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RESEARCH ARTICLE

Planting time and seedling age: Deciphering yield and economic output under mechanized transplanting of rice in Tamil Nadu

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Abstract

Tamil Nadu Rice Research Institute, Aduthurai, conducted a study to establish a package of techniques for mechanised rice transplantation in 2021-22 and 2022-23. Six treatments were tested in a randomised block design, including two ages of seedlings (15 and 21 days old), two planting periods (normal and 15 days delayed) and conventional transplanting with 25 days old seedlings under normal and 15 days delayed conditions. The mat nursery was constructed for the 8-row "Yanmar" transplanting machine. Mechanised transplanting with 15-day-old seedlings under regular June planting resulted in a higher number of tillers (355 m^{-2}), grains per panicle (162) and grain yield (5511 kg ha^{-1}). Delaying transplanting by 15 days resulted in a drop in grain output. Rice transplanting delayed beyond June 30th resulted in a yield drop ranging from 361 to 1001 kg ha^{-1}. Mechanised transplanting of 15-day-old seedlings resulted in higher net revenue (54506 ₹ ha^{-1}) and B-C ratio (2.2) during the regular June planting season. Regardless of the age of the transplanted seedling, a 15-day delay in transplantation resulted in a drop in grain output.

Keywords: mechanized transplanting; planting time; rice; seedling age; yield

Introduction

Rice is India's most significant cereal crop. It is believed to be in the forefront of the battle against global hunger and poverty. Increasing rice production has the potential to address the country's food dilemma. To achieve higher yield with low cost of production with mechanized cultivation under changing climatic scenario is inevitable and it is a challenge for ensuring food, economic and social security. In India rice farmers face greater challenges of low income due to natural resources degradation, climate change, as well as biotic and abiotic constraints (1). Rice production can be achieved in two ways *viz.,* increasing the rice area and increasing the production per unit area per unit time. In this case, increasing area under cultivation is ruled out, the only possibility is to increase the productivity. This can be achieved by following intensive and improved production technologies in rice. India's rice production objective for 2025 is 140 million tonnes, which may be attained by increasing rice output by 2.0 metric tonnes per year during the next decade (2).

The optimal transplanting date is the most critical aspect in maximising production. Early date of planting increases the physiological activities and yield (3). Right planting time ensures the full vegetative and reproductive stages coincide with the optimum temperature and solar radiation requirement (4). Delayed time of transplanting in rice resulted in reduction in the grains per panicle and higher sterility percentage (5). Optimum planting time is important for tillering panicle initiation and grain yield (6). Planting period indirectly influences the soil temperature and weather conditions to which young rice seedlings and sowing rice plants are exposed during various phonological stages. The timing of planting has a significant impact on seed quality in addition to the growth and productivity of rice. Due to the many climatic circumstances that affect seed development and maturity, planting timing has an impact on seed quality by influencing seed growth and development (7). Even among crops that mature early, mid and late, there are differences in seed quality. Early maturing crops generate low-quality seed due to prolonged exposure to warm weather, but this is not the case for most other crops.

Yield of rice also differs due to different growing environments, seasonal fluctuations and different dates of transplanting (8). Transplanting at the right age of seedling is helpful for uniform crop growth and better seedling establishment, whereas delayed planting results in poor

tillering (9). Transplanting young seedlings has a higher yield than older seedlings (10). Age of seedling is the most important factor influencing the yield than inputs (11). Neither young seedling nor old seedling is suitable for machine transplanting. Transplanting older seedlings had reduced seedling vigor, tiller production and the yield (12). Age of seedling has great influence on tiller production and grain formation and yield (13, 14). Finding out the optimal age of seedlings suited for mechanised transplanting is critical. Very meager work is done on the age of seedling suitable for machine transplanting. In this regard, the current experiment was conducted to evaluate the optimal seedling age necessary for machine transplanting at regular and delayed transplanting periods to enhance rice yield.

