



# Seed Quality Enhancement Techniques in the Production of Elite Seedlings Suitable for Machine Transplanting in Rice

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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

The goal of the current study was to study the effect of seed enhancement techniques for the production of elite seedlings suitable for machine transplanting in rice (ADT 45, CO 51) and an experiment was laid out in Factorial Completely Randomized Block Design (FCRD) in three

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replications in the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore during 2023. In order to overcome the major constraint in machine transplanting of rice i.e., planting density (number of seedlings per hill), an improved seedling characteristics should be obtained. The treatment consists of T<sub>0</sub>- Dry seeds, T<sub>1</sub>- Seed coating with Vithai Amirtham, T<sub>2</sub> - Seed coating with Vithai Amirtham + Priming, T<sub>3</sub> - Sprouted seeds, T<sub>4</sub> - Seed coating with Vithai Amirtham+ Sprouted seeds, T<sub>5</sub> - Seed coating with Vithai Amirtham+ Priming + Sprouted seeds. Among the different treatments, T<sub>5</sub> sprouted seeds after coating with Vithai Amirtham (20 ml/kg) and hydro priming exhibits higher speed of germination, root length, shoot length, dry matter and vigour index than the control (dry seeds). From this study, it was concluded that seed coating with Vithai Amirtham and hydro priming has led to improved seedling quality characteristics, thereby the number of seedlings per hill during machine transplanting could be reduced and hence this would be a successful pre-sowing seed treatment to overcome the problem in machine transplanting of rice.

**Keywords:** *Vithai amirtham; coating; priming; seedling quality.*

## 1. INTRODUCTION

Rice (*Oryza sativa* L.) is an important staple cereal food crop for more than 60 percent of the world people which ranks second after wheat. India has the highest acreage whereas China has the highest production and Australia has the highest productivity [1]. India is the second largest paddy producer in the world next to China with an area of around 45.768 million ha, production of 124.368 million tonnes and an average productivity of 2717 kg/ ha [2].

The most popular and complex way of cultivating paddy under low land conditions in India is transplanting which can be done manually or mechanically. Manual transplanting is the oldest and most popular way of approach followed in rice transplantation. Among the different components involved in the production of rice, labour is considered the most expensive one [3]. Therefore, in order to overcome this constraint, it has become necessary to utilize mechanical/machine transplantation that results in manpower savings, timely transplanting, optimal plant density and lower costs [4]. For the rice transplanter to operate well, along with technical considerations optimum seedling characteristics should also be considered. For instance, seedlings should be cultivated in trays with extra care when it has opted for machine transplantation. Successful production of seedlings for transplanting includes many factors viz., preparation of pre-germinated seeds for sowing, preparation of soil for nursery beds and finally the selection of appropriate aged seedlings. For machine transplantation, the seedlings should be at 3 leaf stage with a height of 12 to 15 cm [5]. During transplantation, the average number of seedlings picked by a

machine transplanter is greater than five which is a major disadvantage when compared to manual transplantation [6,7].

The major problems faced during machine transplantation are lack of proper tray nursery technique for elite seedlings production and more number of seedlings per hill. Pre-sowing seed treatment is the first criterion to be considered during elite seedling production in which various seed quality enhancement techniques like seed coating and priming were employed to improve seed germination and seedling vigour for numerous crops. GA<sub>3</sub> based seed coating polymer Vithai Amirtham helps to increase the germination percentage by 8-10 % and also increases the root growth and its proliferation [8].

Vasudevan S. N. et al. [9] pointed out that GA<sub>3</sub>, plant growth regulator helps to increase cell division and cell elongation which led to improved root and shoot growth that naturally synthesizes more photosynthates and translocated towards the root that may have contributed to an improved seedling vigour which is suitable for machine transplanting in rice.

