Madras Agric. J., 99 (4-6): 325-328, June 2012
https://doi.org/10.29321/MAJ.10.100077

Yield and Economics of Transplanted Rice as Influenced by Crop Establishment Methods, Weed and Nutrient Management Practices

V. Sridevi[1*], S. Jeyaraman[2], S. Ramasamy[3], C. Chinnusamy[2], P. Muthukrishnan[2], Subalakshmi Lokanadhan[2] and N. Thavaprakaash[2]
[1]Department of Agronomy, PAJANCOA&RI, Karaikal
[2]Directorate of Crop Management, Tamil Nadu Agricultural University, Coimbatore
[3]Adhiparasakthi College of Agriculture and Research Institute, Kalavai

Field experiments were conducted in clay loam soil of Tamil Nadu Agricultural University, Coimbatore during *rabi,* 2009 and 2010 to evaluate the different crop establishment methods, weed and nutrient management practices in transplanted rice. The treatments consisted of four crop establishment methods and weed management practices in main plot and four nutrient management practices in sub plot. The results revealed that SRI planting (25 cm x 25 cm) and weeding with two way rotary weeder thrice at weekly interval starting from 15 DAT along with recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) + 12.5 t FYM ha^{-1} + *Azophosmet* (seed and soil application) + PPFM (foliar spray) at active tillering, panicle initiation and 50 per cent flowering stage registered higher grain yield and net return. However, B:C ratio was higher with SRI planting and weeding with two way rotary weeder thrice at weekly interval starting from 15 DAT and application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}).

Key words: Transplanted rice, yield, harvest index, economics

Rice (*Oryza sativa* L.) is the staple food for nearly 3 billion people and the demand continues to grow as population increases (Carrieger and Vallee, 2007). In India, rice is cultivated round the year in one or the other part of the country, in diverse ecologies spread over 44.6 m ha (Rai, 2004) with a production of 131 m t of rice with average productivity of 3.37 t ha^{-1} (IRRI, 2011). It is estimated that by 2020 at least 170 to 180 m t (115-120 m t milled rice) of rice is to be produced in India with an average productivity of 4.03 t ha^{-1} to maintain the present level of self sufficiency (Mishra *et al*., 2006), which means, the productivity should go up by a tonne from the current level.

Manual transplanting is the most common practice being followed under lowland ecosystem. Non-availability of irrigation water, shortage of labour during peak period of transplanting and escalating labour cost make transplanting more expensive which invariably leads to delay in transplanting and results in reduction of yield and profit (Gangwar *et al*., 2008). To mitigate this problem, the System of Rice Intensification (SRI), a revived method of transplanted rice cultivation by exploiting the genetic potential of rice provides a favourable growing environment to increase the productivity and economic returns. Besides, it enhances soil health with reduction in input use such as seeds, water, labour, etc (Gujja and Thiyagarajan, 2009). Hence, the experiment was carried out to evaluate the productivity of transplanted rice under different crop establishment methods, weed and nutrient management practices.

*Corresponding author email: srideviagr@gmail.com

Materials and Methods

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during *rabi*, 2009 and 2010 to elucidate the effect of crop establishment methods, weed and nutrient management practices on the yield and economics of lowland transplanted rice. The medium duration rice variety CO(R)50 was used as test variety. Soil of the experimental fields was clay loam in texture classified taxonomically as *Vertic Ustochrept*, low in available nitrogen (202.6-216.0 kg ha^{-1}), medium in available phosphorus (12.6-16.1 kg ha^{-1}) and high in available potassium (420.4-511.0 kg ha^{-1}).

Field experiments were laid out in split plot design with the following treatments *viz*., rice establishment and weed management methods (M_1: Conventional planting + hand weeding, M_2: Conventional planting + one way rotary weeder weeding, M_3: SRI planting + hand weeding, M_4: SRI planting + two way rotary weeder weeding) in main plot and nutrient management practices (S_1: Absolute control, S_2: 150:50:50 kg NPK ha^{-1}, S_3: S_2 + 12.5 t FYM ha^{-1}, S_4: S_3 + *Azophosmet* (Seed treatment @ 2 g kg^{-1} and soil application @ 2 kg ha^{-1}) + PPFM (foliar spray @ 0.1% at active tillering, panicle initiation and at 50 per cent flowering stage)) in sub plot, replicated thrice.

Conventional planting was taken up at 25 cm x 15 cm spacing with 21 days old seedlings obtained from conventional wet nursery. Under SRI, 14 days old seedlings obtained from modified rice mat nursery were transplanted at 25 cm x 25 cm spacing. Rotary weeder weeding was done thrice starting from 15 DAT at weekly interval in one direction under conventional planting (25 cm x 15 cm) and both the directions under SRI planting (25 cm x 25 cm). Hand weeding was done twice at 20 and 40 DAT.

