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Standardization of Seed to Solution Ratio and Hydropriming Duration for Seed Priming of Fenugreek (*Trigonella foenum-graecum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A laboratory experiment was carried out to standardize the seed to solution ratio and hydropriming duration for seed priming in fenugreek at Department of Seed Science & Technology, College of Agriculture, UAS, Raichur during *Rabi* 2023-24. The experiment was laid out in Two Factorial Completely Randomized Design. The first factor consisted of seed to solution ratios *viz.,* 1:1, 1:1.5,

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1:2, 1:2.5 and 1:3. The second factor was hydropriming durations *viz.,* 8, 12, 16, 20 and 24 hours. The results revealed that seed priming in 1:2.5 seed to solution for 12 hours has recorded higher seed quality parameters *viz.,* seed germination (97.25 %), seedling length (21.50 cm), seedling dry weight (11.24 mg), seedling vigour index-I and II (2091 & 1093). While, seed priming in 1:1 seed to solution for 8 hours has recorded lower seed quality parameters (89.50 %, 15.99 cm, 8.30 mg, 1431 and 743, respectively). Based on the results, it can be concluded that for priming in fenugreek 1:2.5 seed to solution ratio for 12 hours duration suitable to get good quality seedlings.

Keywords: Germination; hydropriming; seed to solution ratio; seedling vigour index.

1. INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) belongs to the Fabaceae family. It is a short duration crop and mainly grown as a leafy vegetable as well as a seed spice. It is one of the oldest medicinal plants with an exceptional medicinal and nutritional profile. Fenugreek seeds are frequently used in human medicine to manage hypercholesterolemia, cancer and diabetes as they possess hypoglycaemic, antilipidemic, anticarcinogenic and cholagogic properties (Murlidhar and Goswami, 2012). Its fresh tender leaves are also consumed as vegetable which are rich in iron, calcium, vitamins and essential amino acids like lysine, leucine and phenylalanine (Mungofa et al., 2022). Seeds contain a substantial amount of fiber, phospholipids, glycolipids, oleic acid, linolenic acid, linoleic acid, choline, vitamins A, B1, B2, C, nicotinic acid, niacin and other elements (Awulachew, 2022; Malarkodi et al., 2023).

Vegetables are considered as essential building blocks of any diet, provides good source of vitamins, minerals, high dietary fiber and complex carbohydrates with low fat content. But per capita consumption of fruits and vegetables in India is very low (160 to 184 g/person/day) against world health organization standards of 400 g/person/day. So, we are in the stage of increasing the production and productivity of vegetable crops. Fenugreek is a valuable plant for its culinary and medicinal uses, but its growth is often hindered by poor seed quality including low germination rates and seed-borne diseases (Bradford, 1986). The success of pre-sowing seed management techniques depends on the duration of priming and the seed to solution ratio. However, these factors vary with crops depending on their chemical composition. The efficacy of treatments depends on the level of moisture content to which the seeds are hydrated just before radicle emergence. This study was aimed to standardize the appropriate seed to solution ratio and hydropriming duration to optimize fenugreek seed performance. To provide higher quality seeds, many researchers have developed new technologies called seed quality enhancement techniques (Panse & Sukhatme, 1954). In the last two decades, seed priming, an effective seed invigoration method has become a common method to increase the germination rate, uniformity of emergence and crop establishment in most vegetable and flower crops especially in advanced countries (Fischer, 1950). The priming is influenced by several factors. Among them the most important factors are selection of priming agent, its concentration, the method of priming and duration of priming (Krishnakumary et al., 2008). As a first step studies were initiated to standardize priming by evolving seed to solution ratio to be adopted for priming and the duration of priming using water, the universal priming agent suitable for all kinds of seed. Keeping these in view, the present experiment was conducted in fenugreek to standardize the seed to solution ratio and hydropriming duration for seed priming and its influence on seed quality characters.

2. MATERIALS AND METHODS

The laboratory experiment was conducted at Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, located at 16° 15´ North latitude and 77° 20´ East longitude with an altitude of 389 m above mean sea level at Raichur, Karnataka during 2023-24. The experiment was laid out in Two Factorial Completely Randomised Design with four replications. The first factor comprised of five seed to solution ratios *viz*., 1:1 (S_1), 1:1.5 (S_2), 1:2 (S_3), 1:2.5 (S_4) and 1:3 (S_5). The second factor consisted five hydropriming durations *viz*., 8 (D_1), 12 (D_2), 16 (D_3), 20 (D_4) and 24 hours (D_5). The cleaned and graded fenugreek seeds were hydroprimed with different seed to solution ratios (weight by volume) as per the treatments mentioned above, after soaking the seeds were taken out from water as per the different durations and they were uniformly spread on a blotting paper and kept for air drying under shade to re-dry to their original moisture level and then

those seeds were further used for assessing various seed quality parameters. The observations were recorded on seed germination (%), seedling length (cm), seedling dry weight (mg), seedling vigour index-I and II.