Seed priming is a one of the pre-sowing seed enhancement methods which involves soaking the seed in a solution that helps seeds to emerge quickly, retain their homogeneity and higher yield potential. It is a practical method for improving germination and seedling qualities [10]. When compared to unprimed seeds, the primed seeds exhibit faster and more consistent seed germination as a result of various metabolic activities, enzyme activation, biochemical cell repair processes, protein synthesis and enhancements to the antioxidant defense system [11].

Thus, considering the importance of seed quality enhancement techniques in elite seedling production and above mentioned issues during machine transplanting, a study was framed with the objective to standardize the seed enhancement techniques for the production of elite seedling suitable for machine transplanting in rice.

## 2. MATERIALS AND METHODS

### 2.1 Materials

An experiment was carried out at the laboratory of Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore during 2022. Two medium slender rice varieties CO 51 and ADT 45 were collected from Agricultural Research Station, Bhavanisagar. TNAU seed coating polymer Vithai Amirtham was procured from the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore.

### 2.2 Methods

The experiment was conducted by adopting Factorial Completely Randomized Block Design (FCRD) in three replications. Seeds are coated with Vithai Amirtham at the rate of 20 ml/kg of seeds and then seeds were primed with water for 12 hrs and dried back to their original moisture content. For sprouting, seeds are immersed in water for 24 hours in loosely tied gunny bags for easy water transmission. The gunny bags along with seed are then tightly knotted and incubated in the dark for 12 hours (overnight).

### 2.3 Treatments Details

- T<sub>0</sub> : Dry seeds
- T<sub>1</sub> : Seed coating with Vithai Amirtham
- T<sub>2</sub> : Seed coating with Vithai Amirtham + Priming
- T<sub>3</sub> : Sprouted seeds
- T<sub>4</sub> : Seed coating with Vithai Amirtham+ Sprouted seeds
- T<sub>5</sub> : Seed coating with Vithai Amirtham+ Priming + Sprouted seeds

A standard germination test was conducted in roll towel method (ISTA, 2013). The germination percentage was calculated after 14 days of sowing and expressed as percentage. The speed of germination was computed based on seedling emergence in the tray method. Ten normal

seedlings were used to measure the root and shoot lengths in cm. Root length was measured from the collar region to the tip of the primary root and measured the shoot length from the collar region to the growing tip of the shoot and the mean value was calculated and expressed in cm.

After seedling measurement, ten normal seedlings were measured for their dry weight after being shade dried for 24 hours and then dried in a hot air oven for another 24 hours at 80°C. The seedling vigour index was computed using the Abdul-Baki and Anderson [12] method and the mean values were reported as whole numbers.

$$\text{Vigour index I} = \text{Germination (\%)} \times \text{Total seedling length (cm)}$$

$$\text{Vigour index II} = \text{Germination (\%)} \times \text{Dry matter production (g per 10 seedlings)}$$

### 2.4 Statistical Analysis

Agdata and Agres software was used to statistically analyze the data and the critical differences were calculated at the 5% probability level [13].

## 3. RESULTS AND DISCUSSION

The obtained result showed highly significant variations among the treatments in seedling parameters like germination, speed of germination, root length (cm), dry matter production (g/ 10 seedlings), vigour index I and vigour index II in both the varieties. As a general rule, priming treatments increased the germination (%) and seedling vigour over control (without priming).

Among the treatments, seed coating with Vithai Amirtham + Priming + Sprouted seeds (T<sub>5</sub>) recorded highest germination percentage, speed of germination, root length, shoot length, dry matter production and seedling vigour followed by seed coating with Vithai Amirtham + sprouted seeds (T<sub>4</sub>) (Table 1) (Figs. 1, 2). Highly statistical significant difference was observed among the varieties in speed of germination and vigour of seedlings. The improved seedling parameters was due to the effect of coating with Vithai Amirtham and priming (Fig. 3).

Among the varieties, highest germination percentage (97%), speed of germination (7.35),

root length (18.93 cm), shoot length (9.97 cm), dry matter production (0.176 g), vigour index (2733) was observed in CO 51 rice variety.

