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RESEARCH ARTICLE

Identification of suitable age of seedlings and planting pattern of rice under SRI

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SUMMARY

Field experiments were conducted for two consecutive *Kharif* seasons of 2005 and 2006 at Agricultural College farm, Naira, Srikakulam district,A.P. on sandy clay loam soil with an objective of optimization of agro-techniques for higher productivity of rice under SRI in North Coastal Zone of Andhra Pradesh. The treatments comprised of combination of four different ages of seedlings (8,12,16 and 20 days old) and four planting patterns (20 x 20 cm,25 x 25 cm,30 x 30 and 35 x35 cm). Transplanting of 12 days old seedlings resulted in the highest growth stature, yield attributes, yield and returns. Planting pattern of 25 x 25 cm recorded higher growth stature, yield attributes, yield and returns and the lowest with planting pattern of 35x 35 cm.

Key Words : SRI, Rice, Seedling age, Spacing, Yield attributes, Grain yield, Returns

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The increase in rice productivity therefore needs to be achieved through adoption of suitable and newer technologies. The system of rice intensification (SRI), developed in Madagascar over a 20 year period and synthesized in the early 1980's by Father Henry De Laulanie is an important tool in this direction and offers opportunities to researchers and farmers to expand the yield potentials already existing in the rice genome (Stoop *et al.,* 2002, Norman Uphoff *et al.,* 2002). It is also a new sustainable methodology for increasing the productivity of irrigated rice through a change in plant, soil, water and nutrient management resulting in both improvement of soil health and increased yields supported by greater root growth and the soil microbial abundance and diversity. The application of SRI to over 24 million hectares of rice grown under irrigation in the country is projected to increase the irrigated area under rice by at least 50 per cent, leading to about 50 per cent increase in the production with the same amount of water now being used for irrigating the lowland rice crop (Thakkar, 2005). The system of rice intensification (SRI) has been recently introduced to India and is slowly gaining momentum. It has been field tested in the state of Andhra Pradesh by the state department of Agriculture and District Agricultural Advisory and Transfer of Technology centres of Acharya N.G. Ranga Agricultural University. The results indicate higher rice productivity with SRI. However, most of the farmers have expressed difficulties with certain practices envisaged under SRI, one of them being high labour requirement for transplanting of young seedlings, compared to the 25-30 days old seedlings under the traditional method of planting, owing to their tiny size. In addition, scientists and farmers dealing with SRI are of the opinion that the high productivity under SRI calls for adoption of greater nutrient supply as the Indian soils are low in organic matter and nutrient status. Systematic field research on some of the vital agro-techniques for rice culture under SRI in Andhra Pradesh is however limited. In this context, the present study was undertaken with the objectives to determine the optimum age of seedlings and planting pattern for higher productivity under SRI cultivation.

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MATERIAL AND METHODS

Field experiments were conducted for two consecutive *Kharif* seasons of 2005, 2006 at Agricultural College farm, Naira, Srikakulam district, Andhra Pradesh (18.24° N latitude and 83.84° E longitude). The soils were sandy clay loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus and available potassium. In both the years the test variety of rice tried was Swarna (MTU 7029). Experiment was conducted in a Randomized Block Design with factorial concept, replicated thrice. The treatments comprised of combination of four different ages of seedlings [A_1(8 days old), A_2 (12 days old), A_3 (16 days old) and A_4 (20 days old)] and four planting patterns [P_1 (20 x 20 cm), P_2 (25 x 25 cm), P_3 (30 x 30 cm) and P_4 (35 x35 cm)]. The nursery was prepared with raised beds of 1.5 m width and of convenient length. Bold and healthy seeds were soaked for 12 hours and incubated in moist gunny cloth for 24 hours. A fine thin layer of well decomposed farm yard manure (FYM) was spread over the seed bed and then the sprouted paddy seeds were broadcasted uniformly. After broadcasting the seeds, a thin layer of sieved FYM was again spread over the bed surface to cover the seed and water was sprinkled everyday for keeping the soil moist and also for better seedling stand. Coconut palm leaves were also used for covering the beds for retention of soil moisture. The recommended nutrient dose of N, P_2O_5 and K_2O (80-60-50 kg ha^{-1}) was applied. Nitrogen was applied in three equal splits, one each at basal, active tillering and panicle initiation, while P and K were applied basally.

