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Integrated weed management under modified water regimes in System of Rice Intensification

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ABSTRACT

A field study was conducted at Chiplima and Sambalpur under West Central Table Land Zone of Odisha during the winter (*Rabi*) seasons of 2013 and 2014 to evaluate different integrated weed management practices under modified water regimes in rice grown under System of Rice Intensification. Application of 5 cm depth of irrigation water before the day of weeding operation was effective in increasing yield significantly (4.72 t/ha) over saturation moisture regime (3.48 t/ha) due to low weed density, weed dry weight and highest number of ear bearing tillers per plant (24) and filled grains/panicle (72). Out of four levels of different weed management systems tested, the application of pretilachlor 750 g/ha (pre-emergence) *fb* chlorimuron-ethyl + metsulfuron-methyl 4 g/ha (post-emergence) recorded minimum weed density and weed dry weight, higher weed control efficiency and significantly higher grain yield of 5.45 t/ha. The same treatment also recorded highest net return (₹ 41, 441/ha) and highest B: C ratio (2.17).

Key words: Irrigation schedule, SRI, Weed control, Water regime

The food security is entirely dependent on total rice production in India (Kabir 2006). The India contributes 20% of the total rice production in the world. There is an increased demand for rice every year and it is estimated that by 2030 the requirement would be 150 million tonnes. To sustain present food sufficiency and to meet future food demand, India has to increase its rice productivity by 3% per annum (Thiyagarajan and Selvaraju 2011). To meet this, the required amount of rice is to be produced without increase in rice area. In order to increase productivity by improving resource use efficiency, System of Rice Intensification (SRI) offers good opportunity to increase production by 50-100% with less use of external input (Stoop *et al.* 2002). The major factors for increased production in SRI are water management, weed management and nutrient management (Uphoff and Randriamiharisoa 2002). Weeds compete with crops for water, light, nutrients and space. Weeds are the important competitors in their early growth stages than later and hence the growth of crops slows down and finally grain yield decreases (Jacob and Syriac 2005). Water resource limitation, shortage of labour during peak period of transplanting and escalating labour wages are making transplanting more expensive which invariably leads to delay in transplanting and results in reduction of yield and profit (Gangwar *et al.* 2008).

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Weeds are at present the major biotic constraints in increasing rice production which can reduce the yield by 50-60%. In SRI method, since the fields are not flooded continuously, weed growth becomes one of the major deterrents to rice yield. Increasing cost of labour and low-efficiency of weeder operation has necessitated working on integrating of chemical weed control and weeder in SRI method for increasing efficiency of weed control and improving yield.

MATERIALS AND METHODS

The study was undertaken during 2013 and 2014 at Regional Research & Technology Transfer Station, Orissa University of Agriculture & Technology, Chiplima, Orissa, India. The soil of experimental field was sandy clay loam, acidic (pH 5.65), low in organic carbon content (0.47%) and available N, P and K content were 242, 9.2 and 155 kg/ha, respectively. The experiment was laid out in split plot design with 3 replications. Main plot treatments consisted of 3 irrigation schedules, *viz.* I_1 – 5 cm standing water on the day before weeding operation, I_2 – 2.5 cm standing water on the day before weeding operation, I_3- Saturation. The sub plots were allotted with four different weed management practices such as W_1-weeding by Mandwa weeder at an interval of 7 days, W_2-application of pre-emergence herbicide + use of Mandwa weeder after 20 DAT at an interval of 7 days, W_3 – weeding by Mandwa weeder at an interval of 7 days up to 20 DAT + application of post-emergence herbicide, W_4- application of one pre- + one post-emergence herbicide. Pretilachlor was used at 750 g/ha as pre-emergence herbicide and chlorimuron-ethyl + metsulfuron-methyl at 4 g/ha was used as post-emergence herbicide. The rice variety '*MTU-1010'* of 125 days duration was grown under SRI and irrigated as per treatment plan. The FYM was applied at 5 t/ha with a fertilizer dose 80-40-40 N-P_2O_5-K_2O kg/ha, respectively. All P was applied as basal and N was applied in 3 splits *i.e.* 50% as basal, 25% 45 DAT and 25% 60 DAT while K was applied in two splits, *i.e.* 50% as basal and 50% at 60 DAT. The plant protection measures were taken as and when required. All other cultural operations were carried out as per recommendation and weed management was followed as per treatment. Rainfall received during the crop growth period was 30 mm (6 rainy days) in 2014 and 62 mm (9 rainy days) in 2015, respectively. The yield parameters were recorded and the economics was calculated at the prevailing price of inputs and produce. The weeds were counted and the weed dry weights were taken at harvest. The weed index (WI) and weed control efficiency (WCE) were calculated from the mean data over two years by using following formulae.