Material and Methods

The field experiment took place at TRRI in Aduthurai, Tamil Nadu, from *Kharif* 2021-22 to *Kharif* 2022-23. The experimental field's soil was clay-textured, with a pH of 8.21, organic carbon (0.42 %), low available nitrogen (221 kg ha^{-1}), medium available phosphorus (25 kg ha^{-1}) and high accessible potassium (486 kg ha^{-1}). The experiment was conducted in a randomised block design with four repetitions. The treatment included were T_1 - Normal planting time by machine planting with 15 days old seedlings, T_2 - Normal planting time by machine planting with 21 days old seedlings, T_3 - 15 days delayed by machine planting with 15 days old seedlings, T_4 - 15 days delayed by machine planting with 21 days old seedlings, T_5 - Normal planting time by manual transplanting with 25 days old seedlings, T_6 - 15 days delayed by manual transplanting with 25 days old seedlings. ADT 53 was used as a test variety. Normal and delayed time of sowing was done on 19.06.2021 and 04.07.2021 during first year and 30.06.2022 and 15.07.2022 during second year, respectively. Whereas transplanting was done 19.06.21 (T_1), 25.06.21 (T_2), 04.07.21 (T_3), 10.07.21 (T_4), 29.06.21 (T_5), 13.07.21 (T_6) during first year and 30.06.22 (T_1), 06.07.22 (T_2), 15.07.22 (T_3), 23.07.22 (T_4), 11.07.22 (T_5), 28.07.22 (T_6) during second year respectively as per treatment schedule. Seedlings were raised in the mat nursery. Leveled area was selected; polythene sheets were spread on the surface. 70 % soil + 20 % decomposed farmyard manure and 10 % rice husk and 2 kg of DAP is mixed with the soil mixture. A wooden frame of 0.5m long, 1m width and 4cm depth was selected. The soil mixture was filled in the wooden frame; pre-germinated seeds were sown on the soil mixture and covered with dry soil. Watering is done regularly. All the packages of practices were followed as and when necessary. Ten plants were selected randomly for recording data on yield parameters. The crop was picked after the plants turned yellow and reached maturity. Yield was stated in kg/ha, whereas grain weight was expressed at 14 % moisture. To calculate the benefit-cost ratio, divide the gross returns (₹ ha^{-1}) by the total cultivation cost (₹ ha^{-1}). The collected data were analysed with the analysis of variance approach (15).

Results and Discussion

Different growth and yield parameters *viz*., plant height, tillers m^{-2} and grains per panicle were significantly influenced by the different age of seedling and time of planting, whereas panicle weight and test weight did not show any significant difference among age of seedling. Statistically no significant difference in plant height was observed among 15- and 21-days old seedling during normal planting time. Taller plants were noticed when transplanting was done by 21-day-old seedlings as compared to 15 days old seedlings. Normal planting time recorded taller plants irrespective of the age of the seedling. The age of the seedling had a substantial impact on yield and yield characteristics (16). Taller plants were seen when transplanting seedlings at 15 and 21 days old under typical planting conditions. Plants were shown to be shorter with delayed transplantation (17). Machine transplanting with 15 days old seedlings during the normal time of planting recorded significantly higher number of tillers m^{-2} over 15 days delayed transplanting either by 15 or 21- and 25-days old seedlings and statistically on par with normal planting time with 21 days old seedlings. The 15 days old seedlings produced a higher number of tillers m^{-2} (341.2) and the lowest tiller (310.8) was recorded at 25 days old seedling during the first year and the same treatment produced higher (355.3) and lower (321.3) tillers m^{-2} during second year (Table 1). Transplanting younger seedlings increased the number of tillers and encouraged the early appearance of maximal tillers (18). Mechanical transplanting of 15 days old seedlings at normal time recorded significantly higher number of grains per panicle than 21 days and 25 days old seedlings. Transplanting immature seedlings resulted in more grains per panicle (19). The number of grains per panicle reduced as the seedlings aged. Grain yield was higher in 15-day -old transplanted seedlings than in 25-day-old seedlings. The increase in grain yield in 15-day-old seedlings was attributed to an increase in the number of tillers and grains per panicle. The enhanced grain yield in 15-day-old seedlings was attributed to an increase in the number of effective tillers per hill and grains per panicle. Rice grain yield was decreased with delayed transplanting (20).

