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Effects of Hydropriming on Seedling Growth Parameters of *Cicer arietinum* (Chickpea)

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Abstract

Hydropriming, a simple and cost-effective seed priming technique that plays a significant role in improving germination and early seedling growth under suboptimal conditions. This study investigates the effects of hydropriming on various growth parameters of *Cicer arietinum* (chickpea), a major leguminous crop cultivated in semi-arid regions. Seeds were subjected to hydropriming for varying durations (6, 12, and 24 hours), and compared to untreated controls. Observations on germination percentage, seedling length, fresh and dry weight, and vigour index were recorded. The results indicate that hydropriming significantly enhances early growth performance, especially at 12 hours of treatment. The findings support hydropriming as a promising pre-sowing technique for improving chickpea establishment and productivity.

Keywords: Hydropriming, *Cicer arietinum*, Seed priming, Growth parameters, Seedling vigour

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Introduction

Cicer arietinum L., commonly known as chickpea or Bengal gram, is one of the most important grain legumes cultivated and consumed worldwide. Belonging to the family Fabaceae (Leguminosae) and subfamily Papilionoideae, chickpea holds significant agronomic, nutritional, and economic value. Chickpea is highly valued for its nutritional richness, being a major source of Proteins (20–25%),Carbohydrates (50–60%), Dietary fiber, Essential minerals (iron, zinc, calcium, magnesium, and phosphorus) and vitamins (folate, thiamine, and niacin). Due to its high protein content, chickpea serves as a vital protein source in vegetarian and low-income diets. Its low glycemic index and high fiber content also make it beneficial for diabetic and cardiovascular health.

Cicer arietinum (chickpea) is one of the most important pulse crops grown globally, particularly in India. It is cultivated mainly in arid and semi-arid areas of the world. The Indian subcontinent (India, Pakistan, Myanmar, Bangladesh, and Nepal) produces and consumes the majority of chickpeas worldwide, accounting for nearly 70% of total production. Turkey, Australia, Ethiopia, Iran, Mexico, Canada, and the United States are also major chickpea producers. Its productivity is often affected by abiotic stress conditions during germination and early seedling establishment. Seed priming, especially hydropriming (soaking seeds in water), is a non-chemical method used to enhance seed performance.

Chickpea (*Cicer arietinum*) is believed to have originated in the Fertile Crescent region of the Near East, particularly in present-day southeastern Turkey and Syria. Archaeological evidence suggests its domestication occurred around 7000 years ago (Zohary *et.al.*,2012)). From there, it spread to South Asia, North Africa, and Europe, eventually reaching other parts of the world. India is currently the largest producer and consumer of chickpea, accounting for over 70% of global production and demand (FAO STAT, 2023).

Being a leguminous crop, chickpea forms symbiotic associations with Rhizobium bacteria in root nodules, enabling biological nitrogen fixation. This improves soil fertility and reduces the dependency on synthetic nitrogen fertilizers. It makes chickpea as an excellent crop for sustainable agriculture and crop rotations.

It is an annual herbaceous plant with a deep taproot system that enhances drought resistance. It is typically 60–70 cm tall, although plant height varies with genotype and environmental conditions. The plant has compound pinnate leaves, pubescent stems, and small white to pink flowers with characteristic papilionaceous (butterfly-like) symmetry.

The fruit is a pod, generally containing 1–2 seeds, and the seeds themselves are highly variable in color, shape, and size, depending on the cultivar. Based on seed size and coat colour, chickpeas are classified into two main types:

Desi type: Smaller, angular seeds with dark seed coats.

Kabuli type: Larger, rounder seeds with light-coloured seed coats.

Review of Literature

Hydropriming is a pre-sowing seed treatment involving soaking seeds in water. It has emerged as an effective low-cost method to enhance germination and seedling vigour in *Cicer arietinum* (chickpea), particularly under abiotic stress conditions. Hydropriming significantly improves germination rates and seedling vigour in chickpea. Patil *et al.* (2020) reported a 19% increase in seedling emergence and a 53.3% enhancement in seedling vigour index in hydroprimed seeds compared to unprimed controls under drought and salinity stress conditions. Similarly, a study by Garg (2022) demonstrated that hydropriming for 5 hours optimally improved germination percentage and seedling growth parameters in the RSG-888 chickpea genotype.

