Original Research Article

SEED QUALITY ENHANCEMENT TECHNIQUES IN THE PRODUCTION OF ELITE SEEDLINGS SUITABLE FOR MACHINE TRANSPLANTING IN RICE

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 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 ie., planting density (number of seedlings per hill), an improved seedling characteristics should be obtained. The treatment consists of T_0 - Dry seeds, T_1- Seed coating with Vithai Amirtham, T_2 - Seed coating with Vithai Amirtham + Priming, T_3 - Sprouted seeds, T_4 - Seed coating with Vithai Amirtham+ Sprouted seeds, T_5 - Seed coating with Vithai Amirtham+ Priming + Sprouted seeds. Among the different treatments, T_5 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 Amitham, Coating, Priming, Seedling quality

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 (Pathak *et al*., 2020). 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 (www.indiastat.com, 2020-21).

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 (Clayton, 2010). 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 (Manjunatha *et al*., 2009). 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 (Kitagawa *et al.*, 2004). 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 (Sahay *et al.*, 2002; Dewangan *et al.*, 2005).

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_3 based seed coating polymer Vithai Amirtham helps to increase the germination percentage by 8-10 % and also increases the root growth and its proliferation. (Karthi, 2017).

Vasudevan S. N. *et al*. 2014 pointed out that GA_3, plant growth regulator helps to increase cell division and cell elongation which led to improved root and shoot growth that naturally synthesize 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 (Khanal *et al*., 2022). 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 (Waqas *et al*., 2019).

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.

Materials and methods

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.

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).

Treatments details

T_0 : Dry seeds

T_1 : Seed coating with Vithai Amirtham

T_2 : Seed coating with Vithai Amirtham + Priming

T_3 : Sprouted seeds

T_4 : Seed coating with Vithai Amirtham+ Sprouted seeds

T_5 : 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 (1973) method and the mean values were reported as whole numbers.

Vigour index I = Germination (%) x Total seedling length (cm)

Vigour index II = Germination (%) x Dry matter production (g per 10 seedlings)

Statistical analysis

Agdata and Agres software was used to statistically analyze the data and the critical differences were calculated at the 5% probability level (Panse and Sukhatme, 1967).

Result 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_5) 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_4) (Table 1) (Fig. 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 (Karthi, 2017). 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*. (2011) who illustrated that hydro-primed wheat seedlings produced more dry matter than unprimed seedlings. Similar outcomes were observed by Farooq *et al*. (2006), 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 (Kang Jum Soon *et al*., 2000; Basra *et al*., 2002).

The shoot length and root length of 15-day-old seedlings sprayed with GA_3 @ 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). (Vasudevan S. N. et al., 2014)

The results are in parallel with Adhikari B *et al*. (2021) 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*. (2023) 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.

These results are in agreement with Natarajan *et al*. (2012) 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. (2004) who revealed that 200 ppm of GA_3 soaking treatments of kuth seed showed increased root length, fresh and dried weight, plant height, and the number of leaves per plant. GA_3 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.

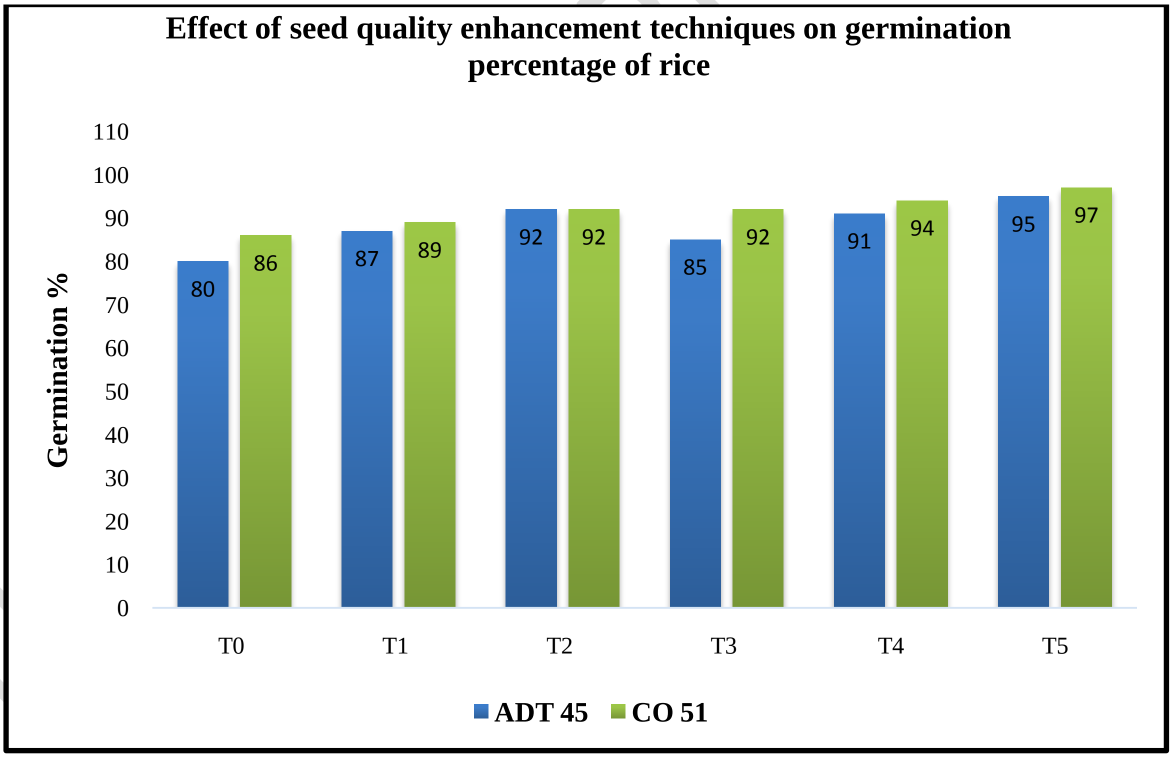


Fig 1. Effect of seed quality enhancement techniques on germination percentage of rice

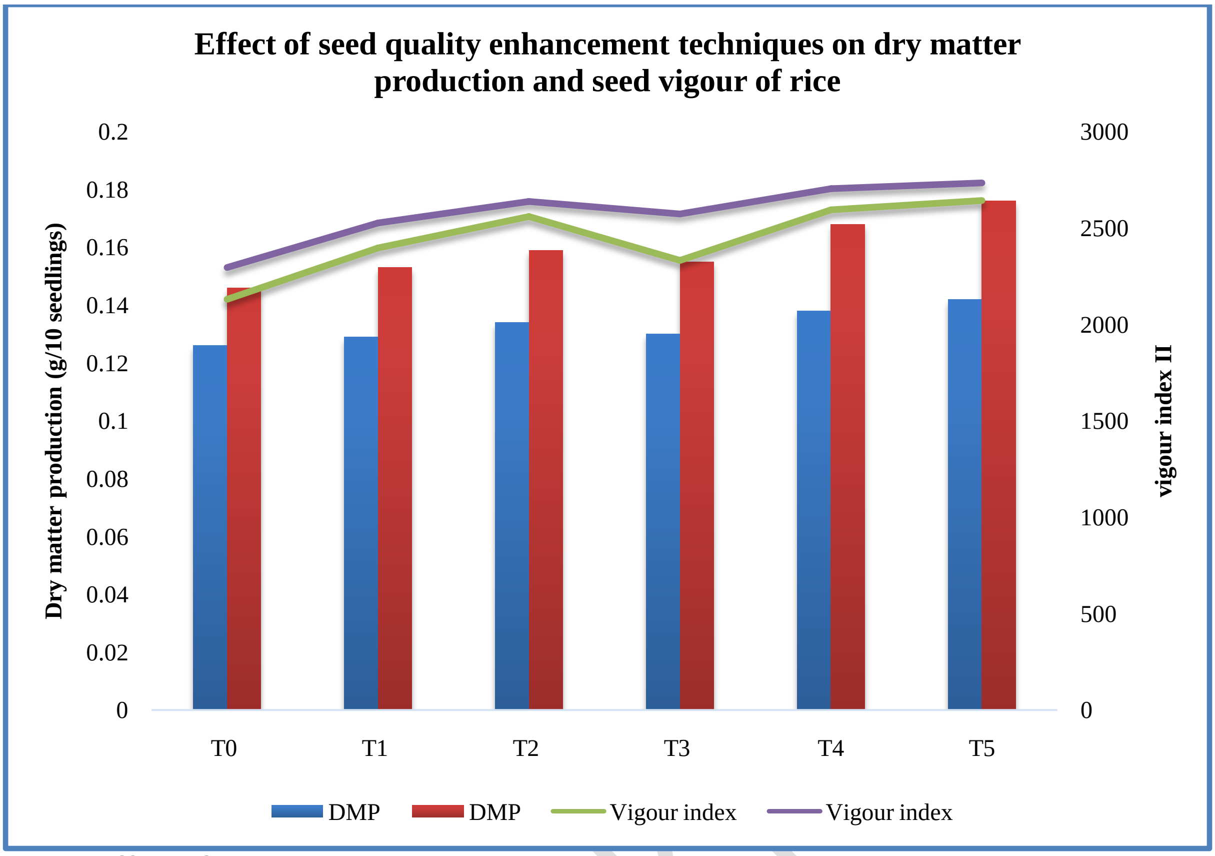
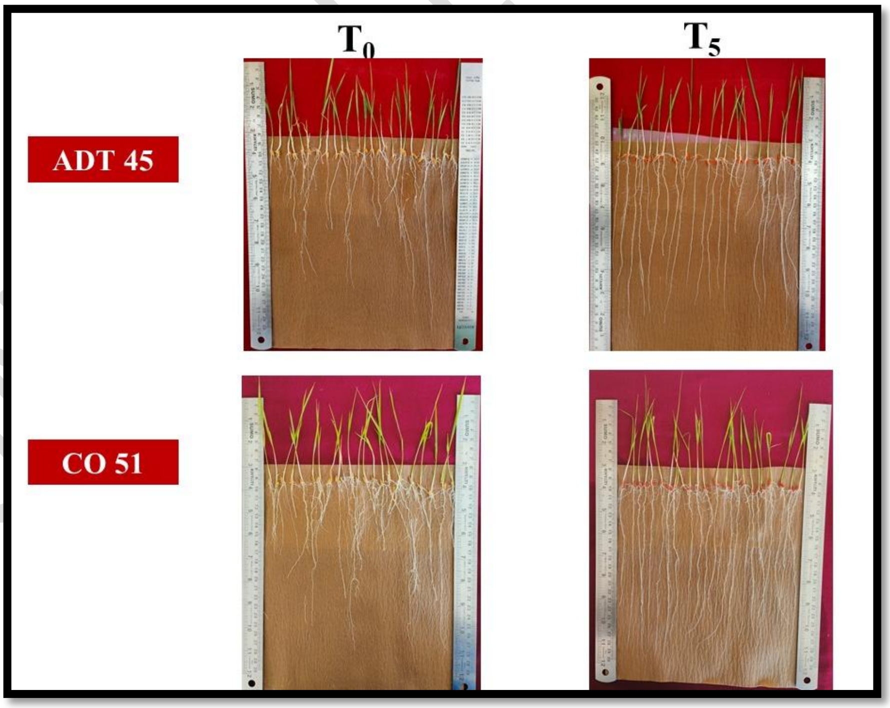


Fig 2. Effect of seed quality enhancement techniques on dry matter production and seed vigour of rice



T_0 – Dry seeds T_5 - Seed coating with Vithai Amirtham + Priming + sprouted seeds

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

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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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_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_0	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_1	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_2	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_3	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_4	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_5	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
	T	V	T × V	T	V	T × V	T	V	T × V	T	V	T × V	T	V	T × V	T	V	T × V	T	V	T × V
SEd	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
CD(0.05)	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
CD(0.01)	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

T_0 Dry seeds

T_1 Seed coating with Vithai Amirtham

T_2 Seed coating with Vithai Amirtham + Priming

T_3 Sprouted seeds

T_4 Seed coating with Vithai Amirtham + Sprouted seeds

T_5 Seed coating with Vithai Amirtham + Priming + Sprouted seeds

V_1 ADT 45

V_2 CO 51