Indian Journal of Agricultural Sciences **91** (6): 857–60, June 2021/Article
https://doi.org/10.56093/ijas.v91i6.114286

Effect of age and number of seedlings on rice (*Oryza sativa*) under SRI in rainfed agro-ecosystem

ADIKANT PRADHAN[1] and ANIL DIXIT[2]*

S G College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh 494 001, India

Received: 15 September 2020; Accepted: 07 January 2021

ABSTRACT

Field experiment was conducted during the *kharif* 2018–19 at S G College of Agriculture and Research Station, Jagdalpur to evaluate the effect of number of seedlings/hill and their age on growth, yield and nutrient uptake of rice (Oryza sativa L.) under SRI. The 12 treatments combinations of 1, 2 and 3 seedlings/hill, transplanted at an age of 10, 20, 30 and 40 days were laid out in RBD with 3 replications. The seedlings were transplanted in a square pattern at 25cmx25cm spacing. The crop was weeded by cono-weeder twice. The results showed that transplanting 1 and 2 seedlings attained similar growth, yield attributes and yields being significantly higher than 3 seedlings/hill and 7% yield advancement was obtained with transplanting 1 or 2 seedlings/hill over 3 seedlings/hill. Among the seedling ages 10 and 20 days old seedlings resulted in significantly higher growth, yield attributes and yield than 30 and 40 days old seedlings. Twenty one days old seedlings are more easy to handle and produced grain yield as much as 14 days old seedlings, but increased 5.8% and 13.9% more grain yield than 28 and 35 days old seedlings, respectively.

Keywords: Seedling age, Seedlings quantity, System of Rice Intensification, Number of seedlings

System of Rice Intensification (SRI) developed in Madagascar, is a package approach to increase rice productivity with less external inputs. The increasing scarcity of water is a major threat to rice production in many countries (Bouman *et al.* 2005). Many measures like alternate wetting and drying and ground cover production system involved in aerobic rice systems (Prasad 2011) and SRI are suggested to save water (Bruderie *et al.* 2009). The SRI has been reported for increasing the yield remarkably with same level of inputs and about 40-50% water savings (WF-ICRISAT 2010). In India, rice is an important ingredient of household food-basket, yet its yield level is low, stagnant and uncertain (Barah 2009). SRI indicates the transplanting of seedlings as an age of 8-12 days, singly and at spacing of 25 cm × 25 cm in square planting geometry. Supply of nutrients is preferably through organic sources (FYM or compost) combined with manual or mechanical weeding and comparatively smaller quantities of water with intermittent drainage (WWF- ICRISAT 2010). Earlier studies under rainfed conditions revealed that crop rose with SRI technique receiving recommended NPK+ FYM @ 10 t/ha registered yield superiority of 15–19% over farmers practice (Krishna and Patil 2009).

Generally, one seedling/hill is recommended under system of rice intensification; however under certain situation 2 seedlings may produce better growth and tiller number per unit area. Transplanting 20 days old seedlings has been commonly reported to generate an increase in grain yield as a result of higher tiller production (Pasuquin *et al*. 2008). Younger seedlings have higher tillering potential which drastically decreases with age. Farmers generally transplant more seedlings/hill at a closer spacing randomly resulting in severe competition and poor tillering. Optimization of the seedling age under the system of rice intensification is therefore an important non-monetary input that may enhance the resource use-efficiency and improve the profitability. Keeping this view in mind, a field experiment was conducted to study the effect of seedling number and age on the growth parameters, yield and nutrient uptake including economics of rice under SRI.

MATERIALS AND METHODS

Field experiment was conducted during the *kharif* 2018–19 at S.G. College of Agriculture and Research Station, Jagdalpur situated between 17°46' and 20°34' North latitude and 80°15' and 82°15' East longitude and at an altitude of 2000 ft. The rainfall is always between 1000 to 1500 mm annually. The soil of the experimental site was silty clay loam in texture, *p*H 6.9 as neutral in reaction, low in available N (242 kg/ha), medium in available P (13.6 kg/ha) and high in K (250 kg/ha). The experiment had 12

Present address: [1]S. G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh; [2]ICAR- National Institute of Biotic Stress Management, Chhattisgarh.*Corresponding author e-mail: anildixit99@gmail.com.