Plant growth characteristics were strongly impacted by the time of transplantation. Rice transplanted on 19th June 2021 and 30th June 2022 recorded significantly higher yield and yield parameters during the first and second year than July transplanting. Normal time of planting results in higher yield and yield parameters like plant height, tillers m-2 and grains per panicle (21). Beyond 19th June 2021 and 30th June 2022, transplanting decreased in tiller m^{-2},grains per panicle and rice yield. Higher grain yields of 5608.1 kg ha^{-1} and 5511 kg ha^{-1} was recorded when transplanting on the 19th June 2021 and 30th June 2022, respectively. Delayed transplanting of rice beyond 19th June 2021 recorded a reduction in yield varied from 311 to 932 kg ha^{-1} and beyond 30th June 2022 recorded a reduction in yield varied from 361 to 1001 kg ha^{-1}(Table 2). It is also noted that every day delay in transplanting recorded 44 to 37 kg ha^{-1} day^{-1} yield reduction in both years (Fig. 1(a, b)). The lowest grain yield (4676 kg ha^{-1}) was recorded on the 14th July 2021 transplanting during the first year and (4510 kg ha^{-1}) was recorded in the 25th July 2022 during the second year. The reduced grain production may be attributed to fewer tillers and grains per panicle (22). Table 3 shows that transplanting 15-day -old seedlings on June 19, 2021, resulted in higher net revenue (56804 ₹ ha^{-1}) and B-C ratio (2.2), while transplanting on June 30, 2022 resulted in lower net income (54506 ₹ ha^{-1}) and B-C ratio (2.2).

Table 1. Influence of different treatments yield attributes and grain yield (*Kharif* 2021 and 2022)

Treatments	Plant height (cm)		Total tiller m^{-2}		Panicle weight (g)		Grains per panicle (Nos.)		Grain yield (kg ha^{-1})		Test weight (g)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Normal planting time by Machine planting with 15 days old seedlings	139.2	146.1	341.2	355.3	2.4	2.5	158.4	162.6	5608.1	5511.0	14.5	14.7
Normal planting time by Machine planting with 21 days old seedlings	142.3	146.5	336.2	347.3	2.2	2.4	149.2	153.5	5317.1	5150.7	14.4	14.5
15 days delayed by Machine planting with 15 days old seedlings	130.6	133.7	317.6	326.3	2.3	2.5	142.4	147.1	4996	4832.7	14.4	14.5
15 days delayed by Machine planting with 21 days old seedlings	136.8	142.4	310.8	321.3	2.1	2.3	138.2	142.2	4819	4615.7	14.2	14.4
Normal planting time by Manual transplanting with 25 days old seedlings	121.2	124.0	330.6	341.3	2.1	2.2	140.1	147.6	5156	4984.7	14.1	14.4
15 days delayed by Manual transplanting with 25 days old seedlings	119.8	123.3	315.8	326.7	2.2	2.2	131.8	134.9	4676	4510.0	14.2	14.4
SE.d	1.10	1.13	4.01	4.12	***0.02***	***0.02***	2.43	2.58	208.2	247.4	0.05	0.05
CD (P=0.05)	2.45	2.52	8.90	9.19	***NS***	***NS***	5.35	5.74	441.8	551.4	NS	NS

