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RESEARCH PAPER

Assessment of different rice varieties under acidic soils of West Tripura

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Abstract : The modern cultivation practices of paddy with proper variety can play a significant role in increasing production for national food security. The present work was performed to assess the overall performance of eighteen different rice varieties under SRI and conventional practice with equal package of practices in acidic soil of West Tripura district during *Kharif* 2012-13. The plant height, no. of effective tillers per hill, no. of seeds per panicle, filled grains per panicle, unfilled grains per panicle, test weight, grain yield, stover yield, crop duration and pest and diseases were considered as different parameters for comparative assessment among the taken varieties. Results showed that the system of rice intensification (SRI) practice out yielded conventional rice cultivation practice for all the varieties. From the enlisted rice varieties, Pratiksha had been found to perform better than other varieties. Besides Pratiksha, farmers could also choice Ranjit and PAN-819 as other alternatives to MTU 7029 as long duration paddy. On the other hand, in changing climate scenario under rainfed situation in *Kharif* season, farmers may also opt for growing short duration variety MTU 1010.

Key Words : SRI practice, Conventional practice, Paddy, Varietal assessment

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INTRODUCTION

An attempt to maximizing production with minimizing inputs is somewhat led to the technology particularly improved variety and modern cultivation practice system of rice intensification (SRI). In reality SRI requires more labour per hectare than traditional methods of growing rice. Irrigation systems that allow water “put on” and “taken off” the field at regular intervals needs the reconstruction of fields which is designed to hold maximum amount of water before initiating SRI production system. Rice is not an aquatic plant where seedling loses much of their growth potential when transplanted beyond about 15 days of age which bring trauma to the seedling during transplanting. Wider spacing of plants leads to greater root growth and accompanying tillering. Wider spacing, less seed, transplanting at 8-12 days old, less water, turning back the weeds into the soil and use of organic manures are the attribution in SRI method that help in achieving higher productivity. The system of rice intensification (SRI) has been promoted for more than a decade as a set of agronomic management practices for rice cultivation that enhances yield (Ceesay *et al*., 2006; Kabir and Uphoff, 2007; Namara *et al*., 2008; Sato and Uphoff, 2007; Senthilkumar *et al*., 2008; Sinha and Talati, 2007; Zhao *et al*., 2009), reduces water requirements (Satyanarayana *et al*., 2007), raises input productivity (Sinha and Talati, 2007), and is more favourable for the environment than conventional practice with its continuous flooding of paddies and heavy reliance on inorganic fertilization (Uphoff, 2003). SRI is referred to as methodology, not a technology or fixed set of practices (Uphoff, 2003), to be tested and optimized under a range of different agro-ecological environments (Stoop *et al*., 2002). This study was designed to assess the full set of recommended SRI and conventional practices on eighteen different rice varieties. The main objective behind this experiment was to replace the traditional method of cultivating local poor yielding rice varieties with SRI practices blended with high yielding promising varieties.

Table A : Cultural management sets for *Kharif* paddy under both conventional and SRI cultivation

Sr. No.	Type of cultural practice		Applied dose
1.	Chemical fertilizer, organic manure and Biofertilizer (As basal)	SSP	150 kg/ha
		MOP	40 kg/ha
		Urea	26.25 kg/ha
		Cowdung	150 kg/ha
		Azospirillium	10.5 kg/ha
		Biophos	10.5 kg/ha
2.	1st Top Dressing and	Urea	75 kg/ha
	Biopesticide spray (35 DAP)	Neem oil 1500 ppm + *Psuedomonas fluorescens* + *Trichoderma viride*	(6 ml + 5 g + 5 g)/lit. of water
3.	2nd Top Dressing (55 DAP)	Urea	75 kg/ha

MATERIAL AND METHODS

Experimental site and soil:

Experiments were conducted at the Instructional farm of Divyodaya Krishi Vigyan Kendra, Chebri, Khowai, Tripura (23.72° N, 91.74° E) during the wet season (July–November) in 2012. Soils of the experimental site was sandy loam (62-65% sand, 18% silt, 16-17% clay), acidic with a pH of 5.85, 0.52% organic carbon, low in available nitrogen (217.65 kg ha^{-1}), medium in available phosphorus (22.82 kg /ha), and available potash (174.68 kg/ ha).