Farm yard manure was applied @ 12.5 t ha^{-1} uniformly as per the treatment schedule, incorporated and then leveled. Recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) for the medium duration rice variety was followed as per the treatments. Nitrogen was applied in four splits *viz*., 40 kg ha^{-1} each at basal, active tillering and panicle initiation stage and 30 kg ha^{-1} at flowering stage. The entire dose of phosphorus was applied as basal. Potassium was applied in four splits *viz*., 25 per cent each at basal, active tillering, panicle initiation and flowering stages.

The experimental plots were irrigated to 2 cm depth uniformly in all the treatments after the appearance of hair line cracks, up to panicle initiation stage. After panicle initiation, the plots were irrigated to 5 cm depth on disappearance of ponded water. Irrigation was stopped 15 days prior to harvest.

Data on yield were subjected to an analysis of variance (F-test) as per the methods suggested by Gomez and Gomez (2010). Economics for all the treatments was worked out on the basis of prevailing input cost and market price of grain and straw at the time of experimentation.

Results and Discussion

Grain yield

Crop establishment methods, weed management and nutrient management practices had significant influence on grain yield (kg ha^{-1}) during both the years of experimentation (Table 1). The SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_4) produced distinctly more grain yield during both the years. However, it was comparable with conventional planting with one way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_2) during both the years. Conventional planting combined with hand weeding at 20 and 40 DAT (M_1) recorded lucidly lesser grain yield during both the years. However, comparable grain yield was obtained with M_2 and SRI planting combined with

Table 1. Effect of crop establishment methods, weed and nutrient management practices on grain yield (kg ha^{-1}) of transplanted rice

Treatment	*Rabi*, 2009					*Rabi*, 2010				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
S_1	4433	4839	4748	4679	4675	4003	4393	4387	4732	4379
S_2	5290	5542	5470	6015	5579	4866	5525	5376	5700	5367
S_3	5607	6063	5787	6752	6052	5318	5953	5400	6376	5762
S_4	5812	6477	5882	6982	6288	5463	6428	5516	6795	6050
Mean	5286	5731	5472	6107		4912	5575	5170	5901	
	M	S	M at S	S at M		M	S	M at S	S at M	
SEd	189	112	270	223		194	100	260	201	
CD (5%)	461	231	608	461		475	207	593	414	

hand weeding at 20 and 40 DAT (M_3) during *rabi* 2009 and with M_3 during *rabi* 2010. The SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_4) in transplanted rice recorded 15.5 and 20.1 percent higher grain yield than conventional planting with hand weeding (M_1) during *rabi* 2009 and *rabi* 2010, respectively. This might be due to less crop weed competition, larger root system and crop canopy and higher microbial population which facilitated the enhanced nutrient uptake, photosynthetic activity and remobilization of photosynthates to grain which resulted in higher yield attributes and yield. This is in accordance with the findings of Hugar *et al*. (2009) who stated that SRI gave higher grain yield due to large root volume, strong tillers with improved yield attributes. Chandrapala *et al*. (2010) also reported increased grain yield with SRI which was attributed to lesser competition, enhanced solar radiation interception, nutrients uptake and higher yield attributes.

Combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM and biofertilizers *viz*., *Azophosmet* as soil and seed treatment and PPFM as foliar spray (S_4) attained its statistical supremacy by recording higher grain yield during both the years. Significantly more grain yield was observed with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM (S_3) than application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) (S_2). Distinctly lower grain yield was obtained with absolute control without fertilizer (S_1) over all other nutrient management practices during both the years. Higher grain yield in S_4 might be attributed to greater root development and activity, higher microbial population and increased nutrient availability throughout the crop growth which resulted in improved yield attributes. This finding is in accordance with the results of Virdia and Mehta (2010) who found that improvement in nutrient supply with organics improved soil physico-chemical and biological properties, in turn increased the nutrient availability which ultimately enhanced the grain yield. Further, Belimov *et al*. (1995) claimed earlier that inoculation of bacterial mixture of N_2 fixing and P solubilizing bacteria provided more balanced nutrition for the plants.

Crop establishment methods, weed management and nutrient management practices had significant interaction with each other at all the crop growth stages during both the years. The SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT in association with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM and biofertilizers *viz*., *Azophosmet* as soil and seed treatment and PPFM as foliar spray (M_4S_4) registered higher grain yield during both the years. This might be due to larger canopy with greater root development and activity, less intra plant competition, improved remobilization of assimilates to grain and higher nutrient availability. Whilst, lesser grain yield was recorded under conventional planting combined with hand weeding at 20 and 40 DAT and absolute control without fertilizer (M_1S_1) during both the years.