treatments combinations of number (1, 2 and 3 seedlings/hill) and four ages of seedlings (10, 20, 30 and 40 days). The experiment was laid out in RBD with 3 replications. Nursery was prepared on raised beds with well decomposed FYM applied @ 1 kg/m^2. The sowing of the recommended variety MTU 1010 was started on 25th of May and further sowings were done in staggered required. Seedling came to 2 leaf stage 10 days and became more robust at 20 days. N, P and K were applied @ 80:60:40 kg/ha in combination with FYM @ 5 t/ha to all the treatments. Marked ropes were used to achieve square planting with 25 cm × 25 cm spacing. The transplanting of all the treatments was done on 5th July during both the years. From flowering to 15 days before harvesting, a thin film of water was maintained by frequent light irrigations. To control weeds a combination of herbicide butachlor @ 1.5 kg a.i./ha and weeding by cono-weeder at 15 and 30 days after transplanting was followed. Leaf area and dry matter accumulation were recorded at flowering stage. The straw and grain samples were taken at harvest for analysis of N, P and K concentration using standard methods. Bastar is characterized by humid climate with medium growing season extending from June to October. Rice crop is often exposed to medium temperature at seedling and flowering stages depending on the prevailing weather.

RESULTS AND DISCUSSION

Growth attributes: The number of seedlings/hill significantly affected the plant height, LAI, tillers/hill and dry matter/hill. Transplanting 1 or 2 seedlings/hill produced significantly taller plants with higher leaf area index and dry matter accumulation due to higher tiller production (Table 1). Seedling age also significantly influenced plant height, younger seedlings of 10 and 20 days produced significantly taller plants than 30 and 40 days old seedlings. Leaf area index (LAI) was significantly influenced by seedling age at 75 DAS and transplanting of seedlings on 10 and 20 days age produced similar LAI among themselves but higher than older seedlings of 30 and 40 days age. Seedlings of 10 and 20 days age accumulated at par dry matter but the same was significantly lower in case of older seedlings of 30 and 40 days triggering higher tiller production. Previous studies on age of seedling under SRI crop establishment showed that transplanting of seedlings at young age of 14 days under tropical climate obtained higher crop growth than transplanting 21 to 23 days old seedlings (Thiyagarajan *et al.* 2002).

Yield attributes: The number of seedlings/hill had significant effect on the panicles/m^2 and 1 and 2 seedlings/hill expressed superiority over 3 seedlings/hill, whereas panicle length, panicle weight, grains/panicle and 1000-grain weight though numerically superior for 1 and 2 seedlings/hill but were statistically similar with 3 seedlings/hill. Transplanting 1 seedling/hill under SRI method produced on an average of 50% more tillers than the 3 seedlings/hill, and at harvest the number of panicles/square metre was 32% higher with 1 seedling/hill (WWF-ICRISAT 2010). Panicles/m^2 registered a consistent decrease with the increase in seedling age from 10 to 40 days. Panicle weight, grains/panicle and 1000-grain weight showed similar trends with regard to the seedling age (Pradhan *et al*. 2014).

Grain and straw yield: Transplanting 1 or 2 seedlings/hill was statistically superior with regard to the grain yield than 3 seedlings/hill. Straw yield was significantly higher for 1 and 2 seedlings/hill than 3 seedlings/hill in account of higher tillering contributing to the higher biomass during 2018 and same trend, though statistically non-significant was observed during 2019 (Table 2). Younger seedlings of 10 and 20 days old seedlings produced on par straw yield but were superior to the 30 and 40 days old seedlings. Transplanting younger seedlings at an age of 10 or 20 days produced at par grain yields which were convincingly higher than 30 and 40 days seedlings. The magnitude of increase in the

Table 1 Effect of number and age of seedlings on growth attributes and yield attributes of rice under System of Rice Intensification (SRI) method of rice cultivation (Mean data of 2 years)