Seed germination (%): The standard germination test was conducted in four replications of 100 seeds in between paper method and rolled towels were incubated in the walk-in seed germination chamber maintained with 25±2°C temperature and 90±5 % relative humidity. The final count was taken on 14th day. The number of normal seedlings from each replication were counted and the mean germination was expressed in percentage (ISTA, 2024).

Seedling length (cm): From the germination test, ten normal seedlings were randomly selected from each treatment. The seedling length was measured from the tip of shoot to tip of root of the seedlings. The mean seedling length was expressed in centimeters (ISTA, 2024).

Seedling dry weight (mg): Ten seedlings used for measuring the seedling length were kept in butter paper covers and dried in a hot air oven at 70±2°C for 24 hours. Then the butter paper bags were removed and cooled in a desiccator for 30 minutes and weighed on an electronic balance and mean seedling dry weight was expressed in grams (ISTA, 2024).

Seedling vigour index-I and II: The seedling vigourindex was calculated as per the formula given by Abdul-Baki and Anderson (1973).

Seedling vigour index - I = Seed germination (%) × Seedling length (cm)
Seedling vigour index - II= Seed germination (%) × Seedling dry weight (mg)

3. RESULTS AND DISCUSSION

The results showed that different seed to solution ratio and hydropriming durations had shown significance difference for seed germination (%), seedling length (cm), seedling dry weight (mg) were presented in Table 1. And seedling vigour index-I and II were presented in Table 2.

The seed germination is an important seed quality parameter. The significantly highest seed germination was recorded in 1:2.5 seed to solution ratio (96.55 %) compared to 1:1 seed to solution ratio (91.95 %). Among hydropriming durations 12 hours had recorded significantly highest seed germination (95.20 %) than 24 hours (93.35 %). In case of interactions, priming in 1:2.5 seed to solution ratio for 12 hours had recorded significantly highest seed germination (97.25 %) compared to 1:1 seed to solution ratio for 8 hours duration (89.50 %). The probable reason for enhancement of percentage and uniformity of germination of the hydroprimed seed might have completed pre-germination process, repair and synthesis of nucleic acids (DNA and mRNA), proteins (Ibrahim, 2019), initiation of biochemical reactions and enzyme activation. Wattanakulpakin et al. (2012) observed an increased germination percentage in maize due to hydropriming for 6 hours. The availability of optimum moisture at an appropriate duration to enhance germination and growth by hydrolysing complex molecules into simpler sugars, which are readily utilized in the synthesis of auxins and proteins. The auxins produced help to soften cell walls, facilitating growth, while the proteins are readily used in the production of new tissues. Soaking in the equal volume of water for brinjal and chilli seeds for 12 hours significantly resulted in higher seed germination than unprimed seeds which was observed by Ponnuswamy and Vijayalakshmi (2011). Similar findings were reported by Georghiou et al. (1982) in tomato Anbarasan and Srimathi (2015) in Redgram and Mahmoudi et al. (2020) in fenugreek.

The 1:2.5 seed to solution ratio had significantly recorded the longest seedling length (20.26 cm) compared to the 1:1 seed to solution ratio (17.02 cm). Among hydropriming durations, hydropriming for 12 hours had recorded significantly the longest seedling length (18.97 cm) than 24 hours (17.73 cm). Among interactions, hydropriming in 1:2.5 seed to solution ratio for 12 hours duration (S_4D_2) had recorded significantly the longest seedling length (21.50 cm) compared to hydropriming in 1:1 seed to solution ratio for 8 hours duration (S_1D_1) which had recorded shortest (15.99 cm) seedling length (Table 1). This may be due to better physiological activities which is associated with the washing away of the inhibitor ABA. The increased porosity of the seed coat enhanced the water and gas exchange, which in turn accelerated the germination process. This improvement in resource uptake supports more vigorous metabolic activities as a result, seedlings exhibit greater seedling length. These results are in conformity with Mohsen et al. (2013) in chickpea, Kamithi et al. (2016) in chickpea and Tanwar et al. (2023) in wheat.

Table 1. Influence of seed to solution ratio and hydropriming duration on seed germination, seedling length and seedling dry weight of fenugreek

	Seed germination (%)						Seedling length (cm)						Seedling dry weight (mg)					
Treatment	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**Mean (S)**	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**Mean (S)**	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**Mean (S)**
S_1	89.50	93.00	92.75	92.50	92.00	**91.95**	15.99	17.49	17.36	17.24	17.02	**17.02**	8.30	9.29	9.24	9.06	8.89	**8.96**
S_2	94.00	94.25	94.25	93.75	93.25	**93.90**	18.00	18.16	18.07	17.88	17.72	**17.97**	9.73	9.85	9.77	9.47	9.42	**9.65**
S_3	95.75	96.00	95.75	95.00	94.75	**95.45**	18.77	19.02	18.88	18.51	18.39	**18.71**	10.26	10.37	10.30	10.06	9.93	**10.18**
S_4	96.75	97.25	96.50	96.25	96.00	**96.55**	20.90	21.50	20.12	19.57	19.19	**20.26**	11.13	11.24	10.95	10.78	10.59	**10.93**
S_5	95.25	95.50	94.50	91.50	90.75	**93.50**	18.59	18.69	18.25	16.54	16.33	**17.68**	10.09	10.15	9.88	8.63	8.50	**9.45**
Mean (D)	**94.25**	**95.20**	**94.75**	**93.80**	**93.35**	**94.27**	**18.45**	**18.97**	**18.54**	**17.95**	**17.73**	**18.33**	**9.90**	**10.18**	**10.03**	**9.60**	**9.46**	**9.83**
Factors	**S.Em. ±**			**CD @ 1 %**			**S.Em. ±**			**CD @ 1 %**			**S.Em. ±**			**CD @ 1 %**		
S	0.23			0.85			0.11			0.41			0.09			0.32		
D	0.23			0.85			0.11			0.41			0.09			0.32		
S × D	0.51			1.90			0.25			0.92			0.19			0.72		