The results were supported by novel "seed coating formulation" created by Tamil Nadu Agricultural University based on gibberellic acid that significantly improved the seed germination and seedling growth of various crops [8]. A study was carried out to examine the impact of various combinations of seed priming and seed coating with new seed coating formulations on field emergence, crop growth, sex expression and crop productivity of ridge gourd in order to maximize the invigoration potential of both practices.

The findings were in line with those of Yari et al. [14] who illustrated that hydro-primed wheat seedlings produced more dry matter than unprimed seedlings. Similar outcomes were observed by Farooq et al. [15], hydro-priming for 48 hr improved the growth and dry weight of rice seedlings. Moradi Dezfuli et al. (2008) observed increased dry weight in the maize inbred line MO17 under different hydro-priming durations (12, 36, and 48 hrs). The well-developed root

systems of the treated plants may have boosted nutrient uptake, which in turn may have enhanced the growth characteristics and consequently the production and yield of dry matter. Increased metabolic activity in the hydroprimed seeds may be the cause of the quicker and uniform germination [16,17].

The shoot length and root length of 15-day-old seedlings sprayed with GA<sub>3</sub> @ 50 ppm were considerably higher (24.17 cm and 10.85 cm, respectively), while the shoot and root length of control seedlings was the lowest (16.78 cm and 7.66 cm) [9].

The results are in parallel with Adhikari B et al. [18] who stated that 48 hrs of hydropriming of seeds is effective for improving the germination and seedling vigour in bittergourd.

When compared to the control, Tanwar H et al. [19] pointed out that the hydropriming for up to 12 hours increased the germination % and other seed vigour indicators. The germination rate and other seed vigour metrics significantly decreased for durations longer than 12 hours, i.e. 16 and 20 hours, especially at the twofold volume.