Straw yield

Significant difference due to the crop establishment methods and weed management practices was evident only during *rabi* 2010 (Table 2). SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_4) resulted in significantly higher straw yield. However, comparable straw yield was observed with conventional planting with one way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_2) with that of M_4 due to higher tillers and DMP. Likewise, SRI planting combined with hand weeding at 20 and 40 DAT (M_3) registered lesser straw yield which was comparable with conventional planting combined with hand weeding at 20 and 40 DAT (M_1). This result is in corroboration with the findings of Revathi (2009) who reported that higher straw yield in SRI due to higher tillers and DMP.

Combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM and biofertilizers *viz*., *Azophosmet* as soil and seed treatment and PPFM as foliar spray (S_4) recorded higher straw yield during both the years. However, comparable straw yield was noticed with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM (S_3) and application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) (S_2). Invariably, lesser straw yield was registered with absolute control without fertilizer (S_1) over all other nutrient management practices during both the years. Kumar *et al*. (2010) also reported that straw yield was higher with application of 100% NPK + 20 t FYM ha^{-1} + 10 kg ha^{-1} BGA.

Table 2. Effect of crop establishment methods, weed and nutrient management practices on straw yield (kg ha^{-1}) and harvest index of transplanted rice

Treatment	Straw yield (kg ha^{-1})		Harvest Index 2010	
	2009	2010	2009	2010
Crop establishment and weed management methods				
M_1	7237	6565	0.423	0.428
M_2	7608	7229	0.430	0.435
M_3	7076	6523	0.436	0.441
M_4	7761	7526	0.440	0.439
SEd	281	209	0.005	0.004
CD (5%)	NS	512	0.012	0.009
Nutrient management practices				
S_1	6106	5651	0.434	0.437
S_2	7718	7178	0.419	0.427
S_3	7848	7503	0.435	0.434
S_4	8010	7510	0.440	0.445
SEd	170	172	0.003	0.006
CD (5%)	352	354	0.007	0.012

Interaction was absent

Crop establishment methods, weed and nutrient management practices did not exhibit significant interaction effect on straw yield during both the years.

Harvest index

SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_4) recorded higher harvest index during both the years which could be attributed to better soil aeration provided by rotary weeding and better translocation of photosynthates from vegetative parts to grains (Table 2). However, comparable harvest index was observed with SRI planting combined with hand weeding at 20 and 40 DAT (M_3) and conventional planting with one way rotary weeder weeding thrice at weekly interval starting from 15 DAT (M_2) during both the years. Whereas, conventional planting combined with hand weeding at 20 and 40 DAT (M_1) resulted in lower harvest index than with other planting systems during both the years. However, it was comparable with M_2 during *rabi* 2010.

Combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM and biofertilizers *viz*., *Azophosmet* as soil and seed treatment and PPFM as foliar spray (S_4) registered higher harvest index during both the years because of the efficient translocation of food assimilates by biofertilizers. However, comparable harvest index was observed with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM (S_3) and absolute control without fertilizer (S_1) with that of S_4 during both the years. Obviously, application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) (S_2) recorded lesser harvest index over other nutrient management practices during both the years. However, comparable harvest index was noticed with S_1 and S_3 during *rabi* 2010. This result is in conformity with the findings of Kalaiyarasi (2009) who reported that application of scheduled fertilizer pulled down the harvest index compared to no-manure. The negative impact was either reduced or nullified only when farm yard manure and biofertilizers were added to the fertilizer schedule.

Table 3. Effect of crop establishment methods, weed and nutrient management practices on economics of transplanted rice

Treatment	*Rabi*, 2009			*Rabi*, 2010		
	Total cost (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio	Total cost (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
$M_1 S_1$	23260	21936	1.94	23920	16935	1.71
$M_1 S_2$	26727	27809	2.04	27387	22469	1.82
$M_1 S_3$	33477	23888	1.71	34137	20258	1.59
$M_1 S_4$	34107	25150	1.74	34767	20606	1.59
$M_2 S_1$	22960	26330	2.15	23620	21073	1.89
$M_2 S_2$	26427	28746	2.09	27087	29242	2.08
M_2S_3	33177	28810	1.87	33837	26693	1.79
M_2S_4	33807	32141	1.95	34467	30706	1.89
$M_3 S_1$	22780	25141	2.10	23440	20951	1.89
$M_3 S_2$	26247	29760	2.13	26907	27828	2.03
$M_3 S_3$	32997	25703	1.78	33657	21145	1.63
$M_3 S_4$	33627	25508	1.76	34287	21369	1.62
$M_4 S_1$	21980	25601	2.16	22640	25397	2.12
M_4S_2	25447	37475	2.47	26107	32009	2.23
$M_4 S_3$	32197	36078	2.12	32857	31852	1.97
$M_4 S_4$	32827	37679	2.15	33487	35164	2.05

Data not statistically analysed

Significant interaction did not exist in between the crop establishment methods, weed management and nutrient management practices.

