Biological Forum – An International Journal **13(3): 196-199(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Impact of SRI Components on Growth and Productivity of Conventional Transplanted Rice

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(Received 22 May 2021, Accepted 27 July, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Conventional puddled rice cultivation is labour intensive and water consumptive, while SRI addresses these issues. So, the effect of System of Rice Intensification (SRI) components studied on growth and yield of conventional transplanted *kharif* rice, an experiment was conducted at research farm of Bihar Agricultural University, Sabour, Bhagalpur, India during *kharif* 2019. The experiment was laid out in completely randomized block design with eight treatments replicated thrice. The first treatment was conventional puddled transplanted rice (CPTR), thereafter six treatments were also CPTR with an addition component of SRI in each treatment and the last treatment was sole SRI. Results revealed that all growth parameters i.e., plant height, leaf area index and dry matter accumulation obtained highest in the SRI at all growth stages. The highest grain yield (6020 kg ha^{-1}) was recorded in the SRI, which was statistically at par with CPTR with 12 days seedling (5693 kg ha^{-1}). The highest straw yield (6693 kg ha^{-1}) was recorded in the SRI, which was statistically at par with CPTR with 12 days seedling (6473 kg ha^{-1}), CPTR with 1 seedling/hill (6447 kg ha^{-1}), conventional PTR (6170 kg ha^{-1}), CPTR with spacing of 25 cm × 25 cm (5943 kg ha^{-1}) and CPTR with N-Organic: inorganic (5873 kg ha^{-1}). Based on these findings, we can suggest the farmers in our country to go for partial implementation of SRI *i.e.*, 12 days old seedling with single seedling/hill in transplanted *kharif* rice if practicing all principles of SRI is not possible.

Keywords: SRI, Puddled transplanted rice, younger seedlings, Square planting.

INTRODUCTION

Globally rice stands second position in area (216 Mha) and production 655 (Mt). However, in India rice has an area of about 43.2 Mha with the production 110.1 Mt annually. Now the big challenge to the farmers and researchers is that to achieve the Country's needs of around 140 Mt of rice (Dinesh *et al.*, 2017) in the year 2025 considering the worsening condition of water scarcity and reduction in cultivable land (Shobharani *et al*., 2010). The traditional system of rice cultivation requires large quantity of water and the continuous water stagnation markedly reduce the water use efficiency. Researchers observed that the use of excess water and the transplanting shock by use of older seed lings are the major drawback of traditional transplanted system which leads to low productivity of rice. By continuous cultivation of rice through traditional method hampers the soil physical properties. On the other side the system of rice intensification has potential to sustain the productivity of rice, we have to practice cultivation methods in which all these challenges will be resolved. System of rice intensification (SRI) has that potential to sustain the productivity with better water use efficiency. The technique, SRI was firstly used by the farmer of Madagascar, thereafter in India this technology was spread with a goal of increasing the productivity of irrigated rice with better growth and yield attributing characters. The researchers also noticed the greater root growth with soil microbial abundance and diversity in SRI technique (Kumar and Shivay, 2004). The SRI system is found to be an efficient alternative to increase the rice production upto 55% compared to conventional method (Nirmala *et al*., 2021) as it requires less water, less seed, reducing cost of cultivation by 22.5% (Nirmala *et al.*, 2021) and saving labour over time (Patel *et al.*, 2021) thus increases labour for other activities. Basically under SRI technique the six components are very important *viz.* early transplanting (8-12 days seedlings), carefully transplanting with single seedling hill^{-1}, wider spacing (25cm × 25cm), weeding and aeration through mechanical rotating hoe/cono-weeder, water management by alternate wetting and drying) and application of farm yard manure or vermicompost. The single seedling transplanting provides the less competition of plants, better root development, more sunlight interception, enhanced soil microbial population, high organic matter content and better nutrient and water availability. All weed species under SRI are controlled easily as compared to conventional puddled rice and DSR