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Age of seedlings:

Plant height measured at flowering stages was not significantly influenced by varied age of seedlings planted during both the years of study. During both the years of study planting of 12 days old seedlings (A_2) resulted in the largest value of LAI, which was comparable with planting of 8 days old seedlings (A_1) and significantly higher than with the planting of other two ages of seedlings. The lowest LAI was recorded with the planting of 20 days old seedlings (A_4), which was however, comparable with that of planting 16 days old seedlings (A_3). The highest number of total tillers m^{-2} and dry matter production was recorded with planting of 12 days old seedlings (A_2), followed by planting of 8 (A_1), 16 (A_3) and 20 days (A_4) old seedlings, with significant disparity between any two of them (Table 1).

Production of the highest growth stature with 12 days old seedlings might be due to their potential for profuse rooting and tillering ability under SRI method. Agronomically, it is not uncommon that the seedlings with high initial seedling vigour, especially in case of transplanted rice of any version, setout their growth very quickly and produce larger rhizosphere and planophile, which will be expressed in the form of taller plants with better tiller production containing more number leaves of larger photosynthetic area, resulting in accrual of higher dry matter production. In the present study, planting of 12 days old seedlings has resulted in all the above said biological and physiological events, which led to enhanced growth stature of rice under SRI. Variation in growth stature with different age of seedlings in a given environment under SRI has been amply documented by a number of earlier researchers (Gani *et al*, 2002; Mulu, 2004 and Sarath and Thilak, 2004).

The highest number of panicles m^{-2} was produced with planting of 12 days old seedlings (A_2), followed by planting

Table 1 : Effect of age of seedlings and planting patterns on growth parameters of rice under SRI

Treatments	Plant height (cm)		LAI at flowering		Tillers m^{-2} at flowering		Dry matter production (kg ha^{-1})	
	2005	2006	2005	2006	2005	2006	2005	2006
Age of seedlings								
A_1 .8 days old seedlings	100.0	102.0	3.63	3.91	694	735	9487	10923
A_2- 12 days old seedlings	98.3	101.8	3.81	4.10	778	812	10898	12123
A_3- 16 days old seedlings	92.7	101.5	3.15	3.55	580	612	7806	8599
A_4- 20 days old seedlings	93.3	101.8	3.00	3.31	532	550	6362	7894
S.E. ±	0.69	1.05	0.09	0.11	13.1	8.9	189	226
C.D. (P=0.05)	NS	NS	0.26	0.30	37	26	545	653
Planting pattern								
P_1 - 20 x 20 cm	94.6	100.1	3.79	3.96	641	668	9175	10407
P_2 -25 x 25 cm	94.9	101.1	4.08	4.45	857	880	10179	11238
P_3- 30 x 30 cm	96.3	102.2	2.96	3.31	516	588	8076	9394
P_4- 35 x 35 cm	96.8	103.4	2.75	3.14	510	560	7104	8501
S.E. ±	0.69	1.05	0.09	0.18	13.1	8.9	189	226
C.D. (P=0.05)	NS	NS	0.26	0.52	37	26	545	653

