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Potential of water saving in irrigated rice through System of Rice Intensification (SRI)

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ABSTRACT

A field experiment was conducted in wet and dry seasons of 2006 and 2007 at Hyderabad to study the influence of different methods of crop establishment viz., system of rice intensification (SRI), Eco-SRI (nutrients applied through organic source only and conventional method on rice productivity, water use efficiency and its productivity. During wet season, grain yield was significantly higher in SRI than conventional method and Eco-SRI by 10.3 and 33.4%, respectively. Whereas, SRI and conventional method were on par and superior to Eco-SRI in rabi. Among the cultivars, Swarna and DRRH2 were significantly superior to other varieties in kharif and rabi, respectively. There was a mean saving of 32% water in SRI as compared to conventional method. Further the amount of water used for 1 kg grain production was higher (3177 lts) for conventional as compared to SRI method (2162 lts). Hence, SRI can become a viable alternative approach to the conventional transplanting having advantage of both in terms of higher yield and water productivity especially in the areas of limited water situations.

Key words: *System of Rice Intensification, water productivity, water aving*

Rice being the staple food crop holds the key for food security of India and presently it is grown in about 42.0 m.ha with a production of about 91.05 m.t (Economic Survey, 2007). Area under rice is expected to be reduced to about 40 m.ha in the next 15-20 years and most of this reduction is attributed to water shortage and rapid urbanization. Recent estimates indicate that there would be acute water shortages in the coming decades. Rice consumes about 3000-5000 litres of water to produce 1 kg of rice (IRRI, 2001). The per capita availability of water resources declined by 40- 60% in many Asian countries between the years 1955 and 1990 (Glieck, 1993), and expected to decline by 15 to 54% by the year 2025 compared to 1990 (Guerra *et al.,* 1998). Therefore, rice could face a threat due to water shortages and hence there is need to develop and adopt water saving methods in rice cultivation so that production and productivity levels are elevated despite the looming water crisis. System of rice intensification (SRI), originated through participatory on farm experimentation conducted in Madagascar during 1980s by Fr. Henri de Laulanie represents an integrated and ecologically sound approach to irrigated rice cultivation and the productivity is higher in SRI compared to conventional rice farming. Although, SRI s controversial in some circles (Surridge, 2004)), it has shown promising results and it is currently modified and evaluated in different rice-growing countries (Berklaar, 2001). A well developed and healthy root system in SRI plays an important role in uptake and translocation of nutrients from the soil than conventional system (Uphoff 2005) and this ultimately results in healthy plant growth, better tillering, higher biomass and higher yields. Increased yields in SRI compared to conventional method were reported by several authors (Thiyagarajan *et al.* 2005, Uphoff 2005 and Satyanarayana *et al.* 2006). Consequently, there is need to quantify the water requirement in SRI vs Conventional method on the long term basis. Keeping this in view, three methods of crop establishment viz., SRI-organic (Eco-SRI), SRI-INM

(SRI) and conventional method (INM) were evaluated for their productivity, water use efficiency during 2006 - 07 in rice-rice cropping system.

MATERIALS AND METHODS

The field experiment was conducted in wet and dry seasons of 2006-07 at the Directorate of Rice Research-Ramachandrapuram farm in ICRISAT campus, Hyderabad in a sandy clay loam soil. Initial soil samples were collected from three depths and were analysed for important properties using standard procedures. The soil was alkaline [pH 8.5-9.45 in surface (0-15 cm) and sub surface (30-60 cm) depths, respectively]; non-saline (EC-0.47-0.67 in surface and sub surface depths, respectively); with high organic carbon (0.76-1.27%) content. Available N was medium (291 kg ha^{-1}); available P_2O was high (26.8 kg ha^{-1}) and available K_2O was also high (527 kg ha^{-1}) in surface layer.

