International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133, Print ISSN: 2664-7125
Received: 08-09-2025, Accepted: 08-10-2025, Published: 23-10-2025
Volume 7, Issue 4, 2025, Page No. 68-70

Standardization the seed to solution ratio and hydropriming duration for seed priming in cluster bean

Varshini C M*, Sangeeta I Macha, Ganigara, B S, Hemalatha K J, Lokesh K, Basavaraj
Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India

Abstract
A laboratory experiment was conducted to standardize the seed to solution ratio and hydropriming duration for seed priming in cluster bean at the Department of Seed Science & Technology, University of Agricultural Sciences, Raichur during Kharif 2024-25. The experiment was laid out in a Two Factorial Completely Randomized Design. The first factor consisted of seed to solution ratios *viz*., 1:0.5, 1:1, 1:1.5 and 1:2. The second factor was hydropriming durations *viz*., 16, 18, 20, 22 and 24 hours. The results revealed that seed priming in 1:1 seed to solution ratio for 20 hours recorded higher seed quality parameters viz., seed germination (91.50 %), seedling length (19.58 cm), seedling dry weight (21.80 mg), seedling vigour index-I and II (1841 and 1994, respectively), and lower electrical conductivity (0.205 dS m^{-1}). In contrast, seed priming in 1:0.5 seed to solution ratio for 24 hours recorded lower seed quality parameters (82.50 %, 17.13 cm, 18.53 mg, 1407 and 1565, respectively) with higher electrical conductivity (0.319 dS m^{-1}). Based on the results, it can be concluded that hydropriming cluster bean seeds in 1:1 seed to solution ratio for 20 hours is suitable to achieve high-quality seedlings.

Keywords: Cluster bean, seed priming, hydropriming, seed to solution ratio, seed quality

Introduction

Cluster bean (*Cyamopsis tetragonoloba* L. taub.) is an important leguminous crop of the family Fabaceae, widely cultivated for its tender pods used as vegetable, for fodder and as the primary source of guar gum, which has diverse industrial applications. It is also recognized as a drought-tolerant crop that thrives well in arid and semi-arid regions. The seeds are rich in protein, fiber and hydrocolloids andguar gum extracted from the endosperm is extensively used in food, pharmaceutical, paper andtextile industries (Singh *et al*., 2020) [12]. Besides its industrial significance, the crop plays a vital role in sustainable agriculture through nitrogen fixation and as a source of green manure.

Despite its multiple uses, the productivity of cluster bean is often affected by poor seed quality, low germination percentage and uneven seedling emergence under field conditions (Kumar *et al*., 2017) [7]. Seed germination and early seedling growth are critical phases that determine crop stand and yield potential. To overcome these constraints, presowing seed management techniques such as priming have been developed to enhance seed performance. Hydropriming, the process of soaking seeds in water followed by drying to their original moisture content before sowing, is considered the simplest and most ecofriendly method of seed invigouration (Bradford, 1986) [3].

The success of hydropriming depends largely on the seed to solution ratio and duration of priming, which vary with crop species and seed characteristics (Krishnakumary *et al*., 2008) [6]. Proper hydration up to the threshold level before radicle emergence activates repair mechanisms, accelerates metabolic processes and ensures rapid and uniform germination. Hydropriming has been shown to enhance seedling vigour, stress tolerance and field emergence in legumes including cluster bean (Malarkodi *et al*., 2023) [8].

Materials and methods

The laboratory experiment was conducted at the Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India, located at 16°15′ North latitude and 77°20′ East longitude with an altitude of 389 m above mean sea level during 2023–24. The experiment was laid out in a Two Factorial Completely Randomized Design with four replications.

Cluster bean seeds were subjected to hydropriming with different seed to solution ratios and durations. The first factor included four seed to solution ratios, namely 1:0.5 (S_1), 1:1 (S_2), 1:1.5 (S_3) and 1:2 (S_4). The second factor comprised five hydropriming durations, viz., 16 hours (D_1), 18 hours (D_2), 20 hours (D_3), 22 hours (D_4) and 24 hours (D_5). The cleaned and graded cluster bean seeds were soaked in distilled water according to the specified seed to solution ratios and hydropriming durations at room temperature (25 ± 2°C). After the prescribed soaking period, seeds were removed and spread uniformly on blotting paper under shade for 12 hours to dry to their original moisture level. The hydroprimed seeds were then used for evaluating seed quality parameters. The observations recorded on seed germination (%), seedling length (cm), seedling dry weight (mg), seedling vigour index –I and II and electrical conductivity (dS m^{-1})

Seed Germination (%): The standard germination test was conducted with four replications of 100 seeds each by the between-paper method. Rolled towels were incubated in a walk-in seed germination chamber maintained at 25 ± 2°C and 90 ± 5% relative humidity. Final count was recorded on the 8th day. Normal seedlings were counted and expressed as percentage germination (ISTA, 2013).