Experimental design and cultural practices:

The experiment was conducted during the rainy season (*Kharif*) in the year 2012 using Split Plot Design where the main plots were SRI and conventional system and the subplots were different rice varieties of 20 m × 10 m each plot. All the plots were surrounded by 50 cm wide bunds to prevent lateral seepage between plots, with 50 cm wide channels for irrigation and drainage. The varieties used were V_1=PAN-816 GANGA RED, V_2= JARAVA, V_3= RAJLAXMI, V_4= MTU-7029, V_5=CR-HR-2007 AJAY, V_6=IR-36, V_7=PAN-105 GANGA WHITE, V_8=NC-492, V_9=RANJIT, V_{10}=PAN-819 RANJANA, V_{11}=MTU-1010, V_{12}=PAN-804 JAMUNA, V_{13}=PAN-809, V_{14}=BASHKATHI, V_{15}=GANGA PINK PAN-815, V_{16}=PAN-2423, V_{17}=PRATIKSHA, V_{18}=IET-5656. These varieties were grown under the two alternative systems of crop management, the SRI and the conventional. Both the SRI and conventional system plots had the same soil biofertilizer amendments, a combination of chemical fertilizer and organic matter (Table A) with spacing of 25×25 cm and 20 x 15 cm in SRI and conventional plots, respectively. For nursery establishment, germinated seeds were broadcasted on 19th and 30th July, 2012 for conventional and SRI, respectively. In the SRI plots, 10-day-old seedlings were transplanted on 9th August, while in the conventional plots, seedlings of 22 days old, were transplanted on 10th August, 2012. Conventional plots were kept continuously flooded and irrigated whenever required in order to maintain a ponded layer of 5–6 cm depth during the vegetative stage. SRI plot soils were kept saturated but with no standing water during the vegetative stage. Weeding in SRI plots was performed by cono-weeder to incorporate weeds into the soil and for soil aeration; conventional plots were hand-weeded.

RESULTS AND DISCUSSION

The results of the present study have been presented and discussed under the following headings:

Plant height :

In general, plant height was significantly affected by cultivation practices at harvest. At harvest lower plant height was observed in case of conventional practice (C_2) than SRI (C_1). The pooled plant height at harvest was 81.39 cm and 76.44 cm in case of SRI and conventional practice, respectively (Table 1). Plant height varied non-significantly with different rice varieties. In case of rice varieties, it was revealed that the highest plant height of 107.33 cm was attained by V_8 (NC- 492) followed by V_{15} (GANGA PINK PAN-815).

SRI management included many departures from conventionally recommended methods of rice cultivation. It proposes the use of single young seedlings, drastically lowered plant densities, keeping fields unflooded and use of a mechanical weeder which aerated the soil, all with the aim of providing optimal growth conditions for the plant, to get better performance in terms of yield and input productivity. A number of previously published reports on SRI showed enhancement of plant height (Sato and Uphoff, 2007; Senthilkumar *et al.*, 2008; Sinha and Talati, 2007; Zhao *et al.*, 2009).

Number of effective tiller per hill:

Number of effective tiller per hill was significantly affected by cultivation practices at harvest. At harvest higher number of effective tiller per hill was observed in case of SRI (C_1) than conventional practice (C_2). SRI attained the pooled highest number of effective tiller per hill (15.39) at harvest compared to 14.59 in case of conventional practice (Table 1). Number of effective tiller per hill varied non-significantly with different rice varieties. Pooled data revealed that the highest number of tiller per hill @ 19.67 was observed in V_{18} (IET-5656) followed by 18.17 in V_{12} (PAN-804 JAMUNA), 17.67 in V_{10} (PAN-819 RANJANA) and 17.17 in V_{17} (PRATIKSHA).

