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Agronomic evaluation of system of rice intensification methods in Godavari delta

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ABSTRACT

Field experiments were conducted during the wet seasons of 2003-2005 to evaluate the performance of system of rice intensification with various aspects of nutrient management, soil water regime, varieties, and weed growth. Combined application of farm yard manure (FYM) at 5 tha^{-1} along with half the recommended nitrogen through chemical and gypsum at 1 t ha^{-1} registered highest yield (7.6 tha^{-1}). Maximum grain yield (7.2 tha^{-1}), root mass and root volume was recorded with Swarna in SRI method. All varieties exhibited their superior yields in SRI system. The highest grain yield and maximum water use efficiency (8.19 kg mm^{-1} ha^{-1}) were registered under continuous submergence. The water requirement under saturation treatment was 40% lesser than continuous flooding at 5cm depth.

Key words: *System of rice intensification, fertilizer technique, weed flora*

Modern agriculture largely depends on the fossil fuel-based inputs which lead to adverse effects on soil productivity and environmental quality. Intensive agriculture and decreasing inputs of organic materials have led to severe degradation of soil fertility and productivity of rice cropping systems. Addition of organic manures as a means of nutrient recycling in the soil-plant ecosystem is an essential component of sustainability, in nutrient exhaustive rice cropping systems. It alters the soil environment which in turn influences the microbial activity in the soil and subsequent nutrient transformation (Kumar and Goh, 2000). System of rice intensification (SRI) is one way for better water saving, soil fertility improvement and for getting sustainable high yields. The present study was undertaken to evaluate the performance of SRI with various aspects of fertility management, soil water regime varieties, and nature of weed growth in the vertisols of Godavari delta of Andhra Pradesh.

MATERIALS AND METHODS

Three field experiments were carried out during 2003-04 and 2004-05 at Maruteru on vertisols of Godavari delta. The soil was clay loam having pH 6.8, organic carbon (0.63%), available N (302 kg ha^{-1}), available phosphorus (23.1 kg P_2O_5 ha^{-1}) and high in available K_2O (328 kg ha^{-1}). System of rice intensification (SRI) was done by planting 8 day old seedlings (rice variety, Swarna) at 25x25cm spacing with 10 t ha^{-1} FYM (0.46%N, 0.14%P &0.5%K) and weeding was done with cono weeder thrice at 10 days interval.

The trial on integrated nutrient supply system was laid out with five treatments of organic and inorganic combinations in randomized block design with four replications (Table 1). The crop was planted on third week of December during dry season 2003-04. The trial on soil water regimes was also carried out during dry season, 2003-04 with 5 treatments (Table 2) laid out in randomized block design with 4 replications. The experimental bunds were covered with polythene sheet to arrest horizontal seepage and applied water is measured with ‘V’ notch. The trial was conducted during the wet seasons of 2004 and 2005 with 6 varieties grown in both conventional and SRI methods (Table 3) in randomized block design with three replications. The root weight and root volume was estimated as per standard procedures. Weed composition and biomass was estimated at 20 DAT.

RESULTS AND DISCUSSION

Combination of organic and inorganic fertilization

Table 1. Rice yields under SRI as influenced by integrated nutrient supply system (Mean of two seasons)

Treatment	Panicles m^{-2}	Filled grains Panicle^{-1}	Grain yield (tha^{-1})
Sole Chemical fertilization (120 kg N,60 kg P_2O_5, 40 kg K_2O kg ha^{-1})	323	158	4.32
60 kg N through press mud (5 t ha^{-1}) + ½ as chemical N (Urea)	365	175	5.77
60 kg N through press mud (5 t ha^{-1}) + ½ as chemical N(Urea)+1 t. gypsum ha^{-1}	402	201	6.48
60 kg N through FYM (5 t ha^{-1}) + ½ as chemical N (5 t ha^{-1})	391	193	6.13
60 kg N through FYM (5 t ha^{-1}) + ½ as chemical N(Urea) + 1 t. gypsum ha^{-1}	480	225	7.56
CD (P=0.05)	65	21	0.36

Table 2. Performance of various soil water regimes in SRI method (dry season 2004)

Treatment	Grain yield (t ha^{-1})	Days to panicle emergency	Water requirement (mmha^{-1})	Water use efficiency (kg ha^{-1} mm^{-1})	Productivity per day (kg)
Continuous saturation	7.23	110	883	8.19	65
Continuous flooding (5 cm depth)	5.63	102	1482	3.79	55
Intermittent flooding (5cm) 4 DADW	6.34	104	1025	6.18	61
Intermittent flooding (5cm) 6 DADW	5.42	104	814	6.65	52
Intermittent flooding (5cm) 8 DADW	4.52	106	725	6.23	43
CD (P=0.05)	0.81	2.1			

Table 3. Root growth under SRI method during wet seasons (Mean of two years)