(Kumar *et al.*, 2021) with the help of mechanical hand weeder which helps in soil aeration, reduces the green house gases emissions and increases the productivity of rice in sustainable way. In SRI system the implementation of alternate wetting and drying (AWD) enhances the water use efficiencies and may reduces 30-40 % of water wastages from traditional methods (Latif, 2010). However, the use of organic manure results a high cultivation cost which leads to lower profit in SRI than the traditional system. Therefore, it is very important to identify the most important component of SRI technique which can be combined with traditional system for optimum productivity in sustainable manner. It was also observed that based on the water table and soil type, the AWD was found very complicated for the farmers as the water level lower down to about 5-10 cm and 5-15 cm from soil surface during before flowering and grain filling of rice, respectively (Bouman *et al.,* 2007; Kishor *et al*., 2017). So, partial implementation of SRI technique in conventional practice may found to be beneficial in transplanted *kharif* rice (Palanisami *et al*., 2013; Reuben *et al*., 2016).

MATERIALS AND METHODS

The investigation was conducted at the research farm of Bihar Agricultural University, Sabour, Bhagalpur, India during 2019 *kharif* season. Bhagalpur stationed south of the river Ganges and representing of Agro-climatic Zone III-A which is situated at latitude of $25^{o}15'40''$ N and $87^{o}2'42''$ E longitude with altitude of 52.73 meter above mean sea level. The research station Sabour is characterized to sub-tropical climate with hot dry summer, and cold winter. The soil of the experimental plot was sandy clay loam in nature and low in fertility status (192.5 kg available N ha^{-1}, 17.8 kg available P ha^{-1} and 123.8 kg available K ha^{-1}). The experimental site is characterized to sub-tropical climate with hot summer, cold winter, and moderate rainfall. The coldest months are noted as December and January with the minimum temperature recorded as 3.2°C. However, the hottest months are the May and June, having the average temperature ranged from 35°C to 39°C. Around 1207 mm annual average rainfall (averaged over 10 years) was recorded and mostly precipitating between middle of June to middle of September. The experiment was laid out in completely randomized block design with eight treatments replicated thrice. The first treatment was conventional puddled transplanted rice (CPTR), thereafter six treatments were also CPTR with an addition component of SRI in each treatment and the last treatment was sole SRI. The recommended dose of fertilizer was 120:60:40 kg N:P_2O_5: K_2O ha^{-1} and the sources were Urea, Di Ammonium Phosphate, Muriate of Potash and Vermicompost. In CPTR the 22 days old seedlings were used with general spacing was maintained as 20cm × 15cm. The details treatment combinations are explained in Table 1. In treatments T_5 and T_8 where the organic manure was incorporated with chemical fertilizer, the 50% N (60 kg N ha^{-1}) was mitigated with vermicompost (1.75% N) and those plots were received @ 3.4 t vermicompost ha^{-1} during final land preparation. All the treatments received full dose of P_2O_5 and K_2O as basal dose at one day before transplanting. The N fertilizer was applied in three split i.e. 40% as basal and remaining was applied in two equal split (30%) at active tillering (25 DAT) and panicle initiation (45 DAT) stages. As the treatment T_5 and T_8 received vermicompost as basal, here the N was applied in split as 25% in both the active tillering and panicle initiation stages. In the treatment T_7 and T_8, the mechanical rotating hoe was used twice for weed management and the others received one hand weeding and herbicide application as post emergence during the course of investigation.

Table 1: Treatment Details.

T_1	Conventional puddled transplanted rice (CPTR)
T_2	CPTR using 12 days old seedlings (First component of SRI)
T_3	CPTR with spacing of 25cm × 25cm (Second component of SRI)
T_4	CPTR with single seedling/hill (Third component of SRI)
T_5	CPTR with N-Organic: inorganic::50:50 (Fourth component of SRI)
T_6	CPTR with Saturation water management i.e. alternating wetting and drying (Fifth component of SRI)
T_7	CPTR with weed management through Cono-weeder / mechanical rotating hoe(Sixth component of SRI)
T_8	SRI (Spacing: 25cm× 25 cm), single seedling/hill, 12 days old seedling, N-Organic: Inorganic (50:50), Saturation water management, weed management through cono-weeder/ mechanical rotating hoe)