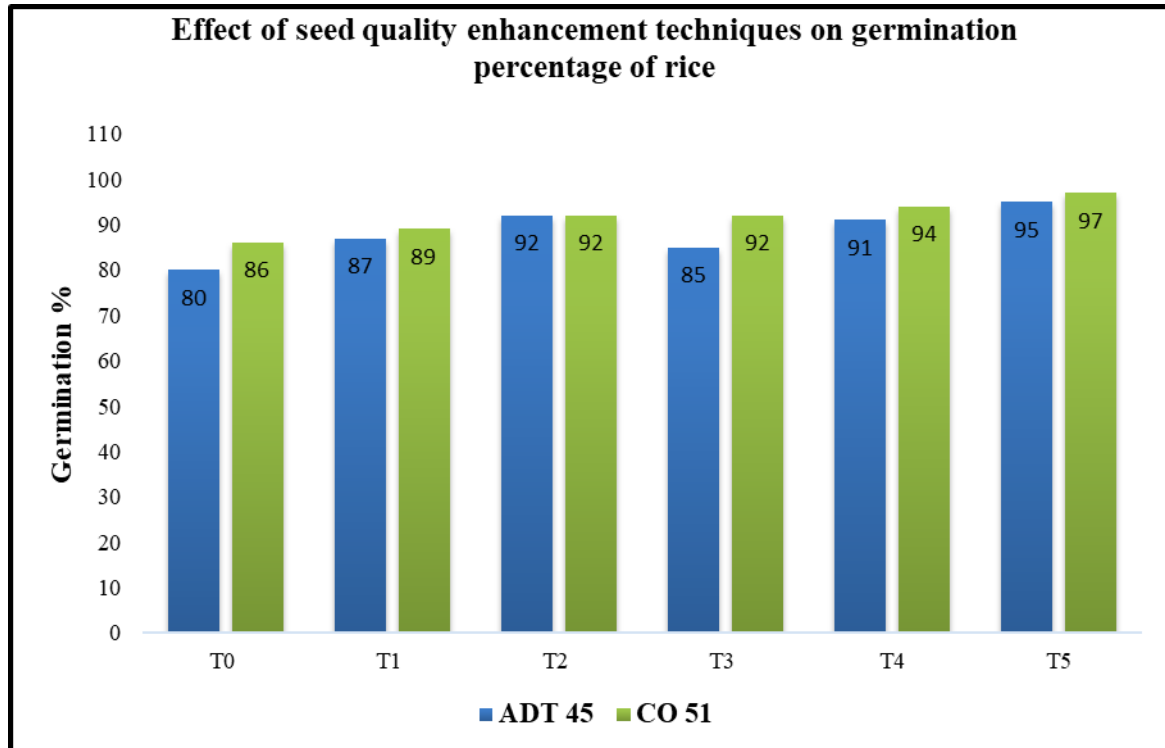


Fig. 1. Effect of seed quality enhancement techniques on germination percentage of rice

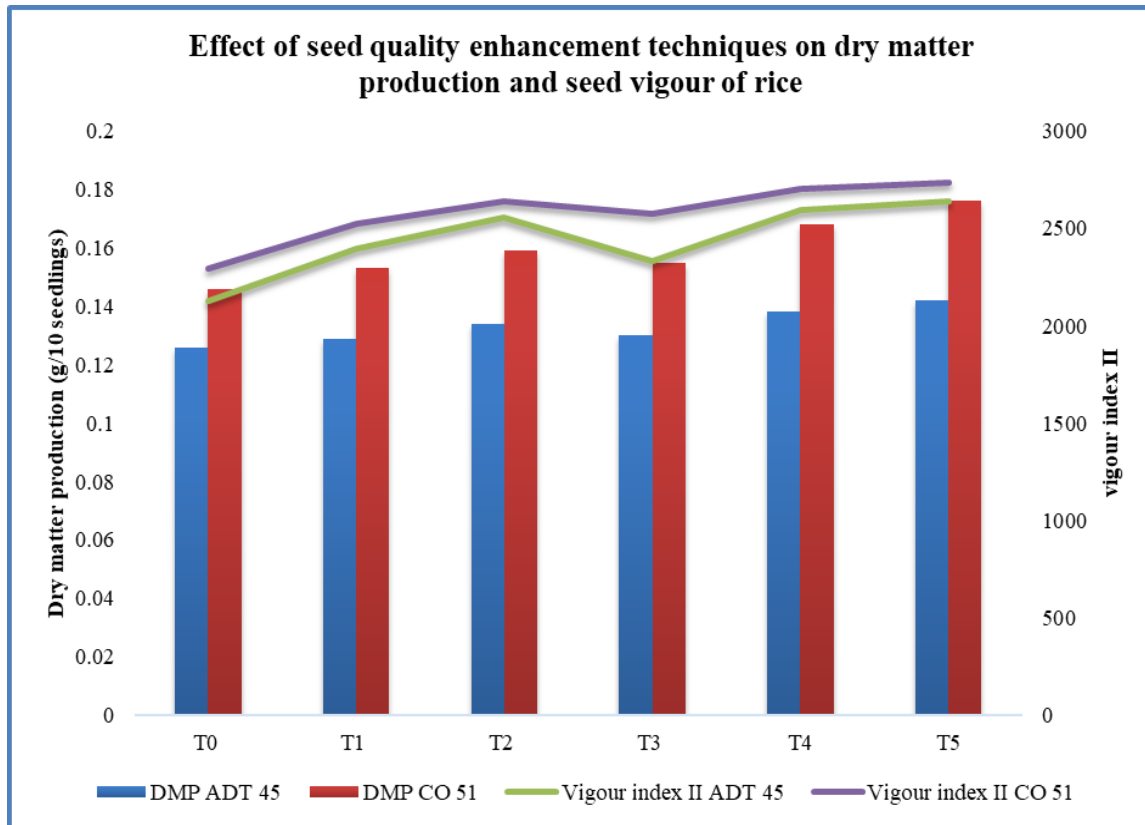


Fig 2. Effect of seed quality enhancement techniques on dry matter production and seed vigour of rice