Table 2. Effect of different treatments on yield of rice

Treatments	Date of planting		Yield reduction due to delay in planting time (kg ha^{-1})		Yield reduction due to every day delay in planting (kg ha^{-1} day^{-1})	
	2021	2022	2021	2022	2021	2022
Normal planting time by Machine planting with 15 days old seedlings	19.06.2021	30.06.2022	-	-	-	-
Normal planting time by Machine planting with 21 days old seedlings	25.06.2021	06.07.2022	311	361	44	52
15 days delayed by Machine planting with 15 days old seedlings	04.07.2021	15.07.2022	612	678	40	45
15 days delayed by Machine planting with 21 days old seedlings	10.07.2021	21.07.2022	789	896	37	39
Normal planting time by Manual transplanting with 25 days old seedlings	29.06.2021	10.07.2022	452	526	45	48
15 days delayed by Manual transplanting with 25 days old seedlings	14.07.2021	25.07.2022	932	1001	37	37

Table 3. Influence of different treatments on the economics of rice

Treatments	Cost of cultivation (₹ ha^{-1})		Gross income (₹ ha^{-1})		Net income (₹ ha^{-1})		B-C ratio	
	2021	2022	2021	2022	2021	2022	2021	2022
Normal planting time by Machine planting with 15 days old seedlings	44142	44692	100946	99198	56804	54506	2.2	2.1
Normal planting time by Machine planting with 21 days old seedlings	44142	44692	95708	92712	51566	48020	2.1	2.1
15 days delayed by Machine planting with 15 days old seedlings	44142	44692	89928	86988	45786	42296	2.0	1.9
15 days delayed by Machine planting with 21 days old seedlings	44142	44692	86742	83082	42600	38390	1.9	1.9
Normal planting time by Manual transplanting with 25 days old seedlings	47372	47922	92808	89724	45436	41802	1.9	1.9
15 days delayed by Manual transplanting with 25 days old seedlings	47372	47922	84168	81180	36796	33258	1.7	1.7

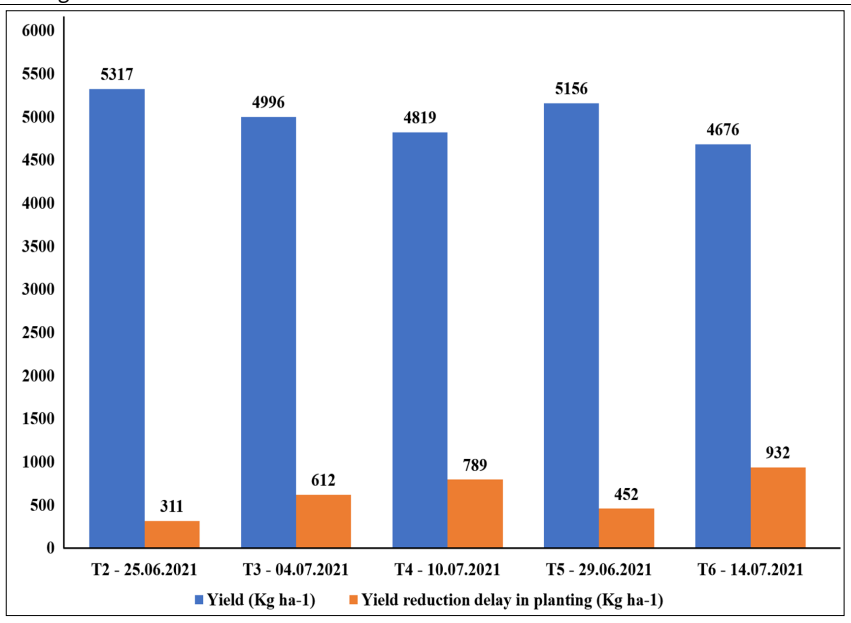

Fig. 1a. Effect of time of planting on yield reduction in rice (2021).

