time (MGT) is a statistical measure used to quantify the germination rate of seeds. The result of *Cicer arietinum* shows that MGT level highest in *Trichoderma viride* 15.71 and lowest in *Pseudomonas fluorescens* (2.317). Control have MGT value (4.96) and tap water have (3.38). Distilled water is followed by (10.17) and glycerol is followed by (13.15). (Graph 6)



Graph 6

Speed of Germination: It refers to the rate at which seeds germinate, typically measured by the time it takes for a certain percentage of seeds to germinate.

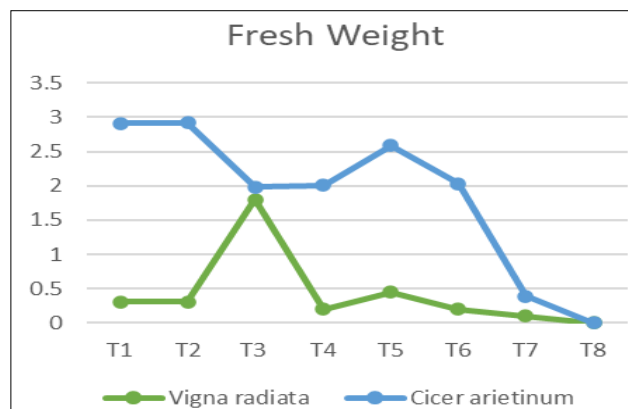
The data analysis showed that germination speed of different treatment was non-significant. The highest germination speed was recorded in control (100), tap water (100), *Trichoderma viride* (100) and glycerol (100). Lowest germination speed was in *Pseudomonas fluorescens* (85.71) and was followed by speed of germination in distilled water (91.83). No priming was recorded in NaCl treatment. Whereas in *Cicer arietinum* the data analysis showed that germination speed of different treatment was non-significant. The highest germination speed was recorded in *Trichoderma viride* (100) and glycerol (100). Lowest germination speed was in *Pseudomonas fluorescens* (75). Distilled water followed by speed of germination (90) and tap water followed by (86.95). Control have speed of germination value (84.09). (Graph 5)



Graph 5

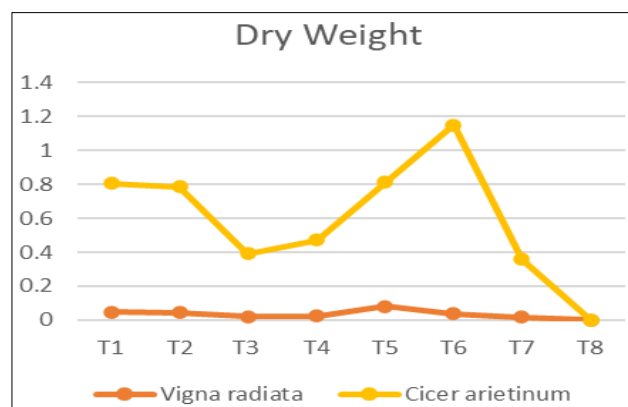
Fresh weight: In *Vigna radiata* the highest fresh weight was observed in the distilled water treatment at 1.805g. The *Trichoderma viride* treatment is recorded as a fresh weight of 0.450g, followed by tap water treatment at 0.313g and control at 0.309g. Among the other treatments, *Pseudomonas fluorescens* showed the fresh weight of 0.205g, while well water recorded as 0.202g. Glycerol had a fresh weight of 0.103g, whereas NaCl resulted in 0 fresh weight, indicating no growth. In *Cicer arietinum*, the highest fresh weight was observed in the tap water treatment at 2.919g. The control is recorded as a fresh weight of 2.913g, followed by *Pseudomonas fluorescens* treatment at

2.59g and *Trichoderma viride* at 2.036g. Among the other treatments, well water showed the fresh weight of 2.006g, while distilled water recorded as 1.98g. Glycerol had a fresh weight of 0.396g, whereas NaCl resulted in 0 fresh weight, indicating no growth. (Graph 8)