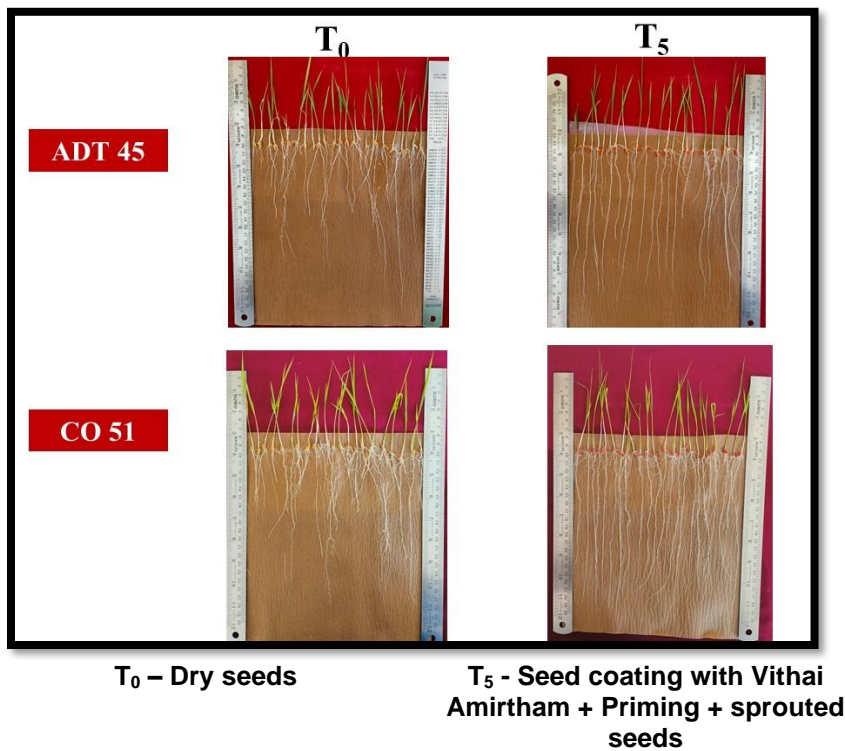


Fig. 3. Effect of seed quality enhancement techniques on seedling quality parameters of rice

**Table 1. Effect of seed quality enhancement techniques on seedling quality parameters of rice**

Treatments	Germination (%)			Speed of germination			Root length (cm)			Shoot length (cm)			Dry matter production (g/10 seedlings)			Vigour index I			Vigour index II		
	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean
T <sub>0</sub>	80 (63.43)	86 (68.02)	84 (66.42)	4.34	4.63	4.44	17.03	17.06	17.38	9.59	9.63	9.70	0.126	0.146	0.127	2130	2295	2263	10	13	11
T <sub>1</sub>	87 (68.86)	89 (70.63)	88 (69.73)	4.54	5.24	5.48	17.73	18.61	17.82	9.81	9.77	9.79	0.129	0.153	0.132	2396	2526	2445	11	14	12
T <sub>2</sub>	92 (73.57)	92 (73.57)	93 (74.65)	4.71	5.56	6.93	17.96	18.78	18.78	9.86	9.89	9.90	0.134	0.159	0.140	2559	2638	2668	12	15	13
T <sub>3</sub>	85 (67.21)	91 (72.54)	88 (69.73)	6.25	7.01	4.93	17.69	18.42	17.83	9.74	9.85	9.70	0.130	0.155	0.149	2332	2573	2410	11	14	14
T <sub>4</sub>	91 (72.54)	94 (75.82)	92 (73.57)	6.71	7.10	6.28	18.66	18.89	18.59	9.84	9.88	9.87	0.138	0.168	0.157	2594	2704	2605	13	16	15
T <sub>5</sub>	95 (77.07)	97 (80.02)	96 (78.46)	7.15	7.35	7.22	18.90	18.93	18.91	9.96	9.97	9.92	0.142	0.176	0.172	2642	2733	2703	13	17	17
Mean	89 (70.63)	91 (72.54)	90 (71.56)	5.50	6.25	5.88	18.06	18.37	18.22	9.78	9.85	9.81	0.145	0.147	0.146	2486	2562	2524	13	13	13
	<b>T</b>	<b>V</b>	<b>T × V</b>	<b>T</b>	<b>V</b>	<b>T × V</b>	<b>T</b>	<b>V</b>	<b>T × V</b>	<b>T</b>	<b>V</b>	<b>T × V</b>	<b>T</b>	<b>V</b>	<b>T × V</b>	<b>T</b>	<b>V</b>	<b>T × V</b>	<b>T</b>	<b>V</b>	<b>T × V</b>
<b>SEd</b>	1.810	1.045	2.560	0.123	0.071	0.174	0.366	0.211	0.518	0.196	0.113	0.278	0.002	0.001	0.004	51.060	29.480	72.210	0.270	0.150	0.380
<b>CD(0.05)</b>	3.736	2.157	5.283	0.254	0.146	0.359	0.756	0.436	1.070	0.406	0.234	0.574	0.006	0.003	0.008	105.380	60.840	149.040	0.560	0.320	0.790
<b>CD(0.01)</b>	5.091	2.939	7.200	0.346	0.200	0.490	1.031	0.595	1.458	0.553	0.319	0.782	0.008	0.004	0.011	143.610	82.910	203.100	0.760	0.440	1.080