For higher yield, profuse tillering is critical, with yield being determined by the number of panicle-bearing tillers per hill (effective tillers), the number of grains per panicle and the weight of individual grains (Yoshida, 1981). In SRI, the number of panicle-bearing tillers per hill by itself was not responsible for higher grain yield. Even without significant increase in this parameter, SRI recorded significantly higher grain yield compared to conventional practice reason being the longer panicles with more grains, better grain filling and a significant increase in grain weight. SRI had a greater percentage of longer panicles than did rice grown with conventional recommended practices; on the other hand, conventional practices produced a greater percentage of shorter panicles. Similar findings have been reported by Senthilkumar *et al*. (2008) and Sinha and Talati (2007).

Number of seeds per panicle:

Number of seeds per panicle was significantly affected by cultivation practices at harvest. At harvest significantly higher number of seeds per panicle was observed in case of SRI (C_1) than conventional practice (C_2). The pooled highest number of seeds per panicle at harvest was 173.67 in case of SRI compared to 164.94 in conventional practice. Number of seeds per panicle varied non-significantly with different rice varieties (Table 1). The highest number of seeds per panicle @ 217.33 was observed in V_{17} (PRATIKSHA) followed by 203.33 in V_7 (PAN-105 GANGA WHITE) and 198.17 in V_9 (RANJIT).

The number of seeds per panicle and the weight of individual grains are critical inputs for higher yield (Yoshida,

Table 1 : Effect of cultivation practices and different varieties of paddy on different agronomic parameters

	Plant height (cm)	No. of effective tiller/hill	No. of seeds/panicle	Filled grain/ panicle	Unfilled grain/ panicle
Cultivation practice					
C_1	81.39	15.39	173.67	144.43	29.26
C_2	76.44	14.59	164.94	131.43	33.46
S.E±	1.62	0.26	2.98	4.03	1.36
C.D. (P=0.05)	9.85	1.60	18.17	24.50	8.29
Varieties					
V_1	92.67	14.33	160.50	131.50	29.00
V_2	68.67	13.83	140.17	126.17	14.00
V_3	80.50	12.33	187.50	149.50	37.83
V_4	46.00	17.00	185.83	163.17	22.83
V_5	83.00	15.50	167.33	144.67	23.00
V_6	82.33	13.50	161.17	130.00	30.83
V_7	90.33	12.83	203.33	158.17	45.17
V_8	107.33	13.50	182.00	149.67	32.33
V_9	80.17	13.50	198.17	150.00	48.33
V_{10}	67.50	17.67	190.50	153.50	36.83
V_{11}	93.83	16.67	134.67	99.33	35.33
V_{12}	70.67	18.17	182.33	162.83	19.50
V_{13}	32.50	14.50	179.33	133.67	45.83
V_{14}	89.17	12.33	134.33	106.00	28.50
V_{15}	94.83	13.00	168.00	134.67	32.83
V_{16}	84.83	14.33	134.67	100.33	34.50
V_{17}	75.67	17.17	217.33	182.33	35.00
V_{18}	80.50	19.67	120.33	107.17	12.83
S.E.±	1.07	0.18	0.55	0.62	0.34
C.D. (P=0.05)	NS	NS	NS	NS	NS

C_1=SRI, C_2= Conventional, V_1=PAN-816 GANGA RED, V_2= JARAVA, V_3= RAJLAXMI, V_4= MTU-7029, V_5=CR-HR-2007 AJAY, V_6=IR-36, V_7=PAN-105 GANGA WHITE, V_8=NC-492, V_9=RANJIT, V_{10}=PAN-819 RANJANA, V_{11}=MTU-1010, V_{12}=PAN-804 JAMUNA, V_{13}=PAN-809, V_{14}=BASHKATHI, V_{15}=GANGA PINK PAN-815, V_{16}=PAN-2423, V_{17}=PRATIKSHA, V_{18}=IET-5656

1981). SRI recorded significantly higher number of seeds per panicle compared to conventional practice reason being the panicles of SRI plants accommodated more grains than conventional practice. For every centimetre increase in SRI panicle length, increase in the number of grains was observed, while with conventional practice, the corresponding increase was very limited. The increased number of grains per unit length was the result of longer primary branches on SRI panicles accommodating a greater number of spikelet (Thakur *et al*., 2009).

