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Crop Establishment Methods and Weed Management Practices on Productivity and Economics of Transplanted Rice

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Field experiments were conducted in clay loam soil of wetland farm, Tamil Nadu Agricultural University, Coimbatore during *rabi,* 2011-12 and 2012-13 to evaluate different crop establishment methods and weed management practices in lowland transplanted rice. The experiment was laid out in strip plot design with three replications. The treatments consisted of three crop establishment methods in horizontal strips and six weed management practices in vertical strips. The results of the study indicated that mechanical transplanting at 30 x 20 cm with conoweeding four times at 10 days interval starting from 10 DAT resulted in higher grain yield, higher net returns and B:C ratio. This practice was comparable with mechanical transplanting at 30 x 20 cm with preemergence application of pretilachlor @ 0.75kg a.i. ha^{-1} + early post emergence application of bispyribac sodium @ 20g a.i. ha^{-1} coupled with conoweeding at 40 DAT.

Key words: Transplanted rice, Machine planting, Grain and straw yield, Economics

The area under rice crop is decreasing year by year due to various factors such as increased cost of inputs, labour shortage and less profitability. Transplanting of rice seedlings in the traditional way is labourious, time consuming and causes drudgery. Non- availability of labourers for transplanting at appropriate time leads to late planting, which results in poor yields. In rice, planting methods have an impact on the growth and yield, besides cost of cultivation and labour requirement. Rice transplanting is done manually and requires about 306 man-h ha^{-1}, which is roughly 42 per cent of the total labour requirement of rice production. At transplanting time, acute labour shortage results in increased wages and delay in the operation. Manual transplanting will not be uniform and results in inadequate population. These problems necessitated the introduction of mechanized rice transplanting, to achieve timely planting and better crop stands (Hemmat and Taki, 2003). In addition, weeds are the bounding factors in agricultural production, and compete with crop plants due to their rapid growth. Weeds decrease about 25 per cent of potential yield and pose serious threat to crop production (Jacob and Syriac, 2005). Besides, weeds compete for water, light and space creating disturbance in cultivation and maintenance with an ultimate result of yield withdrawal, reduction in quality and quantity of produce. Herbicides seems to be promising and viable options because of their immediate performance in decreasing weeds competition, easy usage, low cost and require less workforce. Agronomical manipulations such as crop establishment methods with appropriate weed management practices may offer an effective option for better control of weeds in rice, thereby enhancing rice yield. In cognizance of the above, the present study was undertaken.

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Materials and Methods

Field experiments were conducted during *rabi* 2011-12 and 2012-13 at Tamilnadu Agricultural university, Coimbatore to elucidate the effect of crop establishment methods and weed management practices on the productivity and economics of rice cultivation. The experiment was replicated thrice in strip plot design with three crop establishment techniques *viz.,* conventional planting (C_1), System of Rice Intensification (SRI) - marker planting (C_2), System of Rice Intensification (SRI) - machine planting (C_3) in horizontal strips; and six weed management practices in vertical strips *viz.,* conoweeding 4 times at 10, 20, 30 and 40 DAT (W_1), pre emergence (PE) Pretilachlor 50 % EC @ 0.75kg a.i. ha^{-1} + conoweeding at 20 and 40 DAT (W_2), PE Pretilachlor 50 % EC @ 0.75kg a.i. ha^{-1} + early post emergence (EPOE) Bispyribac sodium 10 % SC @ 20g a.i. ha^{-1} (W_3), PE Pretilachlor 50 % EC @ 0.75kg a.i. ha^{-1} + EPOE Bispyribac sodium 10 % SC @ 20g a.i. ha^{-1} + conoweeding at 40 DAT (W_4), EPOE Laundax power @ 10 kg ha^{-1} + conoweeding at 30 and 40 DAT (W_5) and un-weeded control (W_6). The variety CO (R) 49 was used in both the seasons of the study. The experimental soil was clay loam in texture with low available nitrogen, medium level phosphorus and high potassium.