**Treatment details**

V<sub>1</sub> ADT 45

V<sub>2</sub> CO 51

T<sub>0</sub> Dry seeds

T<sub>1</sub> Seed coating with Vithai Amirtham

T<sub>2</sub> Seed coating with Vithai Amirtham + Priming

T<sub>3</sub> Sprouted seeds

T<sub>4</sub> Seed coating with Vithai Amirtham + Sprouted seeds

T<sub>5</sub> Seed coating with Vithai Amirtham + Priming + Sprouted seeds

These results are in agreement with Natarajan et al. [20] who also reported higher germination (98.00%) and vigour index (82.91) as compared to control (93.00% and 60.54, respectively) in maize with pink polykote @ 3 g/kg of seeds + fungicide + insecticide treatment.

These results are in accordance with Kaushal, S. K., & Rana, U. [21] who revealed that 200 ppm of GA<sub>3</sub> soaking treatments of kuth seed showed increased root length, fresh and dried weight, plant height, and the number of leaves per plant. GA<sub>3</sub> was found to greatly boost root and shoot growth.

Similar results were reported by Leelavathi P and Umarani R. (2017) in ridge gourd. The results concluded that the higher seedling quality characteristics, maximum yield and crop growth can be achieved by applying seed priming and seed coating with brassinosteroids based TNAU seed coating formulation II [22,23].