Filled and unfilled grains per panicle:

Filled grains per panicle were significantly affected by cultivation practices at harvest. The significantly higher number filled grains were observed in case of SRI (C_1) than conventional practice (C_2). Pooled data showed highest filled grains per panicle in SRI at harvest with 144.43 number of filled grains and the lowest of 131.43 in case of conventional practice. But, significantly higher number of unfilled grains was observed in conventional practice (C_2) than SRI (C_1). Number of filled grains per panicle varied non-significantly with different rice varieties. The pooled data revealed that the highest number filled grains per panicle (182.33) was observed in V_{17} (PRATIKSHA) followed by 163.17 in V_4 (MTU-7029) and 162.83 in V_{12} (PAN-804 JAMUNA) whereas highest number unfilled grains per panicle (48.33) was observed by V_9 (RANJIT) and the lowest number unfilled grains per panicle (12.83) by V_{18} (IET-5656) (Table 1).

With SRI management, longer panicles with more grains and better grain filling are the main factors responsible for the yield enhancement. SRI had a greater percentage of grain filling than did rice varieties grown with conventional practices, while on the other hand; conventional practices produced a greater percentage of unfilled grains (Thakur *et al.,* 2009). Panicles of SRI plants accommodated more grains than conventional practice (Thakur *et al.,* 2009). Reports have been confirmed by the findings of Ceesay *et al*. (2006), Kabir and Uphoff, (2007) and Namara *et al*. (2008).

Test weight (1000 seed):

1000 seed weight (test weight) was significantly affected by cultivation practices at harvest. Significantly highest 1000 seed weight was observed in case of SRI (C_1) than conventional practice (C_2). The pooled highest 1000 seed weight was 23.30 g in case of SRI compared to 22.26 gm in conventional practice (Table 2). Test weight varied non-significantly with different rice varieties. The pooled data showed that the highest 1000 seed weight (27.95 g) was observed in V_{17} (PRATIKSHA) followed by 27.49 g in V_{18} (IET-5656) and 25.90 in V_{11} (MTU-1010).

Again repeating the sentence by Yoshida (1981) where he concluded that in case of higher yield being determined by the number of panicle-bearing tillers per hill (effective tillers), the number of grains per panicle and the weight of individual grains. Here we can say that the phenotypical characters of individual rice varieties are expressed fully in case of SRI due to the use of single young seedlings, drastically lowered plant densities, keeping fields unflooded and use of a mechanical weeder which aerates the soil, all with the aim of providing optimal growth conditions for the plant, to get better performance in terms of yield and input productivity. Previously published reports on SRI by Namara *et al*. (2008), Satyanarayana *et al*. (2007) and Sato and Uphoff, (2007) have showed enhancement of test weight.

Grain yield:

Grain yield was significantly affected by cultivation practices at harvest. The significantly higher grain yield

Table 2 : Effect of cultivation practices and different varieties of paddy on test weight, stover yield, grain yield and crop duration

	Test weight (g) (1000 seed)	Stover yield (kg/ha)	Grain yield (kg/ha)	Duration (Days)
Cultivation practice				
C_1	23.30	4612.2	5169.1	120.28
C_2	22.26	3707.7	4880.3	130.61
S.E.±	0.22	117.60	58.39	1.41
C.D. (P=0.05)	1.32	NS	355.29	8.58
Varieties				
V_1	25.12	4209.6	4736.6	122.83
V_2	25.80	4351.4	5359.9	131.17
V_3	25.31	3435.4	4978.5	127.83
V_4	19.86	3522.1	5588.5	135.17
V_5	24.87	4955.8	5172.1	127.83
V_6	20.17	4950.0	5141.7	102.83
V_7	19.99	3659.6	3798.4	117.83
V_8	19.46	5459.3	5747.0	157.83
V_9	20.58	3783.4	6470.8	152.83
V_{10}	22.64	3884.4	6083.7	142.83
V_{11}	25.90	3295.3	2813.7	105.83
V_{12}	22.48	3219.6	5799.1	140.17
V_{13}	21.26	4330.3	3760.5	127.83
V_{14}	19.08	4461.9	1457.1	87.17
V_{15}	21.19	5013.5	5096.2	109.17
V_{16}	20.93	4058.4	4225.3	112.83
V_{17}	27.95	5702.0	6908.5	136.17
V_{18}	27.49	4384.3	5306.8	152.83
S.E.±	0.05	15.21	33.34	0.20
C.D. (P=0.05)	NS	NS	NS	NS