NS=Non-significant

of 8 (A_1), 16 (A_3) and 20 days (A_4) old seedlings, with significant disparity between any two of them and the lowest number of panicles m^{-2} was produced when 20 days old seedlings were planted. Transplanting of 12 days old rice seedlings (A_2) resulted in the highest number of total grains and filled panicle^{-1}, however, which were at par with planting of 8 days old seedlings (A_1) and were significantly higher than with the planting of 16 days old seedlings (A_3) and 20 days old seedlings (A_4). The lowest number of total and filled grains panicle^{-1} grains were produced with 20 days old seedlings (A_4). The lowest spikelet sterility was recorded with transplanting of 12 days old seedlings (A_2) and it was significantly lesser than with all other age of seedlings tried, followed by the seedlings of A_1, A_3 and A_4 with significant disparity between any two of them. The highest spikelet sterility was recorded with older seedlings (A_4). Thousand grain weight of rice was not significantly influenced by varied age of seedlings planted during both the years of study (Table 2).

As has been mentioned earlier, favourable growing environment with planting of 12 days old seedlings that was exhibited during the vegetative stage would have converted larger proportion of tillers into effective tillers and thereby increasing the panicle production. Effective translocation of assimilates to the sink might have resulted in sound filling of grains as revealed by the lowest sterility of spikelets and highest number of filled grains panicle^{-1}. Better performance in respect of yield attributes of rice under SRI with younger seedlings over the older seedlings has also been reported earlier by Mulu (2004) and Sarath and Thilak (2004).

Planting of 12 days old seedlings (A_2) resulted in the highest grain yield, which was at par with 8 days old seedlings (A_1). The lowest grain yield was recorded with older seedlings

Table 2 : Effect of age of seedlings and planting patterns on yield attributes of rice under SRI

Treatments	Paniclesm^{-2}		Total grainspanicle^{-1}		Filled grains panicle^{-1}		1000 grain weight (g)		Spikelet sterility (%)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Age of seedlings										
A_1 .8 days old seedlings	386	403	162	169	124	148	21.09	19.38	23.27	13.12
A_2- 12 days old seedlings	449	468	163	182	134	166	20.10	19.37	17.73	9.53
A_3- 16 days old seedlings	299	310	159	155	109	114	21.19	19.47	32.03	27.13
A_4- 20 days old seedlings	290	306	150	150	94	104	21.21	19.39	38.38	31.85
S.E. ±	4.21	1.8	4.01	4.57	3.84	5.97	0.30	0.35	0.34	0.47
C.D. (P=0.05)	12	5	12	13	11	17	NS	NS	0.98	1.36
Planting pattern										
P_1 - 20 x 20 cm	374	388	167	179	128	150	20.99	19.35	23.65	16.81
P_2 .25 x 25 cm	387	406	170	187	134	161	21.33	19.25	21.44	14.82
P_3- 30 x 30 cm	339	350	153	156	107	120	21.00	19.28	30.17	23.17
P_4- 35 x 35 cm	322	344	143	134	92	99	21.27	19.73	36.15	26.84
S.E. ±	4.21	1.8	4.01	4.57	3.84	5.97	0.30	0.35	0.34	0.47
C.D. (P=0.05)	12	5	12	13	11	17	NS	NS	0.98	1.36

NS=Non-significant

Table 3 : Effect of age of seedlings and planting patterns on grain yield and returns of rice under SRI

Treatments	Grain yield (kg ha^{-1})		Harvest index (%)		Gross returns (Rs ha^{-1})		Net returns (Rs ha^{-1})		Benefit-cost ratio	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Age of seedlings										
A_1 .8 days old seedlings	6848	7161	48.62	49.19	52276	54561	39231	41516	4.00	4.17
A_2- 12 days old seedlings	7039	7368	47.96	49.13	53844	56153	40799	43108	4.12	4.29
A_3- 16 days old seedlings	5163	5770	46.92	49.07	39632	43979	26587	30934	3.02	3.36
A_4- 20 days old seedlings	4993	5487	48.18	48.06	38031	41882	24987	28838	2.89	3.18
S.E. ±	201	209	0.47	0.56	346	396	285	365	0.14	0.17
C.D. (P=0.05)	574	595	NS	NS	1002	1139	821	1052	0.4	0.49
Planting pattern										
P_1 - 20 x20cm	6644	7333	48.85	49.14	50684	53363	36434	39113	3.55	3.74
P_2 .25 x 25cm	6848	7702	48.24	49.05	52324	55895	39191	42757	3.98	4.25
P_3- 30 x 30cm	5543	6020	47.75	48.87	42434	45912	29854	33332	3.37	3.64
P_4- 35 x 35cm	4993	5430	46.84	48.92	38336	41405	26125	29194	3.13	3.38
S.E. ±	201	209	0.47	0.56	346	396	285	365	0.14	0.17
C.D. (P=0.05)	574	595	NS	NS	1002	1139	821	1052	0.4	0.49