Graph 8

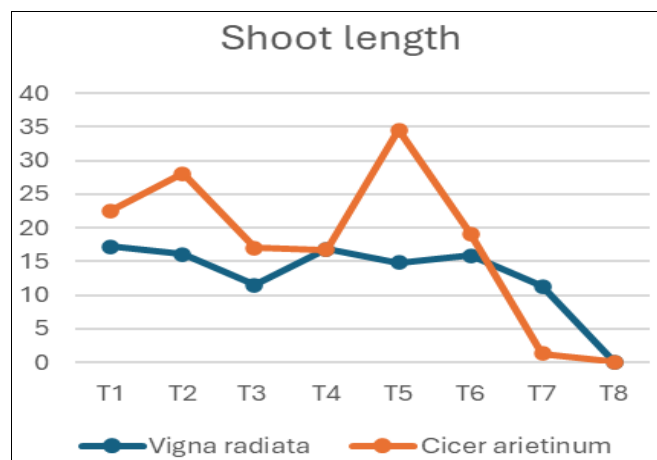
Dry Weight: In *Cicer arietinum*, the highest dry weight was observed in the *Trichoderma viride* at 1.151g. The *Pseudomonas fluorescens* treatment recorded a dry weight of 0.811g, followed by control at 0.805g and tap water treatment at 0.787g. Among the other treatments, well water showed the dry weight of 0.47g, while distilled water recorded as 0.39g. Glycerol had a dry weight of 0.358g, whereas NaCl resulted in 0 dry weight, indicating no growth. In *Vigna radiata*, the highest dry weight was observed in the control at 0.48g. The *Trichoderma viride* treatment is recorded as a dry weight of 0.08, followed by tap water treatment at 0.044g and *Pseudomonas fluorescens* treatment at 0.037g. Among the other treatments, well water showed the dry weight of 0.024g, while distilled water recorded as 0.021g. Glycerol had a dry weight of 0.18g, whereas NaCl resulted in 0 dry weight, indicating no growth. (Graph 9)



Graph 9

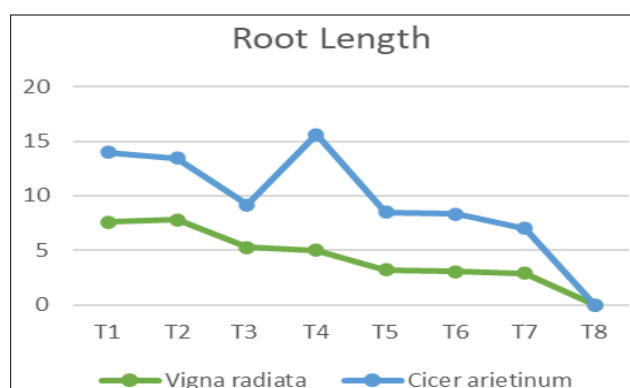
Shoot length: The control treatment showed the highest shoot length in green gram at 17.25cm, followed closely by well water at 16.8cm and tap water at 16.03cm. The *Trichoderma viride* treatment recorded a shoot length of 15.9cm, while *Pseudomonas fluorescens* measured 14.8cm. A further decrease was observed in distilled water 11.5cm and glycerol 11.3cm. The NaCl treatment resulted in no shoot growth (0), indicating its harmful effect on germination. In *Cicer arietinum*, the highest shoot length

was recorded in the *Pseudomonas fluorescens* treatment at 34.6cm, followed by tap water at 28.04cm and control at 22.52cm. The *Trichoderma viride* treatment showed a shoot length of 19.1cm, while distilled water and well water recorded 17cm and 16.75cm, respectively. Glycerol resulted in a significantly lower shoot length of 1.24cm, whereas NaCl showed no shoot growth (0). (Graph 10)



Graph 10

Root length: In *Vigna radiata*, the tap water treatment showed the highest root length at 7.82cm, followed closely by the control at 7.6cm. The distilled water and well water treatments recorded root lengths of 5.25cm and 5.01cm, respectively. The *Pseudomonas fluorescens* and *Trichoderma viride* treatments resulted in slightly lower root lengths of 3.2cm and 3.05cm, while glycerol had a further reduced root length of 2.9cm. The NaCl treatment completely inhibited root growth, with a recorded length of 0. In *Cicer arietinum*, the highest root length was observed in the well water treatment at 15.6cm. The control treatment recorded a root length of 13.98cm, followed by tap water at 13.45cm and distilled water at 9.166cm. Among the other treatments, *Pseudomonas fluorescens* showed a root length of 8.5cm, while *Trichoderma viride* recorded 8.3cm. Glycerol had a root length of 7cm, whereas NaCl resulted in 0 root length, indicating no growth. (Graph 11)

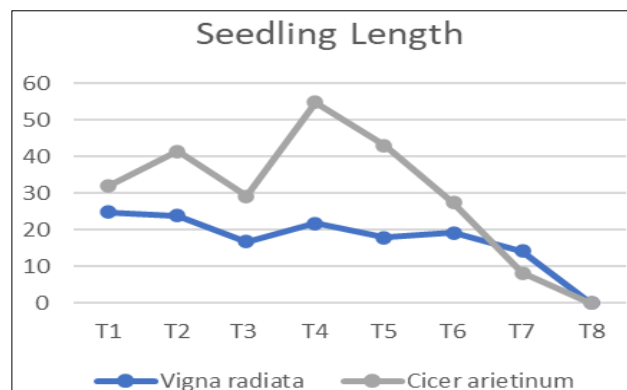


Graph 11

Seedling Length: The control treatment exhibited the greatest seedling length in green gram at 24.86cm, closely followed by tap water at 23.85cm. A moderate reduction was observed in well water 21.12cm, while *Trichoderma viride* 19.25cm and *Pseudomonas fluorescens* 18cm recorded comparatively lower values. Distilled water