The experiment was laid out in a split-plot design with cultivars as main plots (BPT 5204, Swarna & DRRH 2 in wet season; MTU 1010, Shanti & DRRH 2 in dry season) and methods of crop establishment (ECO-SRI, SRI and Conventional method) as sub-plot treatments in four replications. In SRI and conventional methods, the recommended dose of N @ 100 kg ha^{-1} during wet season and 120 kg ha^{-1} during dry season was applied through 50% organics (FYM) + 50% inorganics (urea). P_2O_5 and K_2O at 60 and 40 kg ha^{-1} were given through single super phosphate and muriate of potash, respectively, in both seasons. Whereas, in ECO-SRI method, total nutrients were supplied through organic source, FYM only. Twelve days old seedlings in Eco-SRI and SRI at a spacing of 25 x 25cm and 30 day old seedlings in conventional method at 20 x15cm spacing were transplanted. Water management in the first two treatments was done as recommended for SRI method i.e. depending on the soil moisture content once in 3-4 days, just to keep the soil moist, while it was irrigated regularly in the third treatment to maintain submergence of 5 $\pm$ 2 cm. Weeding was done with cono weeder at in 10days interval starting from 10^{th} day after transplanting. Main plots were bunded with polythene sheet to a depth of 1 m for preventing the lateral seepage of water from one to other treatments. Water applied to each treatment through hose pipe is measured periodically with water meters installed at source point. At harvest, grain and straw samples were collected and were statistically using standard statistical methods (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Experimental results (Table 1) indicated the superiority of SRI (5.27 t ha^{-1}) over conventional method (4.78 t ha^{-1}) and Eco-SRI (3.95 t ha^{-1}) during wet season by 10.3 and 33.4%, respectively. Whereas, during dry season, SRI (3.34 t ha^{-1}) and conventional method (3.46 t ha^{-1}) were on par and both were significantly superior to Eco-SRI (1.66 t ha^{-1}). Among the varieties, grain yield differences were significant. Swarna (5.33 t ha^{-1}) during wet season and DRRH 2 (4.12 t ha^{-1}) during dry season were significantly superior to other varieties recording maximum grain yield. The expected higher yields in SRI could not be attained especially, during *rabi* due to sub-soil alkalinity and delayed planting. Plant growth on saline soils is mainly affected by high levels of soluble salts causing ion toxicity, ionic imbalance and impaired water balance and rice is very sensitive during early growth stage (Dobermann and Fairhurst 2000). Sensitivity of rice to salinity at 1-2 leaf stage and again at flowering stage was also reported by Yoshida (1981). Transplanting at 2 leaf stage and damage caused to the root system due to salt accumulation in the root zone by the upward movement under non-flooded conditions could be the probable reasons for not attaining the potential yield in SRI especially during dry season. The dilution effect due to the advantage of flooding in conventional rice might not have resulted in greater yield reduction. In the arid and semi arid regions, salt accumulation in the root zone of soils with high pH due to upward water movement was reported by Yoshida (1981). Eco-SRI with 100% organics did not perform well because in the initial years of organic farming, yield reduction is expected due to slower release of nutrients and mismatch of nutrient release from organics and crop demand. In case of straw yields, SRI and conventional method were on par and both systems were significantly superior to Eco-SRI in both seasons. Among the varieties, DRRH 2 recorded maximum straw yield in both seasons.

The water application was significantly higher for conventional method due to flooding up to 5 $\pm$ 2 cm (14933 m^3 in wet season and 11177.5 m^3 in dry season as compared to SRI method where in no flooding and

Table 1. Grain and straw yields (t ha^{-1}) as influenced by different methods of crop establishment

	Grain yield (t ha^{-1})							
	Wet Season				Dry Season			
Treatments	BPT 5204	Swarna	DRRH 2	Mean	MTU 1010	Shanti	DRRH 2	Mean
Eco-SRI	3.38	4.83	3.63	3.95	1.30	0.87	2.90	1.69
SRI	5.05	6.00	4.75	5.27	3.32	1.75	4.96	3.34
Conventional	4.52	5.17	4.65	4.78	3.39	2.53	4.45	3.46
Mean	4.32	5.33	4.34		2.67	1.69	4.12	
C.D (0.05)								
Main	0.32	Sub	0.15		Main	0.58	Sub	0.60
	Straw yield (t ha^{-1})							
Eco-SRI	5.48	4.83	3.68	4.66	2.71	3.81	4.99	3.84
SRI	6.31	6.52	7.47	6.77	6.08	5.36	6.92	6.12
Conventional	5.82	7.07	7.47	6.79	6.45	6.60	6.05	6.37
Mean	5.87	6.14	6.21		5.08	5.26	5.99	
C.D (0.05)								
	NS		1.57		Main	0.63	Sub	1.24

* Interaction effects were not significant

only saturation was maintained through out crop growth (9189 m^3 and 8906 m^3 in wet season and dry season, respectively (Table-2 and Fig 1). However, the water applied was lowest in SRI-Eco (water maintained below saturation) i.e 7500 m^3 in wet season and 7109 m^3 in dry season.