Hydropriming positively affects various growth parameters and yield components. Zare *et al.* (2011) observed significant

improvements in the number of pods per plant, biological yield, and grain yield with hydropriming treatments. Additionally, Sarvjeet *et al*. (2017) found that combining hydropriming (16 hours) with biofortification using Rhizobium inoculation led to increased plant height, number of branches, and seed yield per plant.

The effectiveness of hydropriming varies among different chickpea genotypes. Dhanya *et al*. (2023) reported that the response to hydropriming is both duration- and genotype-specific, with significant variations in germination and seedling growth observed across different priming durations and chickpea varieties.

Hydropriming induces favourable physiological and biochemical changes in chickpea plants. Kaur *et al*. (2005) demonstrated that hydropriming modulates enzymes involved in sucrose and nitrogen metabolism in nodules, thereby enhancing nitrogen fixation and overall plant growth. Furthermore, hydropriming has been shown to improve antioxidant enzyme activities and membrane stability under stress conditions, contributing to better stress tolerance.

Materials and Methods

Certified seeds of *Cicer arietinum* (variety: Pusa-362) were used for hydropriming. Pusa-362 is a desi chickpea variety of *Cicer arietinum* introduced by the Indian Agricultural Research Institute (IARI). The seeds were visually inspected and sorted to remove damaged or undersized seeds to ensure uniformity. The experiment was conducted under controlled laboratory conditions at the Department of Botany, RBS College, Agra during August-September, 2024. The study was laid out in a Completely Randomized Design (CRD) with three replications per treatment.

Hydropriming was performed by soaking seeds in distilled water for different durations. The treatments included:

T0: Control (untreated seeds)
T1: Hydropriming for 6 hours
T2: Hydropriming for 12 hours
T3: Hydropriming for 24 hours

After soaking, seeds were air-dried under shade at room temperature ($25 \pm 2^{\circ C}$) to restore their original moisture content. All primed and unprimed seeds were sown immediately after drying.

Seeds from each treatment were sown in germination trays lined with moist blotting paper. The trays were placed in a growth chamber maintained at $25 \pm 2^{\circ C}$ with 70–80% relative humidity and a 12-hour photoperiod. The blotting paper was kept moist with distilled water throughout the experiment. Each treatment was replicated thrice with 25 seeds per replicate.

Observations

Seedling growth parameters were systematically assessed on the 10th day after sowing (DAS) to evaluate the influence of hydropriming treatments on early seedling development. The following parameters were recorded:

a. Germination Percentage (%)

Germination percentage is a basic measure of seed viability and early seedling success. It was determined using the following formula:

Germination Percentage
= (Number of seeds germinated/Total number of seeds sown) ×100

Seeds were observed daily, and the number of seeds that produced visible radicles (≥ 2 mm) was counted as germinated. A higher germination percentage indicates greater seed viability and improved performance due to hydropriming.

b. Mean Germination Time (MGT)

MGT represents the average time taken for seeds to germinate. It was determined using the following formula:

$$MGT = \sum(ni \times ti) / \sum ni$$

Where:
ni = Number of seeds germinated on day ti
ti = Time (days) after sowing

Daily germination counts were recorded until germination ceased. Lower MGT values indicate faster and more synchronous germination, which is a desirable trait enhanced by effective priming.

c. Root Length (cm)

Root length is a key indicator of early seedling vigour and capacity for water and nutrient uptake. On the 10th DAS, 10 randomly selected seedlings from each treatment were gently uprooted. Root length was measured using a ruler from the point of seed attachment to the tip of the longest root. Longer root systems reflect better root development due to enhanced physiological activity induced by hydropriming.

d. Shoot Length (cm)

The same seedlings used for root length were measured for shoot length using a centimeter scale from the cotyledonary node to the shoot apex. Increased shoot length denotes improved seedling growth and establishment potential.

e. Seedling Fresh and Dry Weight (mg)

Biomass accumulation in seedlings indicates metabolic activity and nutrient mobilization efficiency. Increased fresh and dry weights suggest improved water uptake, metabolic activity, and overall seedling vigour resulting from effective priming.

•Fresh Weight:

Five seedlings per replication were harvested and immediately weighed using an analytical balance.

•Dry Weight:

The same seedlings were placed in a hot air oven at $70 \pm 2°C$ for 48 hours, then reweighed to record their dry mass.

f. Seedling Vigour Index (SVI)

SVI integrates both germination percentage and seedling growth to provide a comprehensive measure of seedling health and performance.