Treatment	Plant ht (cm)	LAI at 80 DAT	Tillers/hill	Dry matter/ hill	Panicles/m^2	Panicle wt (g)	Grains/ panicle	1000-grain wt	Panicle length (cm)
No. of seedlings/hill									
1	107.89	4.28	17.56	63.98	323.76	2.73	110.69	24.80	23.35
2	108.56	4.27	17.95	62.82	320.09	2.73	109.72	24.41	23.26
3	105.86	3.69	14.28	58.58	280.53	2.54	106.44	24.61	24.90
SEm±	1.06	0.12	0.61	1.10	12.04	0.13	3.48	0.46	0.71
CD (P=0.05)	2.22	0.24	1.26	2.22	24.99	NS	NS	NS	NS
Age of seedlings (days)									
10	109.82	4.60	19.49	65.91	334.28	2.90	117.44	25.38	24.80
20	109.14	4.38	18.24	64.85	333.50	2.90	115.03	25.38	22.29
30	104.90	3.67	14.09	60.60	280.24	2.34	102.77	23.84	21.91
40	105.38	3.68	13.51	56.07	272.52	2.41	100.55	23.74	0.82
SEm±	1.24	0.14	0.70	1.25	15.34	0.14	4.01	0.54	1.71
CD(P=0.05)	2.57	0.28	1.46	2.61	31.85	0.31	8.34	1.12	NS

Table 2 Yield and economics of rice as affected by number and age of seedlings established by SRI method

	Grain yield (t/ha)			Straw yield (t/ha)			N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)			HI	Economics		
	2018	2019	Mean	2018	2019	Mean	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	(%)	CoC (₹./ha)	Mean NR (₹./ha)	B.C ratio
No. of seedlings/hill																			
1	6.61	6.35	6.48	6.82	6.72	6.76	91.58	53.85	145.43	22.58	10.33	32.91	29.14	90.03	119.18	47.19	30590	48540	1.59
2	6.69	6.55	6.62	6.86	6.61	6.74	91.87	55.10	147.36	22.58	10.71	33.29	31.65	91.48	123.13	47.29	30780	50080	1.63
3	6.29	5.94	6.12	6.47	6.58	6.52	86.08	50.28	136.35	21.04	9.75	30.78	26.63	86.66	113.29	46.61	30880	44200	1.43
SEm±	0.14	0.14	0.13	0.16	0.14	0.12	1.44	1.08	2.05	0.41	0.63	0.77	0.45	1.82	2.06				
CD(P=0.05)	0.28	0.32	0.15	0.33	NS	0.25	2.99	2.24	4.24	0.83	NS	1.60	0.94	NS	4.26				
Age of seedlings (days)																			
10	6.84	6.59	6.72	7.28	7.39	7.33	95.44	58.67	154.11	23.64	11.39	35.03	30.30	98.53	128.83	46.13	30780	51820	1.68
20	6.81	6.57	6.69	7.17	7.24	7.20	95.05	57.80	152.86	22.97	10.71	33.68	29.82	96.31	125.16	46.51	30780	51530	1.67
30	6.43	6.22	6.32	6.30	6.30	6.30	88.01	49.22	137.22	21.33	10.04	31.56	27.60	83.38	110.98	48.35	30780	45930	1.49
40	6.05	5.75	5.90	6.01	6.01	6.04	82.12	46.90	129.02	20.36	8.78	29.24	25.86	79.42	105.28	47.77	30780	41110	1.34
SEm ±	0.15	0.14	0.14	0.16	0.16	0.16	1.67	1.24	2.35	0.45	0.73	0.89	0.52	2.10	2.36				
CD(P=0.05)	0.33	0.36	0.34	0.34	0.34	0.31	3.45	2.59	4.89	0.96	1.52	1.84	1.08	4.37	4.91				

* HI=Harvest Index, CoC=Cost of Cultivation, NR=Net returns

grain yield due to 10, 20 and 30 days old seedlings was 13.1%, 12.6% and 6% over 35 days old seedlings for the year 2018. The corresponding values for the year 2019 are 14.3%, 14.5%, and 8% (Table 2). Transplanting of two leaf stage young seedlings of 8-12 days old under SRI method is possible in tropical climates, because of cooler weather prevailing. Krishna *et al*. (2009) reported that 12 days old seedlings produced more number of tillers and productive tillers per plant at harvest compared to 8, 16 and 25 days old seedlings. Transplanting rice seedlings 20 days old has been commonly reported to generate an increase in grain yield as a result of higher tiller production (Pasuquin *et al*. 2008). The grain and straw yield was lower during the year 2019 might be due to variation in temperature at flowering stage.