NS=Non-significant

(A_4) which was however, comparable with 16 days old seedlings (A_3) with all the planting patterns tried (Table 3). This was due to enhanced stature of yield attributes, forming larger sink size coupled with efficient translocation of photosynthates to the sink, when grown following the optimal agro techniques. Performance of rice under SRI, in terms of grain yield, in the present case, corresponded the display of different yield attributes with varied age of seedlings. Norman Upholf (2005) indicated that enhanced yield under SRI with optimum seedling age was due to the fact that larger rhizosphere with large canopies lead to accrual of more photosynthates, resulting in higher grain yield of rice under SRI. Performance of age of seedlings with variation in the yield has been universally accepted and voluminous research findings to confirm this feature are available across the literature (Sebastein, 2002; Robert Randriamibarisoa and Norman Upholf, 2002 and Norman Upholf, 2005).

Planting of 12 days old seedlings (A_2) resulted in the highest gross returns, net returns, which were significantly higher than with the other three ages of seedlings tried, with distinct disparity between any two of them. Planting of 12 days old seedlings (A_2) resulted in the highest BCR, which was however, comparable with planting of 8 days old seedlings (A_1) and significantly higher than with other two ages of seedlings tried. The lowest gross returns, net returns and BCR were obtained with planting of 20 days old seedlings (A_4) (Table 3). Higher economic returns when 12 days of age of seedlings are transplanted under SRI were obviously due to higher grain and straw yield of rice. These findings are in conformity with those of Kumar *et al.* (2008) and Bommayasamy and Nalliah Durairaj (2008).

Planting pattern:

Plant height measured at flowering stages was not significantly influenced by different planting patterns tried and their interaction during both the years of study. The planting pattern of 25 x 25 cm (P_2) resulted in the highest LAI, which was comparable with the planting pattern of 20 x 20 cm (P_1) and significantly higher than that resulted with the other two planting patterns tried. The lowest value of LAI was associated with the planting pattern of 35 x 35 cm (P_4), which was however, comparable with the planting pattern of 30 x 30 cm (P_3). The plating pattern of 25 x 25 cm (P_2) produced the highest number of total tillers m^{-2} and dry matter production followed by 20 x 20 cm (P_1), 30 x 30 cm (P_3) and 35 x 35 cm (P_4) with significant disparity between any two of them. Plant density plays a major role in determining the efficiency of solar energy conversion to plant product per unit of land area. As a general rule, yield of above ground biomass will be greater for high density stands than for low density stands. planting pattern of 25 x 25 cm seemed to be optimum in the experimental domain compared to one closer and two wider planting patterns tried, which resulted in the production of taller plants with better tiller production containing more number leaves of larger photosynthetic area, resulting in accrual of higher dry matter production. The present findings are in accordance with those of Verma *et al.* (2002); Zhu *et al.* (2002), and Lu-xiang *et al.* (2004).

