EFFECT OF SEED PRIMING TREATMENTS ON SEED GERMINATION AND SEEDLING GROWTH OF BITTER GOURD (*Momordicacharantia L.)*

Abstract

By reducing seed dormancy, seed priming is an effective way to increase bitter gourd seed germination and vigor. To ascertain the impact of seed priming treatment on the physiological quality of bitter gourd seeds, an experiment was carried out in the spring. In a single factorial randomized full block design with three replications, seeds were sowed on 28 celled seed treys for this experiment in an open field setting. Water, cow milk, cow urine, NANO urea, nutrition solution, NaCl solution, and untreated seed were all used as priming agents. Bitter gourd seeds of the Durga variety were sowed, and soil, vermicompost, and sand were used as the growing media in a 2:1:1 ratio. The experiment examined various metrics, including germination rate, germination index, seedling vigor index, root and leaf length, plant height, number of leaves and roots, root-to-shoot ratio, and fresh weight. The treatments including germination % were all found to be positively influenced by the priming. In hydro-priming, the highest germination rate (81.96%) was noted. On hydro-priming, the highest number of roots (11), was recorded. Maximum shoot diameter (0.34 cm) and fresh weight (2.41 g) were recorded under controlled treatment and hydro priming, respectively. The study comes to the conclusion that Durga hydro priming followed by halo priming in seed trays was shown to be effective for seed germination and seedling growth. As a result, Nepali farmers can prime bitter gourd seeds using tap water and a NaCl solution.

Key word:Hydro Priming, SEED PRIMING, SEED GERMINATION, SEEDLING GROWTH, plant height, leaf length

1. Introduction

The bitter gourd, *Momordica charantia* (Cucurbitaceae), is an annual monoecious crop with epigeal germination and a herbaceous subtropical vine that can reach a height of six meters. Generally, it is grown from January through June. (Kole et al., 2020). It is a member of the cucurbitaceous family, which also includes cucumber, squash, watermelon, and muskmelon. The fast-growing vine, which is native to either China or India, is widely planted throughout Asia and is becoming more well-known outside of the continent. Depending on where you reside, "bitter gourd" may also refer to bitter melon, karella, or balsam pear (Palada, 2003).

The cultivation is made easier by the warm, hot weather at elevations up to 1000 meters. The optimal temperatures for germination and growth, respectively, are 25-28°C and 24-27°C. The plant grows best in sandy loam soil with a pH of 6.0 to 6.7 (KV, 1998). Low temperatures, namely those below 18°C, have a deleterious effect on germination (Fonseka, 2009). The use of a mechanical restraint on embryo growth lowers the pace of seed germination and results in a thick layer of confinement of the embryo, which precludes 100% seed germination (VK, 2004).

Bitter gourd's beta-carotene content aids in the management of eye conditions and improves vision. The anti-tumor, anti-inflammatory, antioxidant, anti-diabetic, hypolipidemic, and hypoglycemic activities of bitter melon are impressive (Angadi et al., 2018). According to a study of Bahera et al (2007), Chronic diseases like cancer and cardiovascular disease are at a lesser risk of developing in those who take vitamins like A, B6, C, E, thiamine, and niacin.

Heydecker (1973) first suggested that bitter gourd seed priming for improved germination and growth; it is a straightforward, practical, and inexpensive procedure. Seed priming is a technique to increase seed germination and consistent seedling emergence under field circumstances (Mal et al., 2019). It is a pre-sowing strategy that creates a physiological environment that encourages successful seed germination (Lutts et al., 2016).

Physiologically speaking, seed priming is the process of pre-soaking seeds before planting to allow for some ingestion on their own. This procedure also modifies the seed's temperature and moisture level, advancing it toward the germination stage (Choudhary et al., 2008; Nascimento & Aragão, 2004).

Bitter gourd cultivars respond better to the growth promotion of the seed when it is soaked in water for 12 hours. This improves germination, seedling growth, reduces pest damage, and increases yield (Saleem, 2013). "Seed priming," a post-harvest, pre-sowing treatment that improves seedling emergence and stand establishment, is the most promising way to revive seeds (Pandey, Bhanuprakash, & Umesh, 2017).

The future growth, development, and output of the bitter gourd plant depend greatly on the quality of the seedlings that are produced. Numerous factors, including growing medium, variety, environmental element, seed quality, etc., affect the quality of the seedling. Growing media give plants the nutrients and water they need to grow. Physical support, aeration, water, mineral nutrients, etc. are all provided. It has an impact on a variety of factors, including height, the quantity of leaves, shoot length, plant diameter, yield, etc. Many researchers used various growing media (such as soil, sand, coco peat, peat, FYM, vermicompost, moss, rice husk, perlite, vermiculite, etc.) to determine which ones performed best (Singh, Prasad, Wilson, Bahadur, & Mishra, 2020). The widespread and quite efficient modern way of growing seedlings on trays with various seed priming techniques includes early germination, mortality rate, rapid development, germination percentage, etc. Therefore, this method of seed germination has the ability to deal with unfavorable climatic circumstances, high yield, low cost, and healthy seedlings.