Legend:
Factor I: Seed to solution ratio (S): S_1 = 1:1 S_2 = 1:1.5 S_3 = 1:2 S_4 = 1:2.5 S_5 = 1:3
Factor II: Duration of hydropriming (D): D_1 = 8 hours D_2 = 12 hours D_3 = 16 hours D_4 = 20 hours D_5 = 24 hours

Table 2. Influence of seed to solution ratio and hydropriming duration on seedling vigour indices of fenugreek

	Seedling vigour index-I						Seedling vigour index-II					
Treatment	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**Mean (S)**	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**Mean (S)**
S_1	1431	1626	1610	1595	1566	**1565**	743	864	857	838	817	**824**
S_2	1692	1712	1704	1676	1652	**1687**	915	929	921	888	879	**906**
S_3	1798	1826	1808	1758	1742	**1786**	983	995	987	956	940	**972**
S_4	2022	2091	1942	1883	1842	**1956**	1076	1093	1056	1037	1016	**1056**
S_5	1770	1784	1725	1514	1482	**1655**	961	970	934	790	772	**885**
Mean (D)	**1743**	**1808**	**1758**	**1685**	**1657**	**1730**	**935**	**970**	**951**	**902**	**885**	**929**
Factors	**S.Em. ±**			**CD @ 1 %**			**S.Em. ±**			**CD @ 1 %**		
S	10.88			40.68			8.68			32.43		
D	10.88			40.68			8.68			32.43		
S × D	24.34			90.96			19.40			72.52		

Legend:
Factor I: Seed to solution ratio (S): S_1 = 1:1 S_2 = 1:1.5 S_3 = 1:2 S_4 = 1:2.5 S_5 = 1:3
Factor II: Duration of hydropriming (D): D_1 = 8 hours D_2 = 12 hours D_3 = 16 hours D_4 = 20 hours D_5 = 24 hours

The significantly highest seedling dry weight was recorded with priming in 1:2.5 seed to solution ratio (10.93 mg) compared to 1:1 seed to solution ratio (8.96 mg). Among hydropriming durations, 12 hours had recorded significantly highest seedling dry weight (10.18 mg) than 24 hours (9.46 mg). Among interactions, 1:2.5 seed to solution ratio with 12 hours of hydropriming had recorded significantly highest seedling dry weight (11.24 mg) compared to 1:1 seed to solution ratio with 8 hours (8.30 mg) which had recorded the lowest seedling dry weight (Table 1). Higher accumulation of dry matter in hydroprimed seeds in appropriate seed to solution ratio for appropriate duration. Complete imbibition of seeds occurs when seeds absorb water fully for an effective duration leading to several physiological changes. As a result, the seed coat swells and becomes thinner, making it easier for the seed to leach out of chemicals that are responsible for seed dormancy, such as abscisic acid or other inhibitors. A reduction in the inhibitory effect, facilitates the seeds to proceed with germination and vigorous seedling growth which resulted in the accumulation of more seedling dry weight. Similar findings of higher seedling dry weight were observed by Anbarasan and Srimathi (2015) in pulses and Mounika et al. (2021) in fenugreek.

There was significant difference for the seedling vigour indices among treatments. Significantly the highest seedling vigour index-I (1956) and II (1056) were recorded in seed priming with 1:2.5 seed to solution compared to 1:1 seed to solution ratio (1565 and 824). Among hydropriming durations, 12 hours hydropriming had recorded significantly highest seedling vigour index-I (1808) and II (970) than 24 hours (1657 and 885). In case of interactions, 1:2.5 seed to solution ratio with 12 hours hydropriming had recorded significantly highest seedling vigour index-I (2091) and II (1093) compared to 1:1 seed to solution with 8 hours hydropriming (1431 and 743) which had recorded lowest (Table 2). Comparing the different seed to solution ratios and durations of hydropriming, better shoot length, root length and seed germination were observed in seeds hydroprimed in 1:2.5 seed to solution ratio for 12 hours which finally resulted in higher seedling vigour indices and better performance of seedlings. The seedling vigour index increased mainly due to reduction in imbibition lag time for priming treatments (Bradford, 1986). Similar findings are observed by Lamsaadi et al. *(*2024) in fenugreek.

4. CONCLUSION

From the study, it can be concluded that fenugreek seeds hydroprimed in 1:2.5 seed to solution ratio for 12 hours was suitable to get high quality seedlings.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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