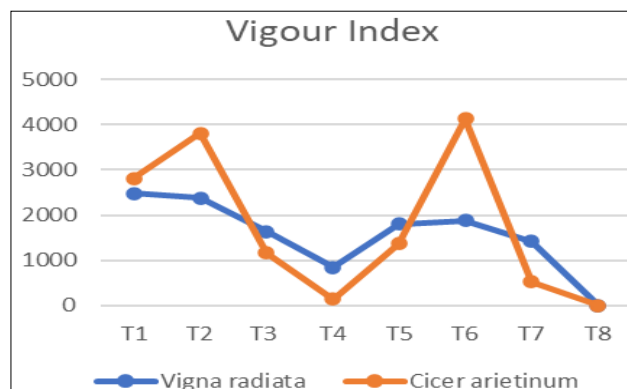
resulted in a further decline, with a seedling length of 16.75cm, whereas glycerol showed a significantly reduced length of 14.2cm. The NaCl treatment completely inhibited seedling growth (0), highlighting its detrimental effect on germination.

In *Cicer arietinum*, the highest seedling length was recorded in the well water treatment at 54.9cm, followed by *Pseudomonas fluorescens* at 43.1cm and tap water at 41.49cm. The control treatment had a seedling length of 32cm, while distilled water and *Trichoderma viride* recorded 29.25cm and 27.4cm, respectively. The glycerol treatment showed a much lower seedling length of 8.24cm, whereas NaCl resulted in no seedling growth (0). (Graph 12)



Graph 12

Seedling Vigour: Seedling vigour is estimated as the indicator of seedling establishment. It can be calculated by analysing the product of germination percentage and mean of the seedling length. Analysis of variants has showed the significant effects on seedling index of primed seeds compared to the non-primed seed. In *Vigna radiata* highest vigour was observed in control (2486) followed by tap water (2385), *Pseudomonas fluorescens* (1886.5), *Trichoderma viride* (1800), Glycerol (1420) and well water (850) and least in the case of NaCl (0). In the case of chickpea, on comparison with control (2815), *Pseudomonas fluorescens* primed seeds has recorded with the highest vigour (4137.6) and tap water (3817.08) and lowest in *Trichoderma viride* (1370) distilled water (1170), glycerol (527.36) and NaCl (0). (Graph 7)



Graph 7

These Parameters are used in a wide range of crops including rice, wheat, black gram, green gram, chickpea, barley and maize etc. It results vary based on the seed types

and climate conditions, higher values generally indicating the better seed quality and seedling vigour. These parameters are crucially used to identify the good quality of the seeds. Recently, commercial seed priming techniques have been utilised to increase seed vigour in terms of germination and capacity for stress tolerance. To put it another way, it is also referred to as pre-germinative metabolism since it initiates metabolic processes before to seed germination, resulting in a robust response to abiotic stress during germination. Plant ecology, physiology, cellular biology, and molecular biology have all provided thorough descriptions of seed priming [14, 15]. Improved seed quality has recently emerged as a top concern for the agricultural industry. To improve agricultural production performance, seed priming is also employed to ensure uniform and quick seed germination and seedling emergence.

When low-quality seeds are used, productivity and crop output suffer. A post-harvest seed treatment known as "seed enhancement" aims to improve germination, seedling growth, and seed distribution during sowing. Numerous methods of seed augmentation are intended to improve seed performance through increased yield. It includes technology for seed hydration, seed coating, and seed conditioning. Controlled and uncontrolled water uptake systems are components of pre-sowing hydration treatments. Priming is therefore a widely used pre-sowing seed treatment that promotes consistent seed germination and leads to a strong stand establishment because of increased crop yield.

Conclusion

Developing a complete priming protocol must address the balance between germination advancement and reduced seed longevity. Physiological, biochemical and biophysical markers are needed to detect the enhanced quality of seeds. The challenges of technology to enhance seed performance provides an opportunity for more in depth studies on physiological and biochemical changes that occur during seed treatments. Attempt to attain the most rapid germination from priming must be weighed against the enhanced liability of the pre-sowing treatment.

Seed germination is one of the most fundamental and vital phases in the growth cycle of plants as it decides the plant establishment and productivity. Seed germination of both plants which had undergone seed priming is recorded accordingly and calculated through standard protocols. At higher concentration halopriming reduced germination. Biopriming (*Pseudomonas fluorescens*, *Trichoderma viride*) increased growth and reduced fungal infections. Glycerol also inhibited plant growth. Distilled water, tap water, and well water provided a medium growth rate when compared to the control. This study concludes since seed priming was discovered to enhance seed performance in the early phases of plant growth. It does this by stimulating the seeds entire metabolic processes, which may ensure improved stand establishment and ultimately increase crop output. In addition to improving crop standing through more consistent and effective germination and seedling vigour, seed priming also promotes better growth and development through enhanced metabolism, which raises yield under various stress scenarios. In order to reduce the negative impacts of stress on crops, seed priming has become a promising approach.

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