Economics

Crop establishment methods, weed management and nutrient management practices showed variations in cost of cultivation, income obtained and benefit: cost ratio (Table 3). The SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT and absolute control without fertilizer (M_4S_1) incurred lesser cost of cultivation due to less seed requirement, labour requirement for transplanting and weeding and no cost involved in manuring. The SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT in association with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM and biofertilizers *viz*., *Azophosmet* as soil and seed treatment and PPFM as foliar spray (M_4S_4) resulted in higher net return due to higher yield.

The B:C ratio was higher with SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT and application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) (M_4S_2) during both the years because of no cost involved in FYM application. This is in line with the findings of Kaliayarasi (2009) who have reported that the net income was higher with scheduled fertilizer + FYM + biofertilizers while higher B: C ratio with scheduled fertilizer. Further, Chandrapala *et al.* (2010) stated that net returns and B:C ratio were higher with SRI due to higher grain yield, less seed requirement, less labour cost for weed control with the use of conoweeder.

Conclusion

Thus, SRI planting with two way rotary weeder weeding thrice at weekly interval starting from 15 DAT in association with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha^{-1}) along with 12.5 t ha^{-1} FYM and biofertilizers *viz*., *Azophosmet* as soil and seed treatment and PPFM as foliar spray is recommended to increase the productivity and profitability of medium duration rice variety CO(R)50 under transplanted condition during *rabi* season.

References

Belimov, A.A., Kojemiakov, A.P. and Chuvarliyeva, C.V. 1995. Interaction between barley and mixed cultures of nitrogen fixing and phosphate solubilizing bacteria. *Plant and Soil.* **173:** 29-37.

Carrieger, F. and Vallee, D. 2007. More crop per drop. *Rice Today.* **6**: 10-13.

Chandrapala, A.G., Yakadri, M., Kumar, R.M. and Raj, G.B. 2010. Productivity and economics of rice (*Oryza sativa*) – maize (*Zea mays*) as influenced by methods of crop establishment, Zn and S application in rice. *Indian J. Agron*., **55**:171-176.

Gangwar, K.S., Gill, M.S., Tomar, O.K. and Pandey, D.K. 2008. Effect of crop establishment methods on growth, productivity and soil fertility of rice (O*ryza sativa*) - based cropping systems. *Indian J. Agron*., **53**:102-106.

Gomez, K.A. and Gomez, A.A. 2010. Statistical procedures for agricultural research.(2nd Ed.). Wiley India Pvt Ltd., India.

Gujja, B. and Thiyagarajan, T.M. 2009. Indian food security? The System of Rice Intensification. *Gate keeper series* **143**: 4-5.

Hugar, A.Y., Chandrappa, H., Jayadeva, H.M., Sathish, A. and Mallikarjun, G.B. 2009. Influence of different establishment methods on yield and economics of rice. *Agric. Sci. Digest* **29** : 202-205.

IRRI. 2011. Trends in the rice economy. *In*:http:// beta.irri.org/ solutions/ index.php

Kalaiyarasi, D. 2009. Studies on stand establishment techniques and nutrient management practices in wet seeded lowland rice. M.Sc. (Ag) Thesis**.** Tamil Nadu Agricultural University, Coimbatore.

Kumar, N, Chopra, K.K. and Singh, R. 2010. IPNS on growth, yield and economics of rice. *Indian J. Fert*. **6**:25-28.

Mishra, D., Asmed, I.M., Rao, K.V. and Bentor, J.S. 2006. Rice research in India: Green revolution to gene revolution. *J. Rice Res.,* **1**: 38-51.

Rai, M. 2004. International year of rice- An overview. Indian farming **54**: 3-6.

Revathi, A. 2009. Establishment techniques and weed management practices in puddled lowland rice. M.Sc. (Ag) Thesis**.** Tamil Nadu Agricultural University, Coimbatore.

Virdia, H.M. and Mehta, H.D. 2010. Integrated Nutrient Management in transplanted rice (*Oryza sativa* L.). *International J. Agric. Sci*. **6**: 295-299.

Received: December 30, 2011; Accepted: April 17, 2012