The main causes of the bitter gourd's low yield include poor seedling germination, hampered emergence, and slow growth. Bitter gourd's poor seedling issue is brought on by the embryo being encased in a thick seed coat that prevents germination and embryo development (Rawat, 2020). Its poor germination rate has also contributed to a decline in interest in the cultivation of bitter gourd in south-east Asian nations. The thick covering on the embryos of bitter gourd plants prevents them from germinating, which results in poor field emergence and seedling establishment (JM, 2001).

In order to meet the rising demand in both the home and international markets, there is an urgent need for contemporary strategic methods, one of which is priming (Behera, 2016).

1. Hydro Priming
2. Hydro priming is the simplest and most affordable method of priming therapy since tap water is used as the priming medium. No specific tools are required. Before planting, seeds are soaked in water, and afterward, they may or may not be allowed to dry naturally in the air. Hydropriming in bitter gourd seed increases bitter gourd output, seed germination, and seedling growth (Tania, Hossain, & Hossain, 2019).
3. NANO Priming

   Nano-priming is a cutting-edge seed priming technique that aids in boosting seed germination, seed growth, and yield by providing plants with resilience to various difficulties. The development of increased surface response and electron exchange capacities connected to various parts of plant cells and tissues are two of nanoparticles' (NPs) significant properties in seed priming. Nano-priming has the following effects: activating reactive oxygen species (ROS) and antioxidant systems in seeds; generating hydroxyl radicals to weaken cell walls; and serving as an inducer for fast hydrolysis of starch. Additionally, nano-priming results in the development of nanopores in shoots, which facilitate the intake of water (Nile et al., 2022).

4. Cow Urine

   About 1.0% nitrogen, residues of P_2O_5, and 1.0% K_2O are found in cow urine. Each animal excretes between 2400 and 2500 L of pee. If nitrogen in the urine, which is largely present in the form of urea, weren't preserved, it would quickly be wasted as ammonia. It is one of the main components of Pancha Kavya, an organic crop booster made and sprayed by Indian farmers, and is also recognized as a natural pest deterrent (Vighneshawaran et al., 2020).

5. Cow Milk

   Lack of effectiveness of current physiological techniques that are easy, inexpensive, quick, natural, accessible and adaptable such as using fresh cow milk to end dormancy. Fresh cow milk consistently, quickly and uniformly affects the physiology of the seeds and breaks their physiological dormancy (Adelani & Bello, 2016).

6. Halo Priming

   Halopriming, which involves soaking seeds in salt solution prior to sowing, increases consistent seedling emergence and germination under challenging environmental circumstances. Afzal et al. (2008) showed that plants from primed seeds have a stronger capacity for osmotic adjustment, which accounts for their improved salt tolerance. Plants from primed seeds had more Na+ and Cl- in roots and more sugars and organic acids in leaves than plants from non-primed seeds. Halopriming may therefore be a useful strategy for improving crops' tolerance to salt (Cayuela, Pérez-Alfocea, Caro, & Bolarín, 1996).

7. Nutrient Solution Priming

   Vitamin solution-soaked maize seed accelerates the physiological process in the leaves. These vitamins support seedling growth under low-temperature stress by increasing anti-oxidant enzymatic activities reducing peroxidation damage to membrane lipids and reducing oxidative stress (Xin Chi et al., 2021).

2. Materials and Methods

2.1. Experimental Materials

Seven priming procedures, including hydro-priming, halo-priming, NANO-priming, priming on nutrient solution (Bio-Dion), priming with milk, priming with cow urine, and non-priming, were carried out. In the experiment, bitter gourd seeds of the Durga variety were used. The seeds were gathered at KankaiAgrovet, Udayapur, Nepal, Latitude 26°57'39.7"N, Longitude 86°22'34.5"E. 28 cells seed treys were used in the experiment. As growing media, soil, vermicompost and sand was utilized in the following proportions: 2:1:1. The appropriate primed seed that had been primed for 12 hours was sowed on seed treys and placed on open field after all the seed treys had been filled with growing media.

2.2. Treatments and Experiment Design

The experiment used the Durga variety of the local bitter gourd and 7 different seed priming techniques (untreated seeds, tap water, nutrition solution, cow urine, cow milk, NaCl solution, and NANO urea priming). Three replications and a total of seven treatments were employed in the experiment's Randomize Complete Block Design. There were 21 seed treys used in the experiment. Except for the controlled treatment, all the seeds were given their respective priming and steeped for 12 hours. Before sowing, the seeds were shade-dried for two hours. The experiment was carried out in an open field setting in March 2023. 588 seeds in total were used.