Varieties	Root volume (ml plant^{-1})		Root weight (ghill^{-1})		Grain yield (tha^{-1})	
	Conventional	SRI	Conventional	SRI	Conventional	SRI
MTU 1071	12.4	26.2	5.36	11.71	4.34	5.94
Samba Mahsuri	13.5	31.5	6.14	13.50	4.11	5.79
MTU 1032	11.6	23.7	4.73	9.89	3.88	4.80
MTU 2716	10.1	22.8	4.18	9.64	3.58	3.96
Swarna	35.6	85.1	8.90	17.91	5.64	7.24
Indra	12.5	31.9	6.24	15.30	5.26	6.47
CD (P=0.05)	7.8		3.7		0.32	

showed significantly higher yields than sole chemical fertilization (Table 1) The superiority of integrated nutrient management (INM) might be due to presence of humic acid compounds which helps in dissolution of minerals and chelation of micronutrients (Mehra, 2006). Among INM treatments, gypsum @ 1 tha^{-1} in combination with press mud and FYM gave 0.7 to 1.4 tha^{-1} more yield. This might be due to additional supply of calcium to the soil from gypsum. Between the press mud and FYM though the press mud contained lower C:N ratio (16.2) than FYM (22.6), performance of FYM was better than press mud. This could be attributed to better mineralization of FYM under prevailing aerobic conditions under SRI method. Combined application of FYM at 5 tha^{-1} along with half recommended nitrogen through chemical and gypsum at 1 tha^{-1}registered highest yield (7.6 tha^{-1}) which was significantly superior to rest of the treatments. In the present study gypsum in combination with FYM was found to be better than gypsum in combination with press mud treatment. Similar results were also reported by Haq *et al*., (2001).

Irrespective of varieties, significantly higher values of root weight, root volume and grain yields were noticed in SRI than conventional method (Table 2). The highest grain yield (7.2 tha^{-1}) was recorded with Swarna in SRI method. The next best was found to be MTU 1061 (6.5 tha^{-1}) followed by MTU 1071. Swarna is known for best utilizer of native nitrogen but prone to lodge easily because of its weak culm. It was reduced under SRI system as the culm strength increased under saturated soil water regime. In addition, the root volume of the variety was 2.4 fold larger in SRI system than normal. It helps in resisting the plant against lodging at post flowering stage. The panicle emergence was slightly delayed by 5-6 days under SRI than conventional system due to lack of flooding.

Continuous flooding (at 5 cm depth) of rice field registered highest water requirement (1482 mm with 'V' notch), which was 40% more, compared with SRI method of cultivation (Table 3). Thus there is a saving of 600 mm irrigation water per hectare for one season in SRI method, which was on par with 6 days after disappearance of water. Intermittent flooding at 8 days ADW (alternate drying and wetting) recorded lowest water requirement (725mm) but grain yield also drastically declined. Panicle emergence was slightly delayed in SRI than in conventional flooding. Maximum water use efficiency (8.19 kg mm^{-1} ha^{-1}) was observed in SRI method and lowest value was obtained in continuous flooding. Raju and Reddy (1987) also recorded higher water use efficiency in alternate wetting and drying regime in Godavari alluvials. The per day productivity was also found higher in SRI (65.1 kg ha^{-1}) closely followed by 4 days ADW.

The soil water regime under SRI and conventional methods has a conspicuous influence on weed composition and its biomass production (Table 4). Most of the grassy weeds and sedges infested SRI plots and broadleaved weeds were dominant in the conventional system where flooding was practiced. The weeds *Echinochloa colona, Digitaria sangunalis, Digitaria ciliaris* were dominant community in SRI method and registered higher biomass and importance value index (IVI) values (32.8, 28.1 and 26.5, respectively). The luxurious growth of broad leaved and water sedge weeds such as *Ludwigia octovalvis, Cyperus difformis* and *Monochoria vaginalis* were noticed under conventional method. These findings are in collaboration with the results of Raju *et al*., (1995). The survival of aquatic weeds was attributed to their inherent tolerance. *Marsilia minuta* and *Monochoria vaginalis* were absent in SRI method probably due to unfavourable water regime and severe competition with grassy weeds.

Therefore, it can be concluded that SRI method was found superior in increasing root volume, grain yield and saving water. Swarna variety was best suited to SRI method of cultivation. Combined application of FYM at 5 tha^{-1} along with half the dose of recommended nitrogen through chemical and gypsum at tha^{-1} registered highest yield (7.6 tha^{-1}).

Table 4. Weed biomass and importance value index (IVI) of major weeds in conventional and SRI system (Mean of two seasons)

Weed Species	Conventional		SRI		% increase over
	Weed biomass (g m^{-2})	IVI	Weed biomass (gm^{-2})	IVI	conventional (IVI)
Echinochloa colona	3.2	5.1	24.5	32.8	+84.4
Echinochloa glabrescence	2.8	6.2	16.2	25.3	+75.5
Digitaria ciliaris	0	0	17.3	26.5	+100.0
Digitaria sangunalis	2.5	4.9	17.9	28.1	+82.6
Eleusine indica	0	0	6.3	10.4	+100.0
Fimbristylis miliaceae	8.4	17.6	2.1	3.5	-80.1
Leersia hexandra	4.3	9.2	0	0	-100.0
Ludwigia octovalvis	15.3	29.4	0.8	1.6	-94.5
Cyperus difformis	11.8	17.6	2.6	3.1	-82.3
Marsilea minuta	3.7	10.1	0	0	-100.0
Monochoria vaginalis	8.6	12.4	0	0	-100.0
Commelina benghalensis	2.8	4.2	1.9	2.3	-45.2

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