Seedling Length (cm): Seedling length was calculated by summing shoot and root lengths. Mean seedling length was expressed in centimeters (ISTA, 2013).

Seedling dry weight (mg): Ten seedlings used for length measurement were placed in butter paper bags and dried in a hot air oven at 70 ± 2°C for 24 hours. After cooling in a desiccator for 20 minutes, seedlings were weighed using an electronic balance. Mean seedling dry weight was expressed in milligrams (ISTA, 2013).

Seedling vigour index I: Calculated by multiplying seed germination (%) with seedling length (cm) and expressed as a whole number (Abdul Baki & Anderson, 1973) [1].
SVI I = Seed germination (%) × Seedling length (cm)

Seedling vigour index II: Calculated by multiplying seed germination (%) with seedling dry weight (mg) and expressed as a whole number (Abdul Baki & Anderson, 1973) [1].
SVI II = Seed germination (%) × Seedling dry weight (mg)

Electrical conductivity (dS m⁻¹): One hundred seeds from each treatment were weighed and placed in 250 ml beakers containing 50 ml of distilled water and incubated at 25 ± 1°C for 24 hours. The steep water was gently swirled and the electrical conductivity of the seed leachates was measured using a digital conductivity meter. Lower values indicated reduced solute leakage and better membrane integrity, reflecting higher seed vigour (Milosevic *et al*., 2010) [9].

3. Results and discussion

The results showed that different seed to solution ratios and hydropriming durations had shown significant differences for seed germination (%), shoot length (cm), root length (cm), seedling length (cm), seedling dry weight (mg) seedling vigour indices I and II and electrical conductivity which are presented in Tables 1 and 2.

The seed germination is a key seed quality parameter. The significantly highest seed germination was recorded in 1:1 seed to solution ratio (S_2) (88.80%) compared to 1:0.5 ratio (S_1) (85.15%). Among hydropriming durations, 20 hours (D_3) recorded significantly highest germination (89.25%) than 24 hours (D_5) (84.81%). In case of interactions, priming in 1:1 seed to solution ratio for 20 hours (S_2D_3) recorded significantly highest seed germination (91.50%) compared to 1:0.5 ratio for 24 hours (S_1D_5) (82.50%). The probable reason for enhancement of germination percentage and uniformity of hydroprimed seeds might be attributed to completion of pregerminative metabolism, repair and synthesis of nucleic acids (DNA and mRNA), proteins, initiation of enzymatic activities and early biochemical reactions (Ibrahim, 2019) [4] observed increased germination in maize seeds due to hydropriming for 6 hours. The availability of optimum moisture facilitates hydrolysis of stored macromolecules into simpler sugars, which are utilized for synthesis of auxins and proteins, aiding cell elongation and division. Soaking seeds in adequate water for defined durations has been reported to improve germination in redgram (Anbarasan and Srimathi, 2015) [2] in redgram.

Seedling length was significantly influenced by seed to solution ratios and hydropriming durations. S_2 (1:1) recorded the maximum seedling length (18.82 cm), on par with S3 (18.60 cm), while S_1 recorded the shortest (17.81 cm). Hydropriming for 20 hours (D_3) produced the longest seedlings (19.02 cm) compared to 24 hours (D_5) (17.91 cm). Interaction S_2D_3 recorded maximum seedling length (19.58 cm) compared to S_1D_5 (17.13 cm). Hydropriming likely enhanced mitochondrial activity, enzyme synthesis and repair of cellular components, contributing to elongation of shoots and roots Patel *et al*. (2018) [10] in blackgram and Malarkodi *et al*. (2023) [8] in brinjal.

Seedling dry weight was highest in S_2 (21.01 mg), on par with S_3 (20.95 mg), and lowest in S_1 (19.59 mg). Hydropriming for 20 hours (D_3) produced maximum dry weight (21.28 mg) compared to 24 hours (D_5) (18.53 mg). Interaction S_2D_3 recorded maximum seedling dry weight (21.80 mg) while S_1D_5 recorded minimum (18.53 mg). The increased dry matter accumulation is attributed to efficient mobilization of stored reserves, enzyme activation, and balanced hydration during priming (Poonam *et al*. (2020) [11] and Suthar *et al*. (2022) [13] in legumes.

Seedling vigour index-I (SVI-I) was significantly influenced by seed to solution ratio and priming duration. S_2 recorded the highest SVI-I (1695), on par with S_3 (1657), and lowest in S_1 (1529). Hydropriming for 20 hours (D_3) produced maximum SVI-I (1743), whereas 24 hours (D_5) recorded lowest (1533). Interaction S_2D_3 recorded the highest SVI-I (1841) while S_1D_5 recorded the lowest (1407). The higher SVI-I in optimal treatments is due to improved germination, radicle and plumule elongation, and activation of hydrolytic enzymes (Bradford, 1986 [3] in tomato and Wahocho *et al*., 2023 [14] in okra.

Seedling vigour index-II (SVI-II) was highest in S_2 (1866), followed by S_3 (1814), and lowest in S_1 (1679). Duration 20 hours (D_3) recorded maximum SVI-II (1899) while 24 hours (D_5) recorded minimum (1686). Interaction S_2D_3 recorded highest SVI-II (1994) compared to S_1D_5 (1565). These results indicate that balanced hydration and optimal priming duration enhance biomass accumulation and seedling vigour (Kumar *et al*., 2010 in okra)

Electrical conductivity (EC) was significantly lowest in S_2 (0.226 dSm⁻¹), and highest in S1 (0.298 dSm⁻¹). Duration 20 hours (D_3) recorded lowest EC (0.220 dSm⁻¹) while 24 hours (D_5) recorded highest (0.288 dSm⁻¹). Interaction S_2D_3 showed lowest EC (0.205 dSm⁻¹), and S_1D_5 the highest (0.319 dSm⁻¹), indicating optimal hydration preserves membrane integrity and reduces solute leakage, whereas over or under priming damages membrane stability Anbarasan and Srimathi, 2015 [2] in redgram).

Table 1: Effect of seed to solution ratio and hydropriming duration on seed germination, seedling length and seedling dry weight of cluster bean

	Seed germination (%)					Seedling length (cm)					Seedling dry weight (mg)				
Treatment	**S_1**	**S_2**	**S_3**	**S_4**	**Mean (D)**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean (D)**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean (D)**
D_1	84.50 (66.81)	86.75 (68.65)	85.75 (67.82)	84.75 (67.01)	85.45 (67.57)	17.63	18.23	18.10	17.75	17.93	19.13	20.48	21.40	19.50	19.78
D_2	86.00 (68.44)	89.25 (70.86)	87.00 (68.88)	86.50 (68.88)	87.19 (69.26)	18.05	18.83	18.68	18.53	18.52	19.80	21.00	20.80	20.70	20.58
D_3	87.25 (69.08)	91.50 (73.05)	89.75 (71.33)	88.50 (70.18)	89.25 (70.91)	18.25	19.58	19.20	19.05	19.02	20.50	21.80	21.50	21.30	21.28
D_4	85.50 (67.61)	90.00 (71.60)	89.00 (70.65)	88.00 (68.89)	88.13 (69.69)	17.98	19.08	18.85	18.73	18.66	20.00	21.20	21.25	20.80	20.75

D_5	82.50 (66.81)	86.50 (68.45)	86.25 (69.08)	84.00 (66.81)	84.81 (67.79)	17.13	18.38	18.18	17.98	17.91	18.53	20.58	20.05	19.53	19.67
Mean (S)	85.15 (67.75)	88.80 (71.04)	87.55 (69.67)	86.35 (68.74)	86.90	17.81	18.82	18.60	18.41	18.41	19.59	21.01	20.67	20.37	20.41
Factors	S.Em. ±			CD @ 1 %		S.Em. ±			CD @ 1 %		S.Em. ±			CD @ 1 %	
S	0.20			0.57		0.06			0.22		0.14			0.52	
D	0.22			0.64		0.06			0.24		0.15			0.58	
S X D	0.45			1.28		0.13			0.48		0.31			1.16	

Legend:
Seed to solution ratio (S):
S_1 = 1:0.5 S_2 = 1:1 S_3 = 1:1.5 S_4 = 1:2

Duration of hydropriming (D)
D_1 = 16 hrs D_2 = 18 hrs D_3 = 20 hrs D_4 = 22 hrs D_5 = 24 hrs