#### 4. CONCLUSION

Machine transplanting is an innovative, sustainable technique for the rapid transplantation of rice seedlings into the field, resulting in enhancing the yield, profitability, and environmental sustainability of rice fields. This study illustrated that the rice seeds which were sown as sprouted form after coating with Vithai Amirtham (20 ml/kg) and hydro priming exhibits higher speed of germination, root length, shoot length, dry matter and vigour index than the control (dry seeds). This in turn resulted in production of quality seedlings suitable for machine transplanting in rice.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Pathak H, Tripathi R, Jambhulkar NN, Bisen JP, Panda BB. Eco-regional-based rice farming for enhancing productivity, profitability and sustainability; 2020.
2. Available: <https://www.indiastat.com/>
3. Clayton S. 50 years of rice science for a better world – and it's just the start! rice today. IRR; 2010.
4. Manjunatha MV, Reddy BM, Shashidhar SD, Joshi VR. Studies on the performance of self-propelled rice transplanter and its effect on crop yield. *Karnataka Journal of Agricultural Sciences*. 2009;22(2): 385-387.
5. Kitagawa H, Shiratsuchi H, Ogura A. Effect of seeding rate on the growth and quality of rice seedlings in the long-mat seedling culture system. *Ratio*, 2004;95(85): 79.
6. Sahay CS, Satapathy KK, Agrawal K N, Mishra AK. Evaluation of self propelled rice transplanter in valley and terraced lands of north eastern hilly region. *Agricultural Engineering Today*. 2002;26(5and6):1-10.
7. Dewangan KN, Thomas EV, Ghosh BC. Performance evaluation of a laboratory model rice technology. *Agricultural Engineering Today*. 2005; 29(5and6):38-45.
8. Karthi P. Development of hormone based seed coating formulation to improve seed germination and seedling vigour of crop seeds M.Sc., (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore; 2017.
9. Vasudevan SN, Basangouda RCM, Doddagoudar SR, Shakuntala NM. Standardization of seedling characteristics for paddy transplanter. *Journal of Advanced Agricultural Technologies*. 2014;1(2).
10. Khanal S, Khanal S, Koirala S, Katel S, Mandal HR. Seed priming's effectiveness in improving Okra germination and seedling growth. *Asian Journal of Advances in Agricultural Research*, 2022;18(2):29-34.
11. Waqas M, Korres NE, Khan MD, Nizami AS, Deeba F Ali I, Hussain H. Advances in the concept and methods of seed priming. Priming and pretreatment of seeds and seedlings: Implication in plant stress tolerance and enhancing productivity in crop plants. 2019;11-41.
12. AbdulBaki AA, Anderson JD. Vigor determination in soybean seed by multiple criteria 1. *Crop science*. 1973;13(6):630-633.
13. Panse VG, Sukhatme PV. Statistical methods agricultural workers, published by Indian Council of Agricultural Research. New Delhi (India); 1967.

14. Yari L, Abbasian A, Oskouei B, Sadeghi H. Effect of seed priming on dry matter, seed size and morphological characters in wheat cultivar. *Agriculture and Biology Journal of North America*. 2011;2(2):232-238.
15. Farooq M, Basra SMA, Khalid M, Tabassum R, Mahmood T. Nutrient homeostasis, metabolism of reserves, and seedling vigor as affected by seed priming in coarse rice. *Botany*. 2006;84(8):1196-1202.
16. Kang J, Choi Y, Son B, Ahn C, Cho J. Effect of hydropriming to enhance the germination of gourd seeds. *Journal of the Korean Society for Horticultural Science*. 2000;41(6):559-564.
17. Basra SMA, Zia MN, Mehmood T, Afzal I, Khaliq A. Comparison of different invigoration techniques in wheat (*Triticum aestivum* L.) seeds. *Pakistan Journal of Arid Agriculture*. 2002;5:11–16.
18. Adhikari B, Dhital PR, Ranabhat S, Poudel H. Effect of seed hydro-priming durations on germination and seedling growth of bitter melon (*Momordica charantia*). *PLoS One*. 2021;16(8):e0255258.
19. Tanwar H, Mor VS, Sharma S, Khan M, Bhuker A, Singh V, et al. Optimization of 'on farm' hydropriming conditions in wheat: Soaking time and water volume have interactive effects on seed performance. *PLoS One*. 2023;18(1):e0280962.
20. Natarajan N, Ramesh R. Powel. Effect of hydropriming and polycoating on field performance of maize. *Res. J. Agric. Sci*. 2012;3(2):512-514.
21. Kaushal SK, Rana U. Effect of growth regulators on germination, growth and yield of Kuth (*Saussurea lappa* Clarke). *Indian Journal of Agricultural Research*. 2004;38(1):45-49.
22. International Seed Testing Association. International rules for seed testing; 2013.
23. Leelavathi P, Umarani R. Seed invigoration techniques for enhancing the field emergence, crop growth and productivity of ridge gourd (*Luffa acutangula* L.). *Madras Agricultural Journal*. 2018;105(1-3):1.
24. Moradi Dezfui, Sharifzadeh F, Janmohammadi Mohsen. Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). *Journal of Agricultural and Biological Science*. 2008;3.

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