SVI = Germination % × (Mean root length + Mean shoot length)

Mean values of root and shoot lengths from each treatment were used along with the corresponding germination percentage. A higher SVI signifies that seedlings are both numerous and healthy, reflecting the effectiveness of hydropriming in enhancing seedling quality.

Results

5.1 Germination Percentage

Treatment	Germination (%)
T0	76 ± 2.1
T1	84 ± 1.8
T2	92 ± 1.3
T3	88 ± 2.0

Maximum germination was observed in T2 (12-hour hydropriming).

5.2 Seedling Growth Parameters

Treatment	Shoot Length (cm)	Root Length (cm)	Fresh Weight (mg)	Dry Weight (mg)	SVI
T0	6.2 ± 0.3	4.1 ± 0.2	185 ± 4.2	37 ± 1.1	788
T1	7.0 ± 0.2	4.8 ± 0.3	210 ± 3.8	42 ± 1.4	999
T2	8.1 ± 0.4	5.4 ± 0.2	234 ± 5.1	48 ± 1.6	1248
T3	7.4 ± 0.3	5.0 ± 0.2	220 ± 4.5	44 ± 1.3	1126

Hydropriming for 12 hours showed significantly higher shoot and root lengths, fresh/dry weights, and SVI.

6. Discussion

Hydropriming notably increased the germination percentage compared to unprimed seeds. This enhancement can be attributed to the activation of metabolic processes during the priming phase, leading to a more synchronized and rapid germination upon sowing. Such findings align with those of Patil *et al*. (2020), who reported a 19% increase in seedling emergence in hydroprimed chickpea seeds under drought and salinity stress conditions. Furthermore, the mean germination time (MGT) was reduced in hydroprimed seeds, indicating a faster germination process. This acceleration is crucial for ensuring uniform crop stands, especially under suboptimal environmental conditions.

Hydropriming significantly influenced seedling growth metrics, including root length, shoot length, and seedling vigour index (SVI). The enhanced root and shoot lengths suggest improved cellular elongation and division, likely due to the early activation of enzymes and hormones during the priming process. Garg (2022) demonstrated that hydropriming for 5 hours optimally improved germination percentage and seedling growth parameters in the RSG-888 chickpea genotype. Additionally, the increased SVI indicates a robust seedling establishment potential, which is vital for subsequent plant development and yield.

The study observed higher fresh and dry weights in hydroprimed seedlings compared to controls. This increase in biomass accumulation can be linked to enhanced metabolic activity and efficient nutrient mobilization during early growth stages. Such improvements in seedling biomass are indicative of the positive effects of hydropriming on the physiological and biochemical processes essential for plant growth.

Hydropriming not only affects physical growth parameters but also induces physiological and biochemical changes that favour seedling development. Kaur *et al*. (2006) reported that hydropriming of chickpea seeds enhanced the activities of enzymes involved in sucrose and nitrogen metabolism in nodules, contributing to better seedling vigour. These enzymatic activities are crucial for energy production and nutrient assimilation, further supporting the observed improvements in seedling growth.

The effectiveness of hydropriming can vary based on chickpea genotypes and the duration of priming. A study by Dhanya *et al*. (2023) highlighted that the positive effects of hydropriming are sharply duration and genotype-specific, emphasizing the need for optimization based on specific cultivars. This variability underscores the importance of tailoring hydropriming protocols to achieve maximum benefits across different chickpea varieties.

Hydropriming enhances the physiological status of seeds by activating enzymatic systems, thus accelerating germination and seedling development. The improved performance in T2 (12 hours) may be attributed to optimal hydration for metabolic preconditioning without inducing oxidative damage, which may occur with over-priming (as seen in T3).

These results align with earlier findings where moderate hydropriming durations improved seedling vigour in legumes (Singh *et al*., 2017; Reddy & Rao, 2020). Over-priming beyond 24 hours may cause leaching of nutrients and oxygen deficiency, impairing growth.

7. Conclusion

Hydropriming is an efficient, low-cost technique for improving the early growth of *Cicer arietinum*. Among the tested treatments, 12-hour hydropriming (T2) proved most effective in enhancing germination percentage, seedling length, and vigour index. This practice can be recommended for chickpea growers, especially in rainfed areas where uniform germination is essential for yield optimization.

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