Table 1: Treatment Details

S.N.	Treatment	Composition
1	Bio-Dion	0.25ml/L. of water
2	NANO Urea	5ml/L of water
3	Cow Urine	Pure Urine (concentrated)
4	Cow Milk	Pure milk (concentrated)
5	NaCl Solution	5g/L of water
6	Hydro Priming	Water
7	No treatment (Control)	Direct sowing

2.3. Data Collection

Every seedling had its data collected utilizing a disruptive procedure, which involved uprooting each seedling and taking each parameter. 15 days after the seeds were sown, data collecting began, and it continued every 5 days after that. Four data in all were gathered.

2.3.1 Seed Quality Parameters

(1) Germination Percentage (%)

Daily observation of sowed seeds was used to compute the emergence of radical and plumule, or germination, using the following formula (Krishamy, 1990).

$$\% G = SE/ST \times 100$$

where % G = germination (%),

SE: designated number of emerged seeds,

ST: designated number of total seed.

(2) Germination index

In the GI, seeds that sprouts on the first day are given more weight than seeds that germinate later. The seed with the lowest weight began to sprout on day 10.

The GI therefore places emphasis on both the pace and the proportion of germination. According to Kader (2005), a higher GI grade indicates a higher rate and percentage of germination.

"$GI=(10\times n1) + (9\times n2) + \cdot\cdot\cdot + (1\times n10)$"

(3) Root Length (cm)

At first the seedling was uprooted, washed with clear water to remove ball of earth and the root length of seedling were taken during their respective days using 30 cm scale.

(4) Shoot Length (cm)

At the conclusion of the germination experiment, normal shoot length was measured in accordance with 'International Seed Testing Association' (ISTA). After the plants were uprooted, the data were collected using scale.

(5) Shoot Diameter (cm)

Using a digital vernier caliper, the shoot diameter was measured.

(6) Number of Leaves Per Plant

Each seedling's leaves were counted manually to collect data.

(7) Fresh Weight (g)

After being uprooted, seedlings were cleaned with clear water, dried in the shade to remove moisture, and then placed on a digital scale for weighing.

(8) Vigor Index

The ability of seed to produce seedlings and the toughness of those seedlings are both measured by vigor. The term "seed vigor" refers to the characteristics of the seed that determine the level of activity and performance of the seed or seed lot during germination and seedling emergence.

Visual signs identified it, and the following calculation was made: (Jogaiah, 2014).

"VI = (Mean RL + Mean SL) * GP"

(9) Root to Shoot Ratio

By dividing root length by shoot length, it was calculated.

(10) leaf Length

Scale was used to measure the length of the leaf of each seedling.

(11) Number of Roots per seedling

Roots were counted manually.

2.4. Data Analysis

Microsoft Excel LTSC 2021 was used to tabulate and process the collected data. R-studio 4.2.2 was used to analyze the recorded data for various parameters. With accordance to Salkind (2012), the means were separated using the Least Significance Difference Test (LSDs). The significance difference for each parameter was examined using an ANOVA. The calculation was done at a 5% level of significance.

3. Results and Discussion

3.1 Effect of seed priming on germination percentage

There was positive difference in germination percentage among different priming technique. The maximum (81.96%) germination percentage was recorded in hydro-priming technique and the minimum (65.48%) germination percentage was recorded in treatment cow urine at 23 DAS.

The introduction of stimuli to the seed during priming with water results in a number of connected biochemical changes, including the activation of enzymes, production of growth-promoting substances, metabolism of germination inhibitors, repair of cell damage, and enhancement of germination (Devika et al., 2021).Dhal et al.(2022) found that experimented on vegetable seeds and found halo-priming increased speed of emergence, seedling vigor index, root length and shoot length over hydro-priming in tomato and chilly.

Table 2: Effect of seed priming on germination percentage

Treatment	Germination Percentage (%)				
	8 DAS	11 DAS	15 DAS	19 DAS	23 DAS
Bio-Dion	4.77^{d}	45.24^{c}	58.33	67.67^{cd}	67.86^{bc}
NANO Urea	41.67^{a}	64.28^{ab}	66.67	70.33^{bcd}	72.62^{abc}
Cow Urine	26.19^{c}	54.76^{bc}	64.29	65.33^{d}	65.48^{c}
Cow Milk	30.95^{abc}	60.72^{ab}	69.05	72.33^{abcd}	72.62^{abc}
NaCl Solution	25.00^{c}	67.86^{ab}	71.43	75.00^{ab}	75.00^{ab}
Hydro Priming	28.57^{bc}	63.10^{ab}	77.38	81.00^{a}	81.96^{a}