$$\text{Weed Index (WI)} = \frac{a-b}{a} \times 100$$

where 'a' and 'b' are grain yields from the best treatments and treatment for which WI is to be computed.

$$\text{Weed Control Efficiency (WCE)} = \frac{DWC - DWT}{DWC} \times 100$$

where, DWC and DWT are dry weight of weed from unwedded and weeded plots, respectively.

The data were statistically analyzed by Gomez and Gomez (1978).

RESULTS AND DISCUSSION

Weed flora

Major weed flora in experimental field belonged to sedges like *Cyperus rotundus, Cyperus iria* and *Cyperus difformis* followed by grasses like *Digitaria sanguinalis, Echinochloa colona, Echinochloa crusgalli, Cynodon dactylon* and broad-leaved weeds like *Ludwigia parviflora*, *Commelina benghalensis* and *Marsilea quadrifoliata.* The composition of sedge, grass and broad-leaved weeds varied from 65–80, 18–30 and 15-28%, respectively. Emergence of broad-leaf weeds and grasses were earlier than the sedges which were noticed to be predominant after 30 DAT onwards.

Effect on weed flora

Irrigation depth before the day of weeding had significant effect on weed density, weed dry weight and weed control efficiency of grass, sedge and broad-leaf weeds (Table-2). The lowest weed density and highest WCE was achieved with I_1, which was around 50% both for broad-leaves and grasses and 25.66% for sedges. The weed density and dry weight of grasses were unaffected by different weed control treatments. The broad-leaves and sedges were significantly affected and lowest weed density and dry weight was found with W_4 (herbicide mixture of pre- and post-emergence). Weed control efficiency was highest for grasses (81.11%), 69.44% for broad-leaved weeds and 64.83% for sedges. Control of weeds by herbicides during early stage of rice resulted in lower competition for moisture, nutrient and sunlight that influenced the crop to grow better as evidenced in increased yield attributes and yield (Singh *et al.* 2005). The overall weed control efficiency was higher (24.82-26.75%) when irrigation water was provided in comparison to saturation moisture regime, though the variation with respect to depth of water was not significant. Use of chemical herbicide with or without mechanical weeder was found superior to only Mandwa weeder operation. The application of pre- and post-emergence herbicide mixture gave the highest weed control efficiency (77.14%) followed by Mandwa weeder and post-emergence herbicide combination (44.66%)

Effect on crop growth

Filled grains/panicle (72) was significantly higher with I_1 over I_2 (56) and I_3 (58). This might be due to better soil moisture condition which increased effectiveness of herbicides or operation of weeder resulting thereby reduced competition for growth factors. Weed control treatments affected ear bearing tillers/plant, filled grains/panicle significantly and the highest values 30.83, 69.21, respectively were recorded in treatment W_4. This might be due to low crop weed competition and longer weed free period under these treatments which lead to high growth and yield of rice. Fisher *et al.* (1993) found that longer weed free period favoured significantly increase in yield of rice. Kolhe (1999) observed that post-emergence application of fenoxaprop-p-ethyl + ethoxysulfuron was as effective against hand weeding twice. Test weight was not significantly affected by different weed control treatments.