Water productivity is computed based on the grain yield in kilograms devided by total irrigation in cubic meters indicated that lower water productivity values in conventional method (0.32 and 0.31 kg grain m^{-3}) as compared to SRI method (0.57 and 0.39 kg grain m^{-3}). Is mainly due to application of lower irrigation water as well as higher grain yield from SRI method. Among the cultivars, Swarna recorded highest water productivity (0.52 kg grain m^{-3}) over rest of the cultivars. The amount of water used for producing one kg grain was lowest for SRI (2162 lts) followed by SRI-eco (2936 lts) and conventional method (3177 lts) indicating a saving of 32 % of irrigation water. SRI method saved irrigation water without any penalty on yield compared to conventional method. The number of seedlings planted in SRI is only one per hill , lower

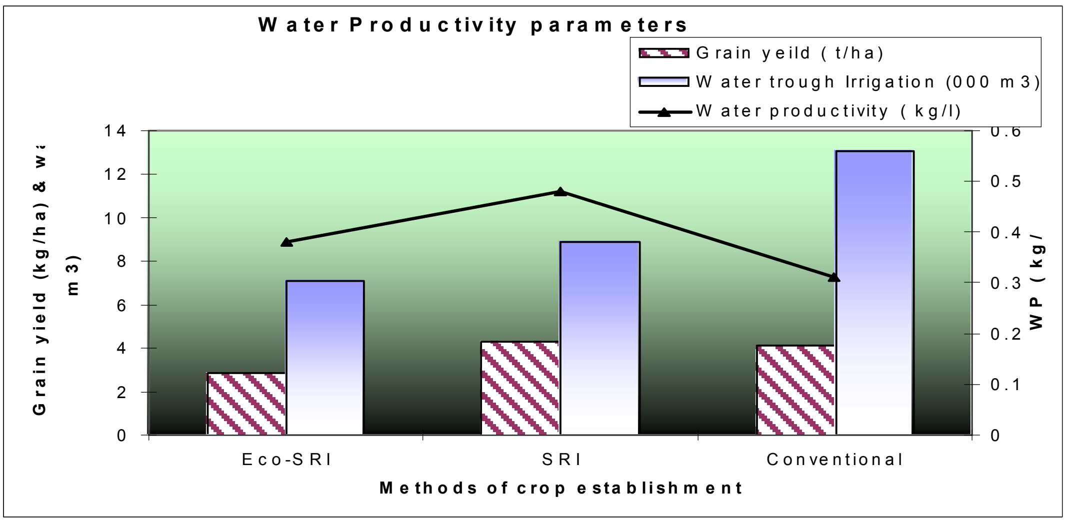

Fig. 1. Water productivity as influenced by different crop establishment methods (Mean of two seasons)

Table 2. Water quantity (m3) as influenced by cultivars and crop establishment methods

Season	Wet Season				Dry season					
Treatments	BPT 5204	Swarna	DRRH 2	Mean	MTU 1010	Shanthi	DRRH-2	Mean		(%) ws
SRI- ECO	7235	7355	7911.5	7500.5	6715	6697.5	6740	6717.5	7109	45.55
SRI	9252	8835	9481.2	9189.4	8562.5	8737.5	8565	8622.5	8906	31.78
Conventional	15350	14350	15099	14933	11172.5	11173	11185	11177.5	13055	
Mean	10612	10180	10831	10541	8817	8869	8830	8839	9690.1	38.66
C.D (O.)5%)										
Main	NS				NS					
Sub	484.8				242.5					
	Water productivity (kg grain per kg -1 water)									
SRI- ECO	0.47	0.66	0.46	0.53	0.19	0.13	0.43	0.25		
SRI	0.55	0.68	0.50	0.57	0.39	0.20	0.58	0.39		
Conventional	0.29	0.36	0.31	0.32	0.30	0.23	0.40	0.31		
Mean	0.41	0.52	0.40	0.44	0.30	0.19	0.47	0.32		

nursery area (1/10 th of normal nursery area) and less number of hills m^{-2} due to wider spacing of 25 x 25 cm. SRI plants exposed for more radiation and circulating air which promoted the edge effect (Birch 1958). The advantage of SRI with one plant per hill and wide spacing helped each plant to develop with edge effect that resulted in higher yield. It is also mutual integrated effect of all the components of the SRI : young seedlings, wider spacing , better soil aeration created with cono weeder which enhanced growth and yield attributes and subsequently grain yield. Randriamibarisoa and Uphoff (2002) reported a yield increase of 1.4 -2.5 t ha^{-1} SRI saved nearly 25% irrigation water without any penalty on yield compared to conventional transplanting (Chowdhury *et al.,* 2005 and Satyanarayana *et al,* 2006). Using intermittent irrigation, Thiyagarajan *et al*., (2002) reported water saving of 50% over the traditional flooding without any effect on grain yield.

From the present study, it can be concluded that SRI resulted in higher yield during *kharif*, and it has been very clearly established that there is a reduction in the water requirement (32%) and also increased yield in SRI as compared to conventional method of crop establishment.

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