SRI machine planting and marker planting involved 12 days old single seedlings hill^{-1} at 30 x 20 cm and 25 x 25cm spacing, respectively in comparison to conventional transplanting (CT) of 21 days old 2-3 seedlings hill^{-1} at 20 cm x 10 cm spacing. The seed requirement in SRI marker and machine planting was 8 and 10 kg ha^{-1}, respectively and 40 kg ha^{-1}for conventional planting. Raised bed nursery for SRI planting (Baskar, 2009), tray type nursery for SRI mechanical transplanting (Bell *et al.,* 2003) and conventional nursery for conventional transplanting (CPG, 2005) were prepared. Other cultural practices and plant protection measures were followed as per recommendations of CPG, 2005. The herbicide was dissolved in 500 litres of water and sprayed with knapsack sprayer using deflector nozzle at 3 days after sowing. The pre emergence herbicide was sprayed 3 days after transplanting. The post emergence herbicide was sprayed 15 days after transplanting. Data on total weed dry weight was recorded 60 days after transplanting using 0.25 m^2 quadrate at four places at random and analysed after subjecting the original data to square root (X + 2) transformation.

Results and Discussion

Weed flora

Important weed species observed in the experimental field were *Echinochloa colonum, Cyperus difformis, Eclipta alba, Marselia quadrifoliata* and *Ammania baccifera*.

Total weed dry weight

Crop establishment methods exerted significant influence on the total weed dry weight recorded on 60 DAT. In SRI machine transplanting total weed dry weight was significantly lower, which was on par with SRI marker planting. Conventional transplanting recorded higher weed dry weight (Table 1). This might be due to early suppression of weeds on one hand and better crop stand on the other hand thereby reducing weed population and dry weight of weeds. The results are in agreement with the findings of Mohapatra *et al.* (2012). Weeds under conventional planting had better conditions for their early emergence, survival and growth resulting in higher weed population thereby reduced crop growth. This result is in agreement with Balasubramanian *et al*. (2003), who reported that occurrence of more number of weed species, higher density unit area^{-1} favoured better growing conditions turning the competition in favour of weeds, thus resulted in increased weed dry weight.

Table 1. Effect of establishment methods and weed management practices on total weed dry weight and grain yield in rice

Treatments	Total dry weight (kg ha^{-1})								Grain yield (kg ha^{-1})							
	2011-12				2012-13				2011-12				2012-13			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
W_1	7.52 (54.5)	4.83 (21.3)	3.39 (9.5)	5.25 (28.4)	6.89 (45.5)	5.42 (27.4)	4.44 (17.7)	5.58 (30.2)	4748	6477	6982	6069	5193	7119	7617	6643
W_2	13.39 (146.2)	11.69 (134.8)	9.59 (90.0)	11.56 (123.7)	10.96 (97.2)	7.66 (56.7)	7.14 (48.9)	8.58 (67.6)	4286	5542	6015	5281	3984	6039	6041	5355
W_3	13.28 (143.8)	12.42 (152.3)	10.16 (101.2)	11.95 (132.4)	10.69 (92.5)	7.74 (57.9)	7.56 (55.2)	8.67 (68.5)	3842	4839	4679	4453	3725	5310	4565	4533
W_4	9.35 (70.3)	6.21 (36.5)	4.39 (17.2)	6.65 (41.3)	8.04 (51.5)	5.55 (28.8)	4.98 (22.8)	6.19 (34.3)	4629	6376	6795	5933	4665	7818	7615	6700
W_5	10.77 (93.9)	8.09 (63.4)	6.31 (37.8)	8.39 (65.0)	8.50 (57.7)	5.84 (32.1)	4.98 (22.8)	6.44 (37.5)	4433	6063	6752	5749	4435	7019	7081	6178
W_6	30.23 (753.1)	23.67 (558.5)	22.28 (494.5)	25.40 (602.1)	29.43 (713.7)	23.97 (572.5)	21.80 (473.1)	25.06 (586.4)	2479	2913	3054	2815	2126	2411	2973	2503
Mean	14.09 (210.3)	11.15 (161.1)	9.35 (125.1)		12.42 (176.3)	9.36 (129.2)	8.48 (106.7)		4070	5368	5713		4021	5953	5982	
	W	C	C at W	W at C	W	C	C at W	W at C	W	C	C at W	W at C	W	C	C at W	W at C
SE_d	0.78	0.75	0.58	0.84	0.81	0.61	0.61	0.73	128	176	162	221	121	103	147	158
CD(P=0.05)	1.90	1.84	1.39	1.95	1.98	1.50	1.44	1.70	314	431	383	484	296	252	339	347