Table 1: Effect of seed to solution ratio and hydropriming duration on seedling vigour indices and electrical conductivity of cluster bean

	Seedling vigour index-I					Seedling vigour index-II					Electrical conductivity (dS m^{-1})				
Treatment	**S_1**	**S_2**	**S_3**	**S_4**	**Mean (D)**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean(D)**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean(D)**
D_1	1488	1592	1557	1505	1535	1616	1776	1715	1653	1690	0.303	0.263	0.268	0.308	0.286
D_2	1575	1710	1673	1637	1649	1713	1874	1809	1803	1800	0.298	0.209	0.207	0.271	0.245
D_3	1637	1841	1765	1728	1743	1788	1994	1930	1885	1899	0.269	0.203	0.205	0.198	0.220
D_4	1539	1728	1691	1654	1653	1710	1908	1869	1826	1824	0.307	0.210	0.209	0.272	0.250
D_5	1407	1605	1601	1522	1533	1565	1780	1749	1651	1686	0.319	0.259	0.264	0.311	0.288
Mean (S)	1529	1695	1657	1609	1623	1679	1866	1814	1760	1780	0.298	0.226	0.231	0.274	0.257
Factors	S.Em. ±			CD @ 1 %		S.Em. ±			CD @ 1 %		S.Em. ±			CD @ 1 %	
S	11.90			44.76		11.60			43.65		0.004			0.01	
D	13.30			50.04		12.97			48.80		0.004			0.01	
S X D	26.60			100.08		25.94			97.61		0.009			0.02	

Legend:
Seed to solution ratio (S): S_1 = 1:0.5 S_2 = 1:1 S_3 = 1:1.5 S_4 = 1:2
Duration of hydropriming (D): D_1 = 16 hrs D_2 = 18 hrs D_3 = 20 hrs D_4 = 22 hrs D_5 = 24 hrs

Conclusion
From the study, it can be concluded that cluster bean seeds hydroprimed in 1:1 seed to solution ratio for 20 hours was suitable to get highquality seedlings.

References

1. Abdul Baki AA, Anderson JD, Vigour determination in soybean seed by multiple criteria. Crop Science,1973:13(6):630–633.
2. Anbarasan T, Srimathi P, Effect of seed priming on germination and seedling growth of redgram (*Cajanus cajan* L.). International Journal of Seed Science,2015:5(2):45–51.
3. Bradford KJ, Manipulation of seed water relations via priming. Hort Science,1986:21(5):1105–1112.
4. Ibrahim M, Hydropriming improves seed germination and biochemical activity in maize (*Zea mays* L.). Seed Science and Technology,2019:47(2):125–133.
5. ISTA, International Rules for Seed Testing. Bassersdorf, Switzerland: International Seed Testing Association,2013.
6. Krishnakumary K, Nair S, Pillai R, Seed priming in legumes: Hydropriming and osmopriming effects on germination. Legume Research,2008:31(3):208–212.
7. Kumar S, Singh R, Sharma P, Seed quality constraints in cluster bean (*Cyamopsis tetragonoloba* L.) and their management. Journal of AgriSearch,2017:4(3):145–150.
8. Malarkodi K, Ramesh M, Kavitha P, Hydropriming effects on germination and seedling growth in brinjal (*Solanum melongena* L.). Asian Journal of Plant Sciences Research,2023:13(1):32–40.
9. Milosevic N, Durovic S, Pavlovic S, Electrical conductivity test as indicator of seed vigour in legumes. Acta Agriculturae Scandinavica Section B Soil and Plant Science,2010:60(3):255–261.
10. Patel D, Mehta P, Joshi A, Effect of hydropriming on seedling growth in black gram (*Vigna mungo* L.). Legume Research,2018:41(6):987–991.
11. Poonam S, Rani P, Kumar V, Seed priming improves seedling dry weight in legumes. Journal of Seed Science,2020:42(1):50–57.
12. Singh R, Sharma P, Gupta A, Cluster bean (*Cyamopsis tetragonoloba* L.): agronomic traits, industrial uses and future prospects. International Journal of Current Microbiology and Applied Sciences,2020:9(3):1201–1212.
13. Suthar R, Patel K, Desai M, Hydropriming and its effect on seedling vigour of legumes. Indian Journal of Agronomy,2022:67(2):155–160.
14. Wahocho NH, Syed S, Baloch MS, Seed priming enhances seedling vigour and early growth in okra (*Abelmoschus esculentus* L.). International Journal of Vegetable Science,2023:29(4):301–310.