Control	39.29[ab]	70.24a	73.81	77.33[ab]	77.38[a]
Sem (±)	51.72	70.74	42.90	25.58	25.00
LSD $_{(0.05)}$	12.79	14.96	11.65	8.99	8.89
F Value	***	*	NS	*	*
CV	25.62	13.81	2.17	6.95	6.83
Grand Mean	28.06	60.88	68.71	72.71	73.13

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.2 Effect of seed priming on seedling vigor index and germination index of bitter gourd

Significance variation was observed in seedling vigor index among different seed priming technique. Hydro-priming, followed by additional priming, produced the highest seedling vigor index (27.96). The minimum seedling vigor index (20.06) was seen in cow urine. Similarly, maximum germination index (19.59) was found in hydro priming.

Increased hydro-soaking time greatly raises the seedling vigor index, according to the results of (Adhikariet al., 2021).

Table 3: Effect of seed priming on seedling vigor index and germination index of bitter gourd

Treatment	**Germination Index GI**	**Seedling Vigor Index SVI**
Bio-Dion	14.52	21.37[cd]
NANO Urea	18.50	24.93[abc]
Cow Urine	16.74	20.06[d]
Cow Milk	17.79	25.29[abc]

Nacl Solution	18.65	23.14[bcd]
Hydro Priming	19.59	27.96[a]
Control	19.19	26.04[ab]
Sem (±)	3.13	5.76
LSD $_{(0.05)}$	3.15	4.27
F Value	NS	*
CV	9.91	9.95
Grand Mean	17.85	24.11

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.3 Effect of seed priming on shoot length of bitter gourd

The study revealed that the priming treatment had a significant impact on shoot length. The effect of seed priming on shoot length at 15, 20, 25 and 30 DAS of bitter gourd was found significant, highly significant, significant and very highly significant respectively. The highest shoot length measurements were obtained after the hydro-priming procedure, which was followed by the application of cow milk, nano urea, and cow urine to all primed seed at 30, 25, and 15 DAS (11.86 cm, 9.58 cm, 9.36 cm, and 8.12 cm), while the lowest measurements were obtained after the bio-dion and subsequent priming (8.49 cm, 7.76 cm, 7.08 cm, and 6.36 cm).

The major increases in shoot length have been directly associated to the increase in physiological traits such elevated enzyme activities, increased photosynthetic rate, and significant nitrogen and phosphorus metabolism (Nile et al., 2022).

Table 4: Effect of seed priming on shoot length of bitter gourd

Treatment	Shoot Length (cm)			
	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	6.36^{c}	7.08^{c}	7.76^{b}	8.49^{d}
NANO Urea	7.89^{ab}	8.66^{ab}	9.29^{a}	10.55^{bc}
Cow Urine	8.12^{a}	9.00^{a}	8.65^{ab}	9.49^{cd}
Cow Milk	7.49^{ab}	9.58^{a}	9.21^{a}	10.36^{bc}
NaCl Solution	7.31^{ab}	7.64^{bc}	8.78^{b}	9.95^{c}
Hydro Priming	7.11^{bc}	8.45^{ab}	9.36^{a}	11.86^{a}
Control	7.49^{ab}	8.71^{ab}	9.00^{a}	11.32^{ab}
Sem (±)	0.28	0.14	0.36	0.44
$LSD_{(0.05)}$	0.94	1.14	1.07	1.18
F Value	*	**	*	***
CV	7.17	7.58	6.78	6.48
Grand Mean	7.39	8.44	8.86	10.29

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.*4 Effect of seed priming on shoot diameter of bitter gourd*

No significant difference existed between the shoot diameters of the various priming methods. However, in the controlled condition, which involved non-primed seed followed by the appropriate priming, the largest shoot diameter (0.34 cm) was found. In hydro-priming, the smallest shoot diameter (0.27 cm) was noted.

Table 5: Effect of seed priming on shoot diameter of bitter gourd

Treatment	Shoot diameter (cm)

	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	0.29	0.29	0.29	0.31
NANO Urea	0.30	0.30	0.29	0.31
Cow Urine	0.30	0.29	0.29	0.30
Cow Milk	0.28	0.29	0.28	0.31
NaCl Solution	0.28	0.30	0.29	0.32
Hydro Priming	0.27	0.28	0.30	0.32
Control	0.30	0.32	0.32	0.34
Sem (±)	0.00	0.00	0.00	0.00
LSD $_{(0.05)}$	0.05	0.02	0.04	0.03
F Value	NS	NS	NS	NS
CV	10.47	5.07	7.70	5.87
Grand Mean	0.29	0.3	0.04	0.31

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.5 Effect of seed priming on fresh weight of bitter gourd seedling

The study revealed that the fresh weight of bitter Gourd seedlings was very highly significant among the seed treatment. The seed priming on fresh weight of the bitter gourd at 15, 20, 25, and 30 DAS was shown to be very highly significant, significant, very highly significant and significant respectively. The hydro-priming treatment had the highest maximum (2.41gm), followed by all other treatments. Cow pee had the smallest fresh weight (0.64gm), which was statistically comparable to hydro priming.