The crop variety 'Sabour Shree' was used in the experiment and this variety generally recommended for long duration (145-150 days) with an average potential yield about 45-55 q ha^{-1}. The maximum plant height, LAI, tiller count, plant samplings were recorded and collected and the economic yield was estimated at the time of harvest. The economic yield was estimated from an area of 5.0 m^2 of each plot. The data were analyzed statistically by applying "Analysis of Variance" (ANOVA) technique of completely randomized block design. The significance of different sources of variations was tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05. Standard error of mean (SEm±) and least significant difference (LSD) at 5% level of significance were worked out for each character.

RESULTS AND DISCUSSION

A. Growth attributes

There was no significant difference observed in plant height and LAI among all the treatments (Table 2). Highest number of tillers m^{-2} was recorded in the T_8 which was statistically at par with T_1, T_2, T_3, T_4 and T_5 at harvest stage. These results are supported by Mohandas *et al*., (2015) who found that SRI cultivation has resulted in higher effective tillers per m^2 than conventional and mechanized transplanting. Total biomass accumulation was also recorded highest in the T_8 which was statistically at par with T_2. These findings are in accordance with Praneeth *et al.*, (2017) who reported that growth parameters obtained in SRI were higher as compared to transplanted rice.

Table 2: Effect of crop establishment method on plant height, leaf area index (LAI), tiller number and total biomass of the rice crop.

Treatments	Plant height (cm)	LAI	Number of tillers m^{-2}	Total biomass (kg ha^{-1})
T1: Conventional PTR (CPTR)	113.2	1.48	281	12186
T2: CPTR with 12 days seedling	118.1	1.52	302	13945
T3: CPTR with spacing of 25cm×25cm	110.7	1.31	278	11376
T4: CPTR with 1 seedling/hill	116.3	1.52	283	12884
T5: CPTR with N-Organic: inorganic::50:50	112.2	1.41	277	11971
T6: CPTR with Saturation water management (AWD)	108.4	1.23	246	10670
T7: CPTR with weed management through mechanical rotating hoe	107.4	1.27	262	11011
T8: SRI	119.6	1.55	308	14274
SEm(±)	4.1	0.13	12.0	437.64
LSD (p= 0.05)	(NS)	(NS)	35.0	1327.50

PTR = Puddled transplanted rice; CPTR = Conventional puddle transplanted rice; AWD = Alternate wetting and drying; SRI = System of rice intensification; SEm(±) = Standard error of mean; LSD = Least significant difference

B. Yield attributes and yield

The highest number of panicles m^{-2} (308) was recorded in the T_8 which was statistically at par with T_1, T_2, T_3, T_4 and T_5 (Table 3). Highest number of grains panicle^{-1} (127) was recorded in the T_2 which was statistically at par with T_8. No significant difference in Test weight (g) was observed among the treatments. However, the highest Test weight (21.6g) was obtained with T_8 treatment. All yield parameters were recorded lowest in the T_6. These findings are in accordance with Duttarangvi *et al*., (2016) who reported that yield parameters recorded in the SRI were significantly higher when compared to conventional and mechanized transplanting. The main reason behind this is that SRI method improves soil quality which leads to increase in the availability of nutrients and water to the crop. Spacing of 25 × 25 cm^2 enables leaves to intercept the maximum sun light which improves the photosynthetic ability of the crop. The highest grain yield (6020 kg ha^{-1}) was recorded in the T_8 which was statistically at par with T_2 but differed significantly with all other treatments (Table 4). These results are in conformity with the findings of Sudhakar *et al*., (2017) who reported that both grain yield and straw yield were recorded significantly higher in SRI method compared to conventional method. The lowest grain yield (4413 kg ha^{-1}) was recorded in the T_6. Treatment T_2 has also recorded significant yield which might be due to transplanting of younger seedlings.

Table 3: Effect of crop establishment method on panicles m^{-2}, grains panicle^{-1} and test weight of the rice crop

Treatments	Panicles m^{-2}	Grains panicle^{-1}	Test weight (g)
T1: Conventional PTR (CPTR)	281	113	21.6
T2: CPTR with 12 days seedling	302	127	21.7
T3: CPTR with spacing of 25cm×25cm	278	111	20.8
T4: CPTR with 1 seedling/hill	283	118	21.6
T5: CPTR with N-Organic: inorganic::50:50	277	99	20.9
T6: CPTR with Saturation water management (AWD)	246	100	20.6
T7: CPTR with weed management through mechanical rotating hoe	262	107	21.5
T8: SRI	308	126	21.6
SEm(±)	12	6	0.6
LSD (p=0.05)	35	19	NS

PTR = Puddled transplanted rice; CPTR = Conventional puddle transplanted rice; AWD = Alternate wetting and drying; SRI = System of rice intensification; SEm(±) = Standard error of mean; LSD = Least significant difference

Table 4: Effect of crop establishment method on the grain yield, straw yield and harvest index of the rice crop.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
T1: Conventional PTR (CPTR)	5280	6170	46.1
T2: CPTR with 12 days seedling	5693	6473	46.8
T3: CPTR with spacing of 25cm×25cm	5193	5943	46.6
T4: CPTR with 1 seedling/hill	5313	6447	45.2
T5: CPTR with N-Organic: inorganic::50:50	4660	5873	44.2
T6: CPTR with Saturation water management (AWD)	4413	5337	45.2
T7: CPTR with weed management through mechanical rotating hoe	4573	5583	45.1
T8: SRI	6020	6693	47.4
SEm(±)	232	272	1.2
LSD (p=0.05)	703	826	NS

PTR = Puddled transplanted rice; CPTR = Conventional puddle transplanted rice; AWD = Alternate wetting and drying; SRI = System of rice intensification; SEm(±) = Standard error of mean; LSD = Least significant difference

These results were supported by Reuben *et al*., (2016) who reported that transplanting of rice seedlings at earlier age (8-12 days) had shown to be more potential in terms of higher number of tillers/hill which may lead into higher yield of rice. Similarly, the highest straw yield (6693 kg ha^{-1}) was recorded in the T_8 which was statistically at par with T_1, T_2, T_3, T_4 and T_5. The lowest grain yield (5337 kg ha^{-1}) was recorded in the T_6. Among all the treatments, there was no significant difference obtained with harvest index. However, treatment T_8(47.4%) and T_5(44.4%) were recorded maximum and minimum harvest index respectively.

CONCLUSION

All growth parameters as well as yield parameters were recorded highest in the SRI which was statistically at par with CPTR using 12 days old seedlings in most of the parameters. Similar trend was observed in grain yield as well as straw yield. Treatments CPTR using 12 days old seedlings and CPTR with single seedling/hill have performed well and are next to only SRI in terms of growth parameters, yield parameters and yield. Transplanting 12 days young seedlings in CPTR would be able to increase the grain yield by 7.2%, over the conventional transplanted rice with 21 days old seedlings. The SRI technique is superior regarding grain yield over the conventional practice (14% higher) but following all principles of SRI is a herculean task for farmers in some regions because of the unavailability of resources. Based on these findings, we can suggest the farmers in our country to go for partial implementation of SRI *i.e.*, 12 days old seedling with single seedling/hill in transplanted *kharif* rice if practicing all principles of SRI is not possible.

FUTURE SCOPE

Vast scope for SRI in rice as it not possible in low land waterlogged area, and need well levelled field for drainage of excess water. So, need of research in this area.

Acknowledgement. We sincerely acknowledge the BAU, Sabour for taken consideration about conducting my research.

Conflict of interest. Nil.

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How to cite this article: Kumar, R., Raj, M., Lal, K. and Ranjan, A. (2021). Impact of SRI Components on Growth and Productivity of Conventional Transplanted Rice. *Biological Forum – An International Journal*, *13*(3): 196-199.