The planting pattern of 25 x 25 cm (P_2) produced the number of panicles m^{-2}, followed by 20 x 20 cm (P_1), and 30 x 30 cm (P_3) with significant disparity between any two of them and the planting pattern of 35 x 35 cm (P_4) resulted in the production of the lowest number of panicles m^{-2}, which was however, comparable with P_3. With respect to different planting patterns tried, planting pattern of 25 x 25 cm (P_2) resulted in the highest number of total and filled grains panicle^{-1}, which were at par with planting pattern of 20 x 20 cm (P_1) and significantly higher than with the other two planting patterns tried. The lowest total number of grains panicle^{-1} was produced with the planting pattern of 35 x 35 cm (P_4).Thousand grain weight of rice was not significantly influenced by different planting patterns tried during both the years of study. Planting pattern of 25 x 25 cm (P_2) resulted in the lowest spikelet sterility, which was significantly lower than with other planting patterns tried, followed by the planting patterns of P_1, P_3 and P_4 with significant disparity between any two of them. The highest spikelet sterility was noticed with the planting pattern of 35 x 35 cm (P_4) (Table 2). Favourable growing environment under the planting pattern of 25 x 25 cm that was exhibited during the vegetative stage would have converted lager proportion of tillers into effective tillers and thereby increasing the panicle production. Effective translocation of assimilates to the sink might have resulted in sound filling of grains as revealed by the lowest sterility of spikelets and highest number of filled grains panicle^{-1}.The poorest stature of all the yield attributes resulted with the planting pattern of 35 x 35 cm following the corresponding trend of growth stature. Better performance under optimum planting pattern in respect of yield attributes of rice under SRI confirms the findings of Robert (2002) and Lu-xiang *et al*. (2004) and Norman Uphoff (2005).

The highest grain yield was produced with planting pattern of 25 x 25 cm (P_2), which was however, comparable with planting pattern of 20 x20 cm (P_1) and both of them were significantly superior to other two planting patterns tried. The lowest grain yield was recorded with the planting pattern of 35 x 35 cm (P_4), which was in parity with the planting pattern of 30 x 30 cm (P_3). Harvest index of rice was not significantly influenced by different planting patterns tried, during both the years of study (Table 3).This was due to enhanced stature of yield attributes, forming larger sink size coupled with efficient translocation of photosynthates to the sink ,when the crop was raised under optimum planting pattern. Performance of rice under SRI, in terms of grain yield, in the present case was corresponding with the stature of different yield attributes under different planting patterns tried. These results corroborate with those reported by Mustapha Cessay (2002), Fernandes and Norman Upholf (2002) and Reddy (2004).

Planting of rice with a spacing of 25 x 25 cm (P_2) resulted in the highest gross, net returns and BCR which were significantly superior to all the other three planting patterns tried, with distinct disparity between any two of them. The lowest gross, net returns and BCR were registered with the planting pattern of 35 x 35 cm (P_4) (Table 3). It is obvious that realization of higher gross returns was the result of higher grain and straw yield with the best treatment. These findings are in accordance with those of Kumar *et al.* (2008) and Bommayasamy and Nalliah Durairaj (2008).

Perusal of two years data of effect of age of seedlings and planting patterns on rice under SRI revealed that transplanting of 12 days old seedlings resulted in the highest growth stature, yield attributes, yield and returns. Planting pattern of 25 x 25 cm recorded higher growth stature, yield attributes, yield and returns and the lowest with planting pattern of 35x 35 cm.

REFERENCES

Bommayasamy, N. and Nalliah Durairaj, S.(2008). Optimisation of establishment techniques for system of rice intensification. In : Extended summaries of 3rd national symposium on system of rice intensification in India. pp. 169-171.

Fernandes, E.C.and Norman, Uphoff (2002).Summary from conference reports. In:Assessment of System of Rice Intensification (SRI) Proceedings of an International Conference, Sanya, China, April 1-4, 2002 (Eds), Norman Upholf *et al.*, pp. 33-39.

Kumar, Ashok, Singh, A.K., Singh, C.S. and Prasad, Rabindra (2008). Agronomic evaluation of different methods of rice establishment under medium land situation of Thaikha. *In* : Extended summaries of 3rd national symposium on system of rice intensification in India. pp. 141-143.