Early or ideal planting for seedling fresh weights may have been made feasible by earlier emergence, which may have increased seedling vigor and improved seedling growth (Rehman et al., 2015).

Table 6: Effect of seed priming on fresh weight of bitter gourd seedling

Treatment	Fresh Weight (gm)			
	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	0.97^{bc}	1.88^{bc}	1.37^{de}	1.53^{c}
NANO Urea	1.66^{a}	2.00^{abc}	1.85^{ab}	1.76^{bc}
Cow Urine	0.64^{d}	1.75^{c}	1.99^{a}	1.93^{b}
Cow Milk	1.20^{b}	2.03^{ab}	2.05^{a}	1.92^{b}
NaCl Solution	1.16^{b}	2.15^{a}	1.28^{e}	1.96^{b}
Hydro Priming	0.87^{cd}	1.81^{bc}	1.56^{cd}	2.41^{a}
Control	1.24^{b}	2.20^{a}	1.67^{bc}	2.11^{ab}
Sem (±)	0.02	0.02	0.01	0.04
LSD $_{(0.05)}$	0.26	0.25	0.22	0.38
F Value	***	*	***	*
CV	13.60	7.32	7.49	11.20
Grand Mean	1.10	1.97	1.68	1.95

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.6 Effect of seed priming on number of leaves of bitter gourd seedling

Using different priming procedure medium, a very noticeable change in the number of leaves was seen at different growth phases. At 15 DAS and 30 DAS, the leaf number was discovered to be significant, and then extremely significant. At 20 DAS and 25 DAS, the number of leaves was observed to be non-significant. At 30, 25, 20, and 15 DAS, the highest values (5.98, 5.44, 4.68, and 2.22) were observed in NANO urea and control.

The number of leaves per plant decreased as saline level increased. However, compared to unprimed plants, the rate of decline was less pronounced in primed plants. When compared to unprimed treatments, seeds that had been primed had more leaves. Similar data were recorded by (Gebremedhn & Berhanu, 2013).

Table 7: Effect of seed priming on number of leaves of bitter gourd seedling

Treatment	No. of Leaves			
	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	1.99^{ab}	4.20	4.67	4.91^{d}
NANO Urea	2.22^{a}	4.11	5.44	5.98^{a}
Cow Urine	2.00^{ab}	4.22	5.56	5.50^{bc}
Cow Milk	2.00^{ab}	4.56	5.33	5.89^{ab}
NaCl Solution	1.89^{b}	4.54	5.22	6.13^{a}
Hydro Priming	1.89^{b}	4.33	5.44	5.44^{c}
Control	2.22^{a}	4.68	5.75	5.78^{abc}
Sem (±)	0.01	0.08	0.47	0.04
LSD $_{(0.05)}$	0.24	0.51	1.22	0.39
F Value	*	NS	NS	***
CV	6.78	6.59	12.87	3.91
Grand Mean	2.03	4.38	5.35	5.66

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.7 Effect of seed priming on number of roots of bitter gourd

With various seed priming strategies and at various growth phases a very highly significant variance in the number of roots was detected. The root number was very highly significantly higher in 25 and 30 DAS (11.00 and 8.89) in hydro and halo priming with non-significant at 20 DAS (7.22) in NaCl solution. The number of roots was reported highly significant at 15 DAS (7.72) in Bio-Dion.

Significance results on increase parameter of number of roots might be due to accumulation of total carbohydrates in the seedling, increased guaiacol peroxidase and increase in proline content (Jisha & Puthur, 2014).

Table 8: Effect of seed priming on number of roots of bitter gourd

Treatment	No. of Root			
	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	7.72^{a}	5.89	6.00^{d}	7.33^{e}
NANO Urea	6.33^{bc}	6.33	7.67^{bc}	9.00^{cd}
Cow Urine	6.22^{bc}	6.33	6.89^{cd}	8.33^{d}
Cow Milk	7.00^{ab}	6.33	7.89^{b}	9.56^{c}
NaCl Solution	6.22^{bc}	7.22	7.64^{bc}	10.55^{ab}
Hydro Priming	5.11^{d}	6.78	8.89^{a}	11.00^{a}
Control	5.89^{cd}	6.55	6.50^{d}	9.89^{bc}
Sem (±)	0.33	0.39	0.30	0.30
$LSD_{(0.05)}$	1.03	1.12	0.98	0.97

F Value	**	NS	***	***
CV	9.15	9.70	7.55	5.86
Grand Mean	6.36	6.49	7.35	9.38

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.8 Effect of seed priming on leaf length of bitter gourd

The effect of different seed priming techniques on leaf length was found to be non-significant. Only after 20 DAS significance was seen in hydro priming (3.70 cm). The leaf length observed after the seed priming was recorded statistically similar. The maximum leaf length (3.52 cm) was reported in treatment number 2. The least leaf length (2.30 cm) was observed in cow urine.

The role of nano-priming in the morphology, physiology, and growth of the plant is significant. It may specifically or inferentially influence the physiological characteristics via changing the formation of ROS, peroxidase, SOD, and CAT enzyme activities as well as the protein, chlorophyll, and total phenolic content of the leaf (Nile et al., 2022).

Table 9: Effect of seed priming on leaf length of bitter gourd

Treatment	Leaf Length (cm)			
	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	2.31	3.52^{ab}	2.87	2.93
NANO Urea	2.89	3.28^{bc}	3.52	3.14
Cow Urine	2.30	3.30^{bc}	3.09	3.17
Cow Milk	2.78	3.33^{bc}	3.29	3.14
NaCl Solution	2.70	3.37^{abc}	3.17	3.10

Hydro Priming	2.51	3.70[a]	3.19	3.21
Control	2.64	3.03[c]	3.32	3.23
Sem (±)	0.12	0.04	0.10	0.04
LSD $_{(0.05)}$	0.62	0.35	0.56	0.36
F Value	NS	*	NS	NS
CV	13.53	5.96	9.91	6.47
Grand Mean	2.59	3.36	3.20	3.13

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.9 Effect of seed priming on Root Length of bitter gourd

The statistical analysis's findings show that the seed priming mix effects on root length were exceedingly highly significant. Cow urine came in second with 23.74 cm, while halo-priming (NaCl Solution) had the highest root length (26.07 cm). Halo-priming also had the shortest root length (12.61 cm).

The results of the current investigation demonstrated that priming with NaCl solution performed best when compared to other treatments; similar findings were made by Nawaz et al (2011). Results with statistical significance for root length may be connected to how priming therapies change hormones or signaling pathways, which may have an effect on the growth and development of roots.

Table 10: Effect of seed priming on Root Length of bitter gourd

Treatment	Root Length (cm)			
	15 DAS	20 DAS	25 DAS	30 DAS
Bio-Dion	12.95[c]	14.21[d]	19.77[d]	22.93[abc]

NANO Urea	13.86[c]	24.40[a]	20.88[cd]	22.91[abc]
Cow Urine	14.11[bc]	15.66[cd]	23.74[b]	21.08[c]
Cow Milk	15.53[ab]	16.84[bcd]	23.20[b]	20.46[c]
NaCl Solution	12.61[c]	18.87[b]	26.07[a]	24.90[a]
Hydro Priming	16.32[a]	18.77[b]	22.37[bc]	24.02[ab]
Control	14.17[bc]	17.19[bc]	20.91[cd]	21.77[bc]
Sem (±)	0.88	2.55	1.59	1.88
LSD $_{(0.05)}$	1.67	2.84	2.24	2.44
F Value	**	***	***	*
CV	6.62	8.88	5.63	6.08
Grand Mean	14.22	17.99	22.42	22.58

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

3.10 Effect of seed priming on Root to Shoot Ratio of bitter gourd

The table demonstrates that the priming techniques had a substantial impact on the root to shoot ratio up to 30 days after sowing. The NANO urea had the highest root to shoot ratio (2.71 cm), followed by cow milk (2.37 cm), hydro-priming (2.28 cm), and cow urine (2.23 cm), in that order. The controlled treatment, which used non-primmed seed, was found to have the lowest root to shoot ratio (1.84 cm).

The length of the roots and shoots can be improved by seed priming with urea and urine. This is mostly explained by the primed seeds faster metabolism which spseeds up imbibition when compared to un-primed seeds (Shrestha et al., 2019).

Table 11: Effect of seed priming on Root to Shoot Ratio of bitter gourd

Treatment	**Root to Shoot Ratio (15 DAS) (cm)**	**Root to Shoot Ratio (30 DAS) (cm)**
Bio-Dion	2.05	2.03^{cd}
NANO Urea	1.78	2.71^{a}
Cow Urine	1.89	2.23^{bc}
Cow Milk	2.07	2.37^{b}
Nacl Solution	1.74	2.10^{bcd}
Hydro Priming	2.31	2.28^{bc}
Control	1.75	1.84^{d}
Sem (±)	0.04	0.03
LSD $_{(0.05)}$	0.39	0.32
F Value	NS	**
CV	11.41	8.27
Grand Mean	0.04	2.22

Non-significant (NS), Significant (*), highly significant (**), Very highly significant (***) at 95% level of confidence.

Figure 1: Showing Experimental Unit after sowing

Figure 2: After Germination

Figure 3: After data collection total plant

4. Conclusion

The study's findings generally indicate that bitter gourd seeds responded in a variety of ways depending on the priming technique used. Based on the study's findings, various seed priming techniques have a substantial impact on the germination and growth of bitter gourd seedlings. For the highest germination rate, the Durga variety primed in hydro-priming and then halo-priming is preferred. Similar to this, Durga variety seeded in hydro and halo priming is excellent for maximizing bitter gourd seedling growth characteristics, including germination percentage, germination index, seedling vigor index, fresh weight, leaf length, number of roots, and root length, respectively. On NANO urea, the highest root-shoot ratio was discovered. On controlled treatment, the largest shoot diameter was observed. Cow pee contains the highest levels of increased seed weight from priming. The overall results demonstrated that, when compared to other priming techniques, hydro and halo-primed seed produced the best outcomes in terms of seed germination and growth traits. The seed primed with water performs best among the results attained. Therefore, farmers and upcoming researchers may use the finding. To ascertain the effect of different seed priming strategies on the morphological traits and production of bitter gourd, more research is needed. It is suggested that future researchers conduct similar investigations by priming seed for 24 hours and use various priming approaches.

Conflicts of Interest

The author claims that there are no conflicts of interest.

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References

Adelani, & Bello, M. I. (2016). Effect of Fresh Cow Milk and Coconut Milk on the Germination of Tamarindus indica Seeds. *Applied Tropical Agriculture*, *21*(3), 37–45.

Adhikari, B., Dhital, P. R., Ranabhat, S., & Poudel, H. (2021). Effect of seed hydro-priming durations on germination and seedling growth of bitter gourd (Momordica charantia). *PLoS ONE*, *16*(8 August), 1–12. https://doi.org/10.1371/journal.pone.0255258

Angadi, A., kumar, Y. H., & Ahmed, S. (2018). National conference on "Conservation, Cultivation and Utilization of medicinal and Aromatic plants" Medicinal and nutritional importance of bitter melon (Momordica charantia L): A review article. ~ *297 ~ Journal of Pharmacognosy and Phytochemistry*, *3*, 297–300.

Bahera, T. K., Staub, J. E., Sanidha, B., & Philip, W. S. (2007). Bitter gourd and human health. *Medicianal and Aromatic Plant Science and Biotechnology*, *1*(2), 224–226.

Behera, S. (2016). A Study the Effect of Salt Priming (KNO3, NA2HPO4, PEG) on Seed Quality Parameters of Solanaceous Vegetables. *SSRN Electronic Journal*, *6*(3), 337–348. https://doi.org/10.2139/ssrn.2835346

Cayuela, E., Pérez-Alfocea, F., Caro, M., & Bolarín, M. C. (1996). Priming of seeds with NaCl induces physiological changes in tomato plants grown under salt stress. *Physiologia Plantarum*, *96*(2), 231–236. https://doi.org/10.1111/j.1399-3054.1996.tb00207.x

Choudhary, D. K., Johri, B. N., & Prakash, A. (2008). Volatiles as priming agents that initiate plant growth and defence responses. *Current Science*, *94*(5), 595–604.

Devika, O. S., Singh, S., Sarkar, D., Barnwal, P., Suman, J., & Rakshit, A. (2021). Seed Priming: A Potential Supplement in Integrated Resource Management Under Fragile Intensive Ecosystems. *Frontiers in Sustainable Food Systems*, *5*(July), 1–11. https://doi.org/10.3389/fsufs.2021.654001

Dhal, P., Sahu, G., Dhal, A., … S. M.-T. P., & 2022, undefined. (2022). Priming of vegetable seeds: a review. *Thepharmajournal.Com*, *11*(2), 519–525. Retrieved from https://www.thepharmajournal.com/archives/2022/vol11issue2/PartH/10-12-207-201.pdf

Gebremedhn, Y., & Berhanu, A. (2013). The role of seed priming in improving seed germination and seedling growth of maize (Zea mays L.) under salt stress at laboratory conditions. *African Journal of Biotechnology*, *12*(46), 6484–6490. https://doi.org/10.5897/ajb2013.13102

https://www.thepharmajournal.com/archives/2022/vol11issue2/PartH/10-12-207-201. (n.d.). https://www.thepharmajournal.com/archives/2022/vol11issue2/PartH/10-12-207-201

Jisha, K. C., & Puthur, J. T. (2014). Halopriming of seeds imparts tolerance to NaCl and PEG induced stress in Vigna radiata (L.) Wilczek varieties. *Physiology and Molecular Biology of Plants*, *20*(3), 303–312. https://doi.org/10.1007/s12298-014-0234-6

Jogaiah, S. (2014). RESEARCH ARTICLE ENHANCE DEFENSE ACTIVITY AND INDUCE RESISTANCE AGAINST EARLY BLIGHT DISEASE OF TOMATO.