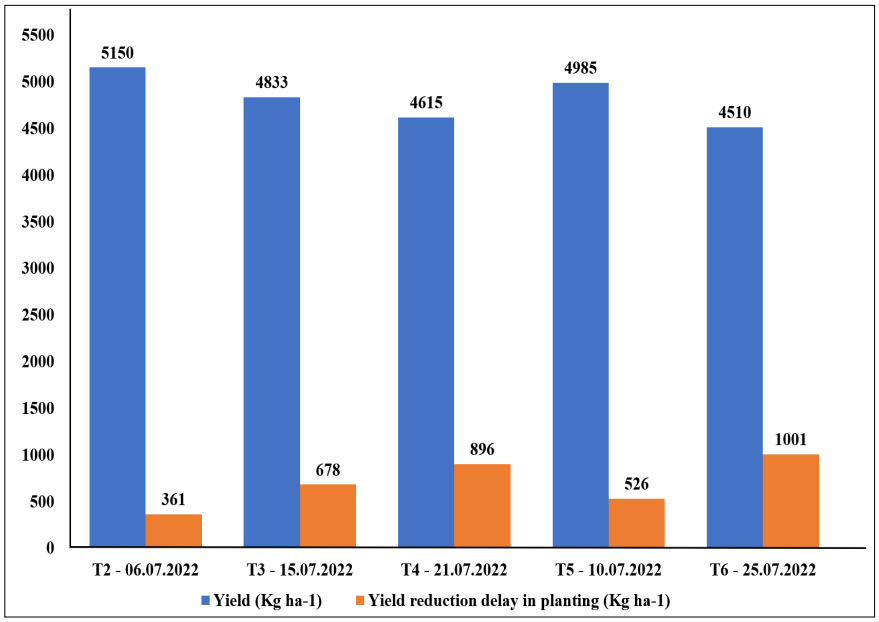

Fig. 1b. Effect of time of planting on yield reduction in rice (2022).

Conclusion

Mechanised transplanting with 15-day-old seedlings in June produced a greater grain yield of 5608.1 and 5511.0 kg ha-1 in *Kharif* 2021 and 2022, respectively. The same treatment resulted in greater net income (56804 and 54506 ₹ ha^{-1}, respectively) and B-C ratios (2.2 and 2.1). During both years of research, 15 days of delayed mechanical transplantation with 15-day-old seedlings resulted in a lower grain production.

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Authors' contributions

SE carried out the experiment recorded observation analyses the data and prepared the original article. KS contributed to the conceptualization study PR, RN, GS and PA are participated in review, editing and PA, RMS and KM participated in summarizing and revising the manuscript.