Lu-xiang, Huang, Q., Liu, J. and Liu, H.Z.(2004). Research on the system of rice intensification. *J. South China Agric. University*, **25** : 5-8.

Mulu, D.(2004). Effect of seedling age, spacing and seasons on phyllochrons, yield and components of yield with SRI, M.Sc (Ag) Thesis In *:* Report on SRI – Visit to Philippines, March 19-28, 2004 (Ed) Norman Uphoff , pp. 5-8.

Mustapha Cessay, M (2002). Experiment with the system of rice intensification in the Gambia, In: Assessment of the system of rice intensification (SRI), Proceedings of an International conference, Sanya, China, April, 1-4, 2002 (Ed.) Norman Upholf *et al.*, pp: 56-57

Norman, Upholf.(2002). Opportunities for raising rice yields by changing management practices: The system of rice intensification in Madagascar. Agro ecological innovations : Increasing food production with participatory development, pp. 145-161.

Norman, Upholf and Robert Randriamiharisoa (2002). Reducing water use in irrigated rice production with Madagaskar System of Rice Intensification(SRI): In: *Water wise rice production* – IRRI, pp:71-87.

Reddy, Krupakara (2004). Varietal performance and spatial requirement of rice under the system of rice intensification (SRI) during *Kharif* season. M.Sc. (Ag.) Thesis, Acharya N.G. Ranga Agricultural Univeristy, Hyderabad, A.P. (INDIA).

Robert, Randriambarisoa (2002). Water saving rice production systems. In: Proceedings of International workshop on Water saving Rice production system in Nanjing University, China, April, 2-4, 2001 (Eds) Heng Sdij K H and Bindraban P pp: 69-71.

Robert Randriamibarisoa. and Uphoff, Norman (2002). Factorial trials evaluating the separate and combined effects of SRI practices In: Assessment of system of rice intensification (SRI), Proceedings of an International Conferences, Sanya, China, April 1-4, 2002 (Eds) Norman Upholf *et al.*, pp. 40-46.

Sarath, P.N. and Thilka, B. (2004). Comparison of productivity of System of Rice Intensification and conventional rice farming systems in the dry-zone region of SRI Lanka. 4th International Crop Science Congress, Brisbane, Australia, 26 September –01 October, 2004.

Sebastien, R.(2002). An NGO perspective on SRI and its origins in Madagaskar, *In:* Assessment of the system of Rice Intensification (SRI), Proceedings of an International Conference, Sanya, China, April 1-4, 2002 (Eds), Norman Uphoff *et al.,* pp. 17-22.

Stoop, A.W., Norman, Uphoff and Kassam, Amir (2002). A review of Agricultural Research issues raised by the System of Rice Intensification (SRI) fromMadagaskar: Opportunities for improving farming systems for resource poor farmers. *Agric. Systems,* **71**(3): 249-274.

Verma, A.K., Pandey, N. and Tripathi, S. (2002). Effect of transplanting and spacing and number of seedlings on productive tillers, spikelet sterility, grain yield and harvest index of hybrid rice. *Internat. Rice Res. Notes,* **27**: 51.

Zhu, D., Chang, S., Zhang,Y. and Lin, X. (2002). Tillering patterns and the contribution of tillers to grain yields with hybrid ice and wide spacing, In: Assessment of the system of rice intensification (SRI), Proceedings of an International Conference, Sanya, China, April 1-4, 2002 (Eds), Norman Uphoff *et al.,* pp. 125-131.

WEBLIOGRAPHY:

Norman, Upholf (2005). On- farm evaluation of SRI in Tamiraparani Command area, Tamil Nadu, India. In: *http:// ciifad.cornell.edu/sri/*

Thakkar, Himanshu (2005). More rice for less water. Infochange News and Features, June 2005, In: *http:// www.infochangeindia.html* .