Table 1. Effect of irrigation and methods of weed control on yield and yield attributes in SRI

Treatment	Effective tillers/plant	Filled grains /panicle	Test weight (g)	Grain yield (t/ha)	Yield increase (%)	Net returns (x10^3 `)	B:C Ratio
Irrigation							
I_1	24.0	72.0	21.87	4.72	35.7	29.49	1.79
I_2	24.0	56.0	21.95	4.01	16.8	17.80	1.45
I_3	21.0	58.0	21.64	3.48	-	7.50	1.18
LSD (P=0.05	NS	NS	NS	1.77	-	-	-
Weed control							
W_1	16.8	50.1	21.50	2.64	-	10.22	1.24
W_2	20.5	60.2	21.76	3.99	51.4	16.57	1.42
W_3	25.2	68.6	22.20	4.24	60.6	20.58	1.53
W_4	30.8	69.2	21.84	54.52	106.5	41.44	2.17
LSD (P=0.05)	2.74	13.1	NS	10.08			

Table 2. Weed dynamics as influenced by irrigation schedules and weed management practices

Treatment	Grasses			Broad-leaved			Sedges			WI
	No./m^2	Dry weight (g)	WCE (%)	No/m^2	Dry weight (g)	WCE (%)	No./m^2	Dry weight (g)	WCE (%)	
Irrigation										
I_1	8.0	3.0	50.0	5.50	2.31	50.1	180.8	168.0	25.7	13.9
I_2	10.0	5.0	16.7	5.25	2.81	39.3	209.6	204.0	9.73	26.3
I_3	18.0	6.0	-	7.25	4.63	-	258.1	226.0	-	
LSD (P=0.05)	5.04	1.2		2.18	0.72		21.1	12.99		33.2
Weed control										
W_1	16.3	7.2	-	8.33	10.8	-	323.7	320.7	-	26.7
W_2	15.5	4.7	35.6	14.0	9.67	10.5	202.8	224.3	30.1	22.2
W_3	13.8	4.9	32.1	25.0	09.2	14.8	162.5	183.5	42.8	
W_4	5.0	1.3	81.1	6.0	03.3	69.4	108.8	112.8	64.8	
LSD (P=0.05)	NS	NS		4.04	2.82		46.55	52.89		

I_1 – 5 cm standing water on the day before weeding operation, I_2 – 2.5 cm standing water on the day before weeding operation, I_3- At saturation. W_1-weeding by Mandwa weeder at an interval 7 days, W_2- application of pre-emergence herbicide + use of Mandwa weeder after 20 DAT at an interval 7 days, W_3 – weeding by Mandwa weeder at an interval of 7 days upto 20 DAT + application of post-emergence herbicide, W_4- application of one pre- + one post-emergence herbicide.

Effect on yield and economics

Crop yield was observed to be highest (4.72 t/ha) in I_1 (Table 1). Significantly higher grain yield was also found at decreasing depth of impounded water on the day before weeding. The response to soil moisture regime was well marked with an increase of 35.68% at I_1 and 16.77% in I_2 over saturation moisture regime.

Weed control by application of both pre- and post-emergence herbicide (W_4) resulted in highest yield (5.45 t/ha) followed by W_3. The increase in yield by 106.51%, 60.61% and 51.44% in W_4, W_3 and W_2, respectively over W_1 was noticed. This was in conformity with the findings of Babar and Velayutham (2012). This might be due to lesser efficiency of the Mandwa weeder alone to control the weeds. Total chemical control with mixture of pre- and post-emergence herbicide proved that chemical control of weeds is most effective than the mechanical and or mechanical and chemical integration. This might be due to provision of total weed free period due to application of both pre- and post-emergence herbicides which reduced partitioning of available resources like moisture and nutrient.

Weed index showed yield reduction to the tune of 23.3 and 26.3% in I_2 and I_3 than I_1 due to increased weed growth under deficit moisture regime. Among the weed control treatments, yield reduction due to weeds was 22, 26 and 33% in W_3, W_2 and W_1, respectively over W_4.

Highest net returns (` 41, 441/ha) and benefit cost ratio (2.17) was found in W_4 due to highest yield and cultivation cost owing to use of chemicals. One time use of herbicide either as pre or post emergence reduced the net return to 55-60% as in case of W_2 and W_3 and the lowest net return was at par with W_1 due to ineffective weed control and higher labour cost for weeding. This is in conformity with the finding of Walia *et al*. (2012), who reported that sole application of pre- or post-emergence herbicide did not provide effective control of weeds as compared to combination of pre- and post-emergence herbicide. The moisture regime of I_1 with chemical weed control with pre- and post-emergence herbicide mixture gave the highest yield due to cumulative effect of increased level of yield attributes, less weed competition, optimum moisture, reduced depletion of nutrients by weeds and increased uptake by crop.

REFERENCES

Baber SR and Velayutham A. 2012. Weed management practices on nutrient uptake, yield attributes and yield of rice under System of Rice Intensification. *Madras Agricultural Journal* **99**(1-3): 51-54.

Jacob D and Syriac EK. 2005. Performance of transplanted scented rice (*Oryza sativa* L.) under different spacing and weed management regimes in southern Kerala. *Journal of Tropical Agriculture* **43**(1&2): 71-73.

Fischer AJ, Lozano RA and Sanist LR. 1993. Yield loss prediction for integrated weed management in direct-seeded rice. *International Journal of Pest Management* **39**(2): 175-180.

Gangwar KS, Tomar OK and Pandey DK. 2008. Productivity and economics of transplanted and direct-seeded rice (*Oryza sativa*) - based cropping systems in Indo-Gangetic plains. *Indian Journal of Agricultural Sciences* **78**: 655-658.

Gomez KA and Gomez AA. 2010. *Statistical Procedures for Agricultural Research*. (2nd Ed.). Wiley India Pvt. Ltd., India. 680 p.

Gujja B and Thiyagarajan TM. 2009. Indian food security? The System of Rice Intensification. *Gate Keeper Series* **143**: 4-5.

Kabir H. 2006. Adaptation and adoption of the System of Rice Intensification in Myanmar using the Farmer Field School (FFS) approach. Available: http://ciifad.cornell.edu/sri/theses/kabirthesis.pdf

Kolhe SS.1999. Evaluation of low dosage- high efficacy herbicides fenoxaprop-p-ethyl + ethoxysulfuron in direct-seeded rice under puddle condition. *Oryza* **36**(2): 177-179.

Singh VP, Singh Govinda, Singh SP, Kumar A, Dhyani VC, Kumar M and Sharma G. 2005. Effect of herbicides alone and in combination on direct- seeded rice. *Indian Journal of Weed Science* **37**: 197-201.

Stoop, W.A., N. Uphoff and A. Kassam. 2002. A review of agricultural research issues raised by the system of rice intensification (SRI) from Madagascar: opportunities for improving farming systems for resource-poor farmers. *Agricultural Systems* **71**: 249-274.

Thiyagarajan TM and Selvaraju R. 2001.Water saving in rice cultivation in India. pp 15-45. In: *Proceedings of an International Workshop on Water Saving, Rice Production Systems*. Nanjing University, China.

Uphoff N. 2002. *Questions and Answers About the System of Rice Intensification (SRI) for Raising the productivity of Land, Labor and Water*. Cornell International Institute for Food, Agriculture and Development, Cornell University, Ithaca, NY, USA.

Uphoff N and Randriamiharisoa R. 2002. Reducing water use in irrigated rice production with the Madagascar System of Rice Intensification. pp. 71-87. In: Water-Wise Rice Production. (Eds. Bouman BAM, Hengsdijk H, Hardy B, Bindraban PS, Tuong TP and Ladha JK), IRRI, Los Banos, Philippines.

Walia US, Walia SS, Sindhu AS and Nayyar S. 2012. Bioefficacy of pre- and post-emergence herbicides in direct- seeded rice in Central Punjab. *Indian Journal Weed Science* **44**(1): 30-33.