Kole, C., Matsumura, H., Kanti, T., & Editors, B. (2020). *Compendium of Plant Genomes The Bitter Gourd Genome*. Retrieved from http://www.springer.com/series/11805

Lutts, S., Benincasa, P., Wojtyla, L., Kubala, S., Pace, R., Lechowska, K., … Garnczarska, M. (2016). Seed Priming: New Comprehensive Approaches for an Old Empirical Technique. *New Challenges in Seed Biology - Basic and Translational Research Driving Seed Technology*, 1–46. https://doi.org/10.5772/64420

Mal, D., Verma, J., Levan, A., Reddy, M. R., Avinash, A. V., & Kumar Velaga, P. (2019). Seed Priming in Vegetable Crops: A Review. *International Journal of Current Microbiology and Applied Sciences*, *8*(06), 868–874. https://doi.org/10.20546/ijcmas.2019.806.105

Nascimento, W. M., & Aragão, F. A. S. de. (2004). Muskmelon seed priming in relation to seed vigor. *Scientia Agricola*, *61*(1), 114–117. https://doi.org/10.1590/s0103-90162004000100019

Nile, S. H., Thiruvengadam, M., Wang, Y., Samynathan, R., Shariati, M. A., Rebezov, M., … Kai, G. (2022). Nano-priming as emerging seed priming technology for sustainable agriculture—recent developments and future perspectives. *Journal of Nanobiotechnology*, *20*(1). https://doi.org/10.1186/s12951-022-01423-8

Palada, M. C. and C. L. C. (2003). Suggested cultural practices for bitter gourd. International Cooperators Guide. *Avrdc*, 03–547. Retrieved from https://avrdc.org/wpfb-file/icg_bitter-gourd-cultural-practices_final-pdf/

Pandey, P., Bhanuprakash, K., & Umesh, U. (2017). Effect of Seed Priming on Seed Germination and Vigour in Fresh and Aged Seeds of Cucumber. *International Journal of Environment, Agriculture and Biotechnology*, *2*(4), 2261–2264. https://doi.org/10.22161/ijeab/2.4.88

Rawat, M. (2020). Effects of seed priming and it ' s duration on bitter gourd, *9*(6), 1950–1953. https://doi.org/10.22271/phyto.2020.v9.i6ab.13237

Saleem, M. S. (2013). Effect of Seed Soaking On Seed Germination and Growth of Bitter Gourd Cultivars. *IOSR Journal of Agriculture and Veterinary Science*, *6*(6), 07–11. https://doi.org/10.9790/2380-0660711

Shrestha, A., Pradhan, S., Shrestha, J., & Subedi, M. (2019). Role of seed priming in improving seed germination and seedling growth of maize (Zea mays L.) under rain fed condition. *Journal of Agriculture and Natural Resources*, *2*(1), 265–273. https://doi.org/10.3126/janr.v2i1.26088

Singh, S., Prasad, V. M., Wilson, D., Bahadur, V., & Mishra, S. (2020). Effect of Different Growing Media with Soil and Sand in Polybags on Seed Germination, Seedling Growth and Survival Percentage of Papaya (Carica papaya) cv. Pusa Nanha. *International Journal of Current Microbiology and Applied Sciences*, *9*(12), 929–936. https://doi.org/10.20546/ijcmas.2020.912.112

Tania, S. S., Hossain, M. M., & Hossain, M. A. (2019). Effects of hydropriming on seed germination, seedling growth and yield of bitter gourd. *Journal of the Bangladesh Agricultural University*, *17*(3), 281–287. https://doi.org/10.3329/jbau.v17i3.43197

Vighneshawaran, G., Ebenezer Babu Rajan, R., Praveen Sampath Kumar, C., Sam Ruban, J., Joshi, J. L., & Muraleedharan, A. (2020). Effect of biological seed priming methods on field performance and seed quality of black gram (vigna mungo l.). cv. vbn 5. *Plant Archives*, *20*, 1672–1674.

Xin Chi, Y., Yang, L., Jiang Zhao, C., Muhammad, I., Bo Zhou, X., & De Zhu, H. (2021). Effects of soaking seeds in exogenous vitamins on active oxygen metabolism and seedling growth under low-temperature stress. *Saudi Journal of Biological Sciences*, *28*(6), 3254–3261. https://doi.org/10.1016/j.sjbs.2021.02.065