Figure in parenthesis are orginal values

Among the vertical strips, considerable reduction in total weed dry weight was recorded with conoweeding four times at 10 days interval, which was on par with PE Pretilachlor followed by EPOE Bispyribac sodium. This might be attributed to the minimum number of total weeds with less biomass during the cropping period (Table 1). Conoweeding four times at 10 days interval recorded lesser weed dry weight due to the incorporation of weeds into soil due to frequent cono weeding. This finding is in line with the findings of Anitha and Chellappan (2011).

Crop establishment methods and weed management practices had significant interaction at all the stages of crop. SRI machine transplanting with conoweeding four times at 10 days interval significantly lowered the weed dry weight followed by PE Pretilachlor and EPOE Bispyribac sodium. This is in conformity with the findings of Uprety (2010), who revealed that machine planting with frequent

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

Treatments	2011-12				2012-13			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
W_1	10448	11245	12433	11375	11128	11022	13426	11859
W_2	8856	9408	10128	9464	8372	9701	10719	9597
W_3	7949	9725	10693	9456	7341	8795	10509	8882
W_4	10335	10988	11793	11039	10842	11804	13034	11893
W_5	8809	9857	10493	9720	10136	10290	11459	10628
W_6	6428	7306	8143	7292	6684	7430	8095	7403
Mean	8804	9755	10614		9084	9840	11207	
	W	C	C at W	W at C	W	C	C at W	W at C
SE_d	129	131	199	222	195	142	245	246
CD(P=0.05)	317	321	459	480	477	347	556	540

conoweeding had encouraged frequent loosening of soil stimulating aerobic conditions with concomitant reduction in the density of weeds, dry matter. Also incorporation of weeds manure to served as the crop.

Grain yield

Crop establishment methods and weed management practices had significant influence on grain yield during both the years of experimentation (Table 1). The SRI machine transplanting (C_3) produced distinctly higher grain yield than conventional transplanting (CT). However, it was comparable with SRI marker planting (C_2) . This might be due to less crop weed competition, larger root system and crop canopy and higher microbial population, which might have facilitated the enhanced nutrient uptake, photosynthetic activity and remobilization of photosynthates to grain resulting 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.

Conoweeding four times at 10 days interval starting from 10 DAT (W_1) recorded higher grain yield, which was on par with Pretilachlor followed by Bispyribac sodium + conoweeding on 40 DAT (W_4) than unweeded control (W_6). This finding is in accordance with the results of Thiyagarajan *et al.* (2002), who found that use of conoweeder resulted in increased yield of rice.

Crop establishment methods and weed management practices had significant interaction with each other at all the crop growth stages. The SRI machine transplanting with conoweeding four times at 10 days interval starting from 10 DAT (C_3W_1) registered higher grain yield than other combinations. This might be due to larger canopy with greater root development and activity, less intra plant competition, improved remobilization of assimilates to grain.

These results are in accordance with the findings of Mohaptra *et al.* (2012), who reported that machine planting with mechanical weeding had encouraged profuse tillering and influenced yield attributes such as number of panicle m^{-2} and number grains panicle^{-1}. The least grain yield was recorded under conventional planting with unweeded check (C_1W_6).

Straw yield

Significant difference with respect to straw yield due to crop establishment methods and weed management practices was evident during both the years (Table 2). The SRI machine transplanting (C_3) resulted in significantly higher straw yield. However, comparable straw yield was observed with SRI marker planting (C_2) with that of SRI machine transplanting (C_3)This was mainly due to more number of tillers and increased the dry matter production. This result is in corroboration with the findings of Revathi (2009), who also reported that higher straw yield in SRI due to higher tillers and DMP.

Conoweeding four times at 10 days interval starting from 10 DAT (W_1) recorded higher straw yield over all other weed management practices during both the years. However, comparable straw yield was noticed with combined application of Pretilachlor (0.75kg a.i. ha^{-1} pre-emergence) + Bispyribac sodium (20g a.i. ha^{-1} early post-emergence) + conoweeding at 40 DAT (W_4) during both the years. Invariably, lesser straw yield was registered with unweeded control (W_6) over all other weed management practices during both the years. Ramamoorthy (2004) and Mohanty and Mohanty (2010) reported that four times conoweeding had removed most of the weeds and incorporated them in to soil, responsible for loosening of top soil. This operation had further stimulated aerobic soil condition and provided weed free environment, which enhanced growth components resulting in increased straw yield.

Crop establishment methods and weed management practices had significant interaction with each other at all the stages of crop growth. SRI machine transplanting with conoweeding four times at 10 days interval starting from 10 DAT (C_3W_1)

Table 3. Effect of establishment methods and weed management practices on economics of rice

Treatments	2011-12				2012-13			
	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C ratio	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C ratio
C_1W_1	57397	83757	26361	1.46	61597	86296	24699	1.40
C_1W_2	58157	74918	16761	1.29	62357	66127	3770	1.06
C_1W_3	57297	67169	9872	1.17	61497	61852	355	1.01
C_1W_4	57897	81837	23940	1.41	62097	77284	15187	1.24
C_1W_5	58022	77065	19043	1.33	62222	73738	11516	1.19
C_1W_6	54997	44899	-10098	0.82	59197	35802	-23395	0.60
C_2W_1	52747	110649	57902	2.10	56047	116501	60454	2.08
C_2W_2	53507	94419	40912	1.76	56807	98963	42156	1.74
C_2W_3	52647	84256	31609	1.60	55947	88024	32077	1.57
C_2W_4	53247	108826	55579	2.04	56547	125904	69357	2.23
C_2W_5	53372	102774	49402	1.93	56672	113866	57194	2.01
C_2W_6	50347	52467	2120	1.04	53647	40671	-12976	0.76
C_3W_1	49992	119650	69658	2.39	52697	125150	72453	2.37
C_3W_2	50752	102378	51626	2.02	53457	99600	46143	1.86
C_3W_3	49892	83017	33125	1.66	52597	77079	24482	1.47
C_3W_4	50492	116076	65584	2.30	53197	123462	70265	2.32
C_3W_5	50617	113871	63254	2.25	53322	115363	62041	2.16
C_3W_6	47592	55577	7985	1.17	50297	49131	-1166	0.98

registered higher grain yield than other combinations. This might be due to larger canopy with greater root development and activity, less intra plant competition, improved remobilization of assimilates to grain. This is corroborated with the findings of Mohapatra *et al.,*(2012). The least grain yield was recorded under conventional planting with unweeded check (C_1W_6).

Economics

Crop establishment methods and weed management practices showed variations on cost of cultivation, income obtained and benefit: cost ratio (Table 3). The SRI machine transplanting along with conoweeding four times at 10 days interval starting from 10 DAT (C_3W_1) incurred lesser cost of cultivation and registered higher net return due to lesser labour requirement for transplanting and weeding. This was followed by SRI machine transplanting along with Pretilachlor (0.75 kg a.i. ha^{-1} pre-emergence) + Bispyribac sodium (20 g a.i. ha^{-1} early post-emergence) + conoweeding at 40 DAT (C_3W_4) and SRI machine transplanting along with Laundax power @ 10 kg a.i. ha^{-1} + cono weeding at 30 and 40 DAT (C_3 W_5). The B:C ratio was higher with SRI machine transplanting along with conoweeding four times at 10 days interval starting from 10 DAT (C_3W_1) during both the years because of lesser cost involved in transplanting and weeding. Similar results were reported by Mohanty and Barik (2010), who stated that benefit cost ratio of rice transplanter was higher when compared to conventional transplanting. Further Sajitha Rani and Jayakiran (2010) stated that the net return in SRI machine planting was higher with increased B: C ratio due to higher grain yield when compared to line transplanting. This was mainly because of low cost incurred in transplanting and less seed requirement reduced cost of nursery preparation and less labour cost for weed control.

Conclusion

From the present study, it could be concluded that SRI machine transplanting with conoweeding four times at 10 days interval starting from 10 DAT (C_3W_1) of rice will be a promising practice to increase the rice productivity and profitability. Under labour scarcity situation, machine planting with the application of Pretilachlor (0.75 kg a.i. ha^{-1} pre-emergence) + Bispyribac sodium (20 g a.i. ha^{-1} early post-emergence) + conoweeding at 40 DAT will be the best alternative option.

References

Anitha, S. and Chellappan, M. 2011. Comparison of the system of rice intensification (SRI), recommended practices, and farmers' methods of rice (*Oryza sativa* L.) production in the humid tropics of Kerala, India. *J. Tropical Agric.,* **49**(1-2):64-71.

Balasubramanian, V., Ladha, J.K., Gupta, R.K., Naresh, R.K., Mehla, R.S.S., Bijay and Singh, Y. 2003. Technological option for rice in the rice-wheat system in South Asia. ***In***: *Improving the Productivity and Sustainability of Rice–Wheat Systems: Issues and Impact,* pp 115–47. Ladha *et al*. (Eds), ASA special publication 65, ASA, CSSA, SSSA, Madison, WI.

Baskar, P. 2009. Standardisaton of nursery techniques and crop geometry for rice under system of rice intensification (SRI). M.Sc., (Ag.) Thesis**,** TNAU, Coimbatore, Tamil Nadu, India.

Bell, M., Balasubramanian, V. and Rickman, J. 2003. International Rice Research Institute (IRRI). ***In***: http:// www.knowledgebank.irri.org.

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.

Cherati, F.E., Bahrami, H. and Asakereh, A. 2011. Evaluation of traditional, mechanical and chemical weed control methods in rice fields. *Australian J. Crop Sci.,* **5**(8):1007-1013.

CPG, 2005. Crop Production Guide. Published by Directorate of Agriculture, Chennai and Tamil Nadu Agric. Univ., Coimbatore.

Hemmat, A. and Taki O. 2003. Comparison of compaction and puddling as pre-planting soil preparation for mechanized rice transplanting in very gravelly *Calcisols* in central Iran. *Soil and Tillage Res.,* **70**: 65–72.

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.

Jacob, D. and Syriac, E. K. 2005. Performance of transplanted scented rice (*Oryza sativa* L.) under different spacing and weed management regimes in southern Kerala. *J. Tropical Agric.,* **43(1/2):** 71-73.

Mohanty, D.K. and Barik, K.C. 2010. Comparative performance of eight row self propelled rice transplanter and manual transplanting ar farmer's field. *Agric. Engi. Today.* **34**(4):15-17.

Mohanty, D.K. and Mohanty, M.K. (2010). Assesment of yield using conoweeder in SRI method of paddy cultivation. *Agric. Engi. Today.* **34**(1): 21-24.

Mohapatra, P.C., Din, M., Parida, B.C. Patel, S.P. and Mishra, P. 2012. Effect of mechanical planting and weeding on yield, water-use efficiency and cost of production under modified system of rice intensification. *Indian J. Agric Sci.,* **82**(3): 280–283.

Ramamoorthy, K. 2004. Effect of square planting and mechanical weeding on the growth and yield of rice. M.Sc., (Ag.) Thesis**,** TNAU, Coimbatore, Tamil Nadu, India.

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

Sajitha Rani, T. and K. Jayakiran. 2010. Evaluation of different planting techniques for economic feasibility in rice. *Electronic Journal of Environmental, Agricultural and Food chemistry,* **9** (1):150-153.

Thiyagarajan, T.M., Senthilkumar, K., Bindraban, P.S., Hengsdijk, H. and Ramasamy, S. 2002. Crop management options for increasing water productivity in rice. *J. Agric. Resour. Manage.,* **1** :169-181.

Uprety, R. 2010. Meshing mechanization with SRI methods for rice cultivation in Nepal. 28 th International Rice Research Conference, 8- 12 November 2010.

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