Nutrient uptake: The number of seedlings/hill significantly influenced N, P and K uptake. Transplanting 1 or 2 seedlings/hill had a similar NPK uptake by grain and straw which was statistically higher than 3 seedlings/hill except in case of P uptake by straw (Table 2). The total NPK uptake followed a similar trend. The higher nutrient uptake was associated to the higher grain and straw yield. NPK uptake by grain, straw and the total uptake decreased with the increase in seedling age from 10 to 40 days. The maximum NPK uptake was recorded for 10 days seedlings which was statistically at par with 20 days old seedlings but significantly higher than the 30 and 40 days old seedlings. The higher nutrient uptake was mainly due to higher biological yield. This attribute to the higher tiller number and dry matter production by younger seedlings was seen led to higher straw and grain yield and nutrient removal. This is also attributed to deeper and more prolific root system developed by young seedlings gown with SRI method and well aerated conditions (Barison 2002).

Relative economics: Transplanting 1 or 2 seedlings/hill affect the input cost marginally but produced higher straw and grain yield and higher net returns (Table 2). Seedling age is a non-monetary input but significantly affected the straw and grain yield. 10 and 20 days old seedlings produced comparable profits but higher than 30 and 40 days old seedlings by a margin of 12.5–25%. Highest net returns of ₹ 50080 was realized by planting 2 seedlings/hill and among seedling ages highest net return of ₹ 51820 was realized for 10 days old seedlings which was comparable with 20 days old seedlings.

The results showd that transplanting 2 seedlings/hill produced higher grain yield than 1 and 3 seedlings/hill in SRI method. Transplanting of young seedlings at an age of 10 or 20 days produced at par grain yield, which were significantly more than 30 and 40 days old seedlings. Seedlings of 20 days age appears to be better option as the seedlings are more robust, easy to manage and have higher establishment. The highest B:C ratio was obtained when 2 seedlings were transplanted and 10 days old seedlings adopted for SRI under rainfed condition (Table 2).

REFERENCES

Barion J. 2002. 'Nutrient use efficiency and nutrient uptake in

conventional and intensive (SRI) rice cultivation systems in Madagascar'. Master thesis, Cornell University, Ithaca, New York, p 1-99.

Bouman B A M, Peng S, Castan A R and Visperas R M. 2005. Yield and water use of irrigated tropical aerobic rice systems. *Agricultural Water Management* **74**: 87–105.

Bruderie K, Shambu P and Roy S. 2009. Vulnerability reduction and adaptation experiences from Rajasthan and Andhra Pradesh: The system of rice intensification, Swiss Agency for Development and Cooperation, Vulnerability and Assessment Programme, India, pp 1–35.

Hussain A, Bhat M A, Ganai M A and Hussain T. 2009.Comparative performance of System of Rice Intensification (SRI) and conventional methods of rice cultivation under Kashmir valley conditions. *Environment and Ecology* **27**(1A): 399–402.

Krishna A and Biradarpatil N K. 2009. Influence of seedling age and spacing on seed yield and quality of short duration rice under system of rice intensification cultivation. *Kamataka Journal of Agricultural Science* **22**(1): 53–55.

Pasuquin E, Lafarge T and Tubana B. 2008. Transplanting young seedlings in irrigated rice fields: Early and high tiller production and enhanced grain yield. *Field Crops Research* **105**: 141–55.

Prasad R. 2011. Aerobic rice systems. *Advances in Agronomy* **111**:207-247

Thiyagarajan T M, Velu V, Ramasamy S, Durgadevi D, Govindaranjan K, Pryadarshini R, Sudhalakshmi C, Senthil Kumar K, Nisha P T, Gayathry G, Hengsdijk H and Bindrahan P S. 2002. Systems of rice intensification (SRI): Evaluation of seedling age and selected components in Indonesia. *(In) Water-wise Rice Production.* IRRI, Philippines, pp. 119–27.

WWF-ICRISAT Project. 2010. More rice for people, more water for the planet. African Oxfam America, WWF-ICRISAT Project, Hyderabad, India

Pradhan A, Thakur A and Sonboir H L. 2014. Response of rice (*Oryza sativa*) varieties to different levels of nitrogen under rainfed aerobic ecosystem. *Indian Journal of Agronomy* **59**(1): 76–79.

Barah B C. 2009. Economic and Ecological Benefits of System of Rice Intensification (SRI) in Tamil Nadu. *Agricultural Economics Research Review* **22**: 209–14.