Compliance with ethical standards

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical issues: None

References

1. NRRI - Annual Report. ICAR - National Rice Research Institute, Cuttack, 2020; 1-10.
2. Sridhar CJ, Ramchandappa BK, Nanjappa HV, Mavarkar NS. Effect of genotypes, planting geometry and method of establishment on growth and yield of aerobic rice. Mysore Journal of Agriculture Science. 2011;45(3):501-5.
3. Singh I, Pannu RK, Prasad D, Ram A. Effects of different transplanting dates on yield and quality of basmati rice (*Oryza sativa*) varieties. Indian Journal of Agronomy. 2013;58(2):256-8. https://doi.org/10.59797/ija.v58i2.4183
4. Farrell123 TC. Avoiding low temperature damage in Australia's rice industry with photoperiod sensitive cultivars.
5. Akram M, Rehman A, Ahmad M, Cheema AA. Evaluation of rice hybrids for yield and yield components in three different environments. Journal of Animal and Plant Sciences. 2007;17(3-4):70-4.
6. Abou Khalifa AA. Physiological behavior of some rice cultivars under different sowing dates and seedling age. In: The 11th Conference of Agronomy. Agron. Dept., Assiut Univ; 2005 Nov 15. p. 285-95.
7. Hussain AS, Hoque MM, Huda MN, Hossain D, Shahjahan M. Effect of planting time and nitrogen application on the yield and seed quality of T. Aman Rice (*Oryza sativa L.*). Bangladesh Journal of Agricultural Research. 2013;38(4):673-88. https://doi.org/10.3329/bjar.v38i4.19660
8. Yoshida S, Parao FT. Climatic influence on yield and yield components of lowland rice in the tropics. Climate and rice. 1976;20:471-94.
9. Sarker U. Stability for grain yield under different planting times in rice. Bangladesh Journal of Agricultural Research. 2002;27(3):425-30.
10. Choudhary V, Machavaram R. Need of automation in paddy nurseries for raising paddy seedlings in India: A Review. Journal of Biosystems Engineering. 2022;47(2):209-22. https://doi.org/10.1007/s42853-022-00139-9
11. Virk AL, Farooq MS, Ahmad A, Khaliq T, Rehmani MI, Haider FU, Ejaz I. Effect of seedling age on growth and yield of fine rice cultivars under alternate wetting and drying system. Journal of Plant Nutrition. 2020;44(1):1-5. https://doi.org/10.1080/01904167.2020.1812642
12. Huang M, Fang S, Cao F, Chen J, Shan S, Liu Y, Lei T, Tian A, Tao Z, Zou Y. Prolonging seedling age does not reduce grain yields in machine-transplanted early-season rice under precision sowing. Annals of Applied Biology. 2020;176(3):308-13. https://doi.org/10.1111/aab.12583
13. Bassi G, Rang A, Joshi DP. Effect of seedling age on flowering of cytoplasmic male sterile and restorer lines of rice. International Rice Research Notes (Philippines). 1994;19(1).
14. Pasuquin E, Lafarge T, Tubana B. Transplanting young seedlings

in irrigated rice fields: Early and high tiller production enhanced grain yield. Field Crops Research. 2008;105(1-2):141-55. https://doi.org/10.1016/j.fcr.2007.09.001

15. Shah ML, Bhurer KP. Response of wet seeded rice varieties to sowing dates. Nepal Agriculture Research Journal. 2005;6:39-48. https://doi.org/10.3126/narj.v6i0.3342
16. Singh S, Singh S, Singh A, Anshuman K, Singh P, Singh G, Singh RD, Srivastav SK. Effect of age of seedling and plant spacing on yield and economics of transplanted rice (*Oryza sativa L.*). International Journal of Environment and Climate Change. 2023;13(11):1235-42. https://doi.org/10.9734/ijecc/2023/v13i113275
17. Hussain A, Bhat MA, Ganie MA. Effect of number and age of seedlings on growth, yield, nutrient uptake and economics of rice (*Oryza sativa*) under system of rice intensification in temperate conditions. Indian Journal of Agronomy. 2012;57(2):133-7. https://doi.org/10.59797/ija.v57i2.4625
18. Gomez KA, Gomez AA. Statistical procedures for agricultural research. John wiley & sons; 1984 Feb 17.
19. Shao-Hua W, Weixing C, Dong J, Tingbo D, Yan Z. Physiological characteristics and high-yield techniques with SRI rice. In assessments of the system of rice intensification (SRI): Proceedings of an International Conference in Sanya, China; 2002 Apr 1.p. 116-124.
20. Sah MK, Shrestha A, Shah P, Mishra A. Impact of age of seeding and varieties on yield and yield attributing characters of rice in Central Terai Region of Nepal. Agronomy Journal of Nepal. 2023;7:88-93. https://doi.org/10.3126/ajn.v7i1.62154
21. Roy BC, Sattar SH, Gaffer MA, Islam MA. Seedling age effect on yield of irrigated rice. Bangladesh Rice Journal. 1992;3(1):83-8.
22. Vishwakarma A, Singh JK, Sen A, Bohra JS, Singh S. Effect of transplanting date and age of seedlings on growth, yield and quality of hybrids under system of rice (*Oryza sativa*) intensification and their effect on soil fertility. Indian Journal of Agricultural Sciences. 2016;86(5):679-85. https://doi.org/10.56093/ijas.v86i5.58355

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