C_1=SRI, C_2= Conventional, V_1=PAN-816 GANGA RED, V_2= JARAVA, V_3= RAJLAXMI, V_4= MTU-7029, V_5=CR-HR-2007 AJAY, V_6=IR-36, V_7=PAN-105 GANGA WHITE, V_8= NC-492, V_9=RANJIT, V_{10}=PAN-819 RANJANA, V_{11}=MTU-1010, V_{12}=PAN-804 JAMUNA, V_{13}=PAN-809, V_{14}=BASHKATHI, V_{15}=GANGA PINK PAN-815, V_{16}=PAN-2423, V_{17}=PRATIKSHA, V_{18}=IET-5656
NS=Non-significant

(Table 2) was observed in case of SRI (C_1) than conventional practice (C_2). The pooled grain yield was 5169.1 kg/ha in case of SRI compared to 4880.3 kg/ha in conventional practice. SRI was found to have yielded 11.98 % higher than conventional paddy cultivation. Grain yield varied non-significantly with different rice varieties. The pooled data showed that the highest grain yield (6908.5 kg/ha) was observed in V_{17} (PRATIKSHA) followed by 6470.8 kg/ha in V_9 (RANJIT) and 6083.7 Kg/ha in V_{10} (PAN-819). The lowest yield (1457.1 kg/ha) was recorded in V14 (Bashkathi), among all the rice varieties.

The divergence in grain yield between SRI and conventional practice was due to differences in harvest index rather than dry matter production. For higher yield, profuse tillering is critical, with yield being determined by the number of panicle-bearing tillers per unit area, the number of grains per panicle and the weight of individual grains (Yoshida, 1981). In SRI, the number of panicle-bearing tillers per unit area by itself was not responsible for higher grain yield. Even without significant increase in this parameter, SRI recorded significantly higher grain yield compared to conventional practice. Reports have been confirmed by the findings of Ceesay *et al.* (2006), Kabir and Uphoff (2007) and Thakur *et al.* (2009).

Stover yield:

Stover yield was significantly affected by cultivation practices at harvest. The significantly higher stover yield (Table 2) was observed in case of SRI (C_1) than conventional practice (C_2). The pooled stover yield was 4612.2 kg/ha in case of SRI compared to 3707.7 kg/ha in conventional practice. SRI yielded 24.4 % higher stover yield than the conventional practice. The stover yield varied non-significantly with different rice varieties. The pooled data showed that the highest stover yield (5702.0 kg/ha) was observed in V_{17} (PRATIKSHA) followed by 5459.3 kg/ha in V_8 (NC-492) and 5013.5 kg/ha in V_{15} (GANGA PINK PAN-815).

Thakur *et al.* (2009) found that the greater straw weight at harvest from SRI plots was due to a greater number of tillers per hill. However, with conventional practice the percentage of productive tillers relative to the maximum number of tillers was less than for SRI. Using SRI management practices, the number of tillers produced in each hill was almost double that of conventional, even though conventional hills contained three plants instead of one. The number of tillers per m^2 was lower with SRI mainly because it had only half as many hills per m^2. The present report corroborates the findings by Kabir and Uphoff (2007) and Zhao *et al.* (2009).

Duration (Days):

The average pooled duration considering all the taken varieties was around 10 days less in SRI than conventional practice. It was 120.28 and 130.61 days in SRI and conventional methods, respectively. Now, coming to individual variety, it was recorded that the average pooled duration (considering SRI and conventional practice for the same) was lowest (87.17 days) in case of variety V_{14} (BASHKATHI) followed by 105.83 days in variety V_{11} (MTU-1010). Similarly, the average pooled duration was maximum (157.83 days) in case of variety V_8 (NC-492) followed by 152.83 days in variety V_{18} (IET-5656). The most outstanding variety in terms of yield, V_{17} (Pratiksha) took only 136.17 days that was quietly better than other promising variety V_9 (RANJIT) having also high yield potentiality and duