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Mechanized weed management to enhance productivity in System of Rice Intensification (SRI)

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ABSTRACT

Rice ecosystems including irrigated rice in India is infested with complex weed flora including semi-aquatic and aquatic weeds which cause yield losses from 15 to 76% in rice crop. ICAR-Indian Institute of Rice Research (IIRR) under All India Co-ordinated Rice Improvement Programme (AICRIP) has conducted experiments across India (11 locations) to evaluate System of Rice Intensification (SRI) method, assessing their potential and the effects of individual SRI practices for enhancing productivity under different agro-ecological conditions compared to standard normal transplanting (NTP) method. SRI method recorded significantly higher grain yield (6.22 t/ha) followed by integrated crop management (ICM) (6.07 t/ha), standard practice of transplanting (5.60 t/ha) and direct seeding with drum seeder (5.13 t/ha). The effect of cono-weedings on grain yield indicated the superiority of 4 times cono weeding (10, 20, 30 and 40 DAT) which recorded better yields over two times cono weeding and the reduction in yield to the tune of 5.7- 11.8% by 2 times cono weeding *i.e.* 10 and 20 DAT (5.7% less) and herbicide application (11.8% less), respectively. Based on multi-location testing, results indicated that SRI has the potential to enhance the productivity of the rice with reduced inputs in different agro-ecological situation and soil types across the country and weeding by cono weeder with reduction in drudgery of weeding in rice.

Key words- Mechanised weed management, System of Rice Intensification (SRI), Productivity of rice

Rice (*Oryza sativa* L.) is one of the most important staple food crops in the world. With an average productivity of 2.49 t/ha, though increasing marginally, but is still well below the world's average yield of 4.36 t/ha (FAOSTAT 2014). To maintain self-sufficiency, the present production level of 105 million tonnes needs to be increased up to 125 million tonnes by the year 2020 (Chandrasekaran 2008). Growing rice by System of Rice Intensification (SRI) method is a novel approach of rice cultivation, which saves water and other inputs (Satyanarayana 2007) through effective integration of crop, soil, water and nutrient management (Uphoff 2003).

Weed competition is one of the prime yield limiting biotic constraints in rice. In view of the increasing labour scarcity and negative impact of indiscriminate herbicide use, weed management strategy needs to be re-oriented towards mechanical means for satisfactory monetary benefits. Rotary weeder was effective in controlling weeds in inter row space as SRI method maintains a spacing of 25 cms at both the directions. The present study was undertaken with an objective to study the effect of different weed management options in SRI and their effect on grain yield at different locations.

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MATERIALS AND METHODS

The field experiment included four establishment methods conducted at 11 locations *viz*., Aduthurai, ARI-Rajendranagar, Coimbatore, Jagdalpur, Nawagam, Karjat, Pusa, Chiplima, Mandya, Siruguppa and Malan during 2004 and 2005 *Kharif* with standard practice of planting (S1), system of rice intensification method -SRI (S2), integrated crop management and modified mat nursery in transplanted rice -ICM (S3) and direct seeding with drum seeder -DS (S4). The nursery area was about 100 m^2/ha. The sprouted seed were sown on raised beds of 5 beds of 20 m^2 and watered frequently to keep wet. Twelve days old seedlings were pulled very carefully by using trays and planted single seedlings at shallow depth of 1-2 cm and spacing of 25 x 25 cm (Gopalakrishnan *et al.* 2014).

Weed management in SRI consisted of three treatments, two times cono weeding (10 and 20 DAT), four times cono-weeding (10, 20, 30 and 40 DAT) and herbicide pre-emergence butachlor 1.5 kg/

ha followed by one hand weeding at 10 locations in *Kharif* (2009 and 2010) and 7 locations in *Rabi* (2009-10 & 2010-11). The data was analyzed based on Fishers method of analysis of variance technique for interpretation of the data as outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Performance of system of rice intensification was better in terms of grain yield at all the locations tested in India compared to other methods of establishment. In Arundhatinagar, SRI recorded highest grain yield (8.59 t/ha) followed by Coimbatore (7.91 t/ha) and least grain yield was at Chiplima (4.34 t/ha). Overall, SRI method recorded significantly superior grain yield of 2.32%, 9.92% and 17.5% over integrated crop management (ICM), standard practice of transplanting and direct seeding with drum seeder, respectively. The lowest grain yield was observed at direct-seeding with drum seeder at most of the locations. Higher grain yield realized with SRI method may be due to the use of younger seedlings, transplanted at shallow depth with wider spacing, repeated cono weeding during vegetative growth (Kumar *et al.* 2011).

Effect of weed management practices on grain yield

Among the weed management practices followed in SRI method, four times cono weeding at 10, 20, 30 and at 40 DAT recorded superior grain yield at all the locations during both *Kharif* and *Rabi* seasons (5.90 and 5.45 t/ha) over pre-emergence butachlor 1.5 kg/ha followed by one hand weeding (5.28 and 4.93 t/ha) and 2 times cono weeding at 10 and 20 DAT (5.57 and 4.71 t/ha), respectively. Whereas in *Kharif* season, two times cono weeding at 10 and 20 DAT performed better and recorded higher grain yield than herbicide application but in *Rabi* season pre-emergence butachlor 1.5 kg/ha followed by one hand weeding showed higher grain yield than 2 times cono weeding at 10 and 20 DAT.

Overall, in *Kharif* season, the effect on grain yield due to weed management practices indicated the superiority of four times cono weeding (10, 20, 30 and 40 DAT) as compared to two times cono weeding and herbicide application which recorded 11.8% and 5.7% less grain yield, respectively. In *Rabi* season there was no significant yield difference due to weed management practices, however, 4 times cono weeding (10, 20, 30 and 40 DAT) recorded higher grain yield (5.45 t/ha) followed by herbicide application (4.93 t/ha) and lowest grain yield was observed with 2 times cono weeding (4.71 t/ha) (Mohapatra *et al.* 2012). SRI with cono weeding four times at 10 days interval resulted in significantly lower weed biomass (Uprety 2010). The use of cono weeder caused 10-17% increase in grain yield during wet season (Mandal *et al*. 2013). Cono weeder further reduced man-days required for weeding from 30 to 10 (Mrunalini and Ganesh 2008), thus helped saving labour and time. Higher numbers of cono weeding effectively buries and incorporates the weeds into soil and minimizes the weed competition. Further it improves the soil aeration, root development, nutrient absorption and more number of tillers, which favoured the crop growth, yield attributes and resulted in higher grain yield (Table 2 and 3). The same findings were confirmed with other researchers (Thiyagarajan *et al.* 2007, Kavitha *et al.* 2010).

It was concluded that SRI method is a promising technology over integrated crop management, standard practice of transplanting (5.60 t/ha) and direct-seeding with drum seeder in terms of higher grain yield across the locations. The effect of cono weeding was promising over hand weeding and herbicides and indicated the superiority of 4 times cono weeding (10, 20, 30 and 40 DAT) followed by 2 times cono weeding (5.7% less) and herbicide application (11.8% less). There is a need to economise the mechanical weeding operations and development of cost effective efficient motorized

Table 1. Effect of different establishment methods on grain yield of rice at different locations across the India (mean of two years)

Treatment	Location											
	ARI, R' Nagar	Siruguppa	Mandya	Coimbatore	Aduthurai	Jagdalpur	Karjat	Nawagam	Malan	Chiplima	Arundhatinagar	Mean
S_1	5.76	5.63	5.58	6.17	4.73	5.67	6.24	5.99	5.54	4.73	5.61	5.60
S_2	6.61	4.96	6.31	7.91	6.50	5.67	6.69	5.88	4.78	4.34	8.59	6.22
S_3	6.03	4.85	6.14	7.05	6.56	5.71	6.65	5.77	4.89	5.11	8.09	6.07
S_4	4.49	5.70	5.91	5.82	4.11	4.97	5.78	5.30	4.69	4.15	5.54	5.13
Mean	5.72	5.29	5.99	6.74	5.48	5.51	6.34	5.74	4.98	4.63	6.96	5.76
LSD (P=0.05) 0.557												

S_1- Standard practice of planting; S_2-System of rice intensification method (SRI); S_3-Integrated crop management and modified mat nursery in transplanted rice (ICM); S_4-Direct seeding with drum seeder

Table 2. Effect of weed management practices on grain yield (t/ha) of rice under system of rice intensification at different locations across India (mean of *Kharif* 2009 and 2010)

Treatment	Aduthurai	ARI-Rajendranagar	Chatha	Coimbatore	Puducherry	Pantnagar	Gangavathi	Karjat	Ranchi	Pusa	Mean
T_1	7.02	5.81	4.05	5.89	4.69	4.80	4.10	5.57	6.08	7.66	5.57
T_2	7.24	5.91	4.49	6.58	4.91	5.19	4.25	6.19	6.14	8.05	5.90
T_3	5.45	6.00	3.40	6.13	4.67	4.00	4.82	6.15	5.56	6.57	5.28
Mean	6.57	5.91	3.98	6.20	4.76	4.66	4.39	5.97	5.93	7.43	5.58
LSD (P=0.05)	0.417										

T_1: 2 times cono weeding (10 and 20 DAT); T_2: 4 times cono weeding (10, 20, 30 1nd 40 DAT); T_3: pre-emegence butachlor 1.5 kg/ha followed by one hand weeding

Table 3. Effect of weed management practices on grain yield (t/ha) of rice under system of rice intensification at different locations across India (*Rabi*, 2009 -2010)

Treatment	Aduthurai	Arundhati Nagar	Annamalai Nagar	Coimbatore	Karjat	Mandya	Puducherry	Mean
T_1	6.85	6.80	1.73	4.59	4.23	4.14	4.61	4.71
T_2	7.44	6.73	2.52	5.87	5.13	5.12	5.36	5.45
T_3	4.58	7.30	3.63	5.55	4.71	4.67	4.05	4.93
Mean	6.29	6.94	2.63	5.34	4.69	4.64	4.67	5.03
LSD(P=0.05)	0.899							

T_1: 2 times cono weeding (10 and 20 DAT); T_2: 4 times cono weeding (10, 20, 30 1nd 40 DAT); T_3: pre-emegence butachlor 1.5 kg/ha followed by one hand weeding

weeders for popularization of the SRI for its large scale adoption in India. However, the use of cono weeder may be exploited as a component of IWM in low land and irrigation rice as a strategy of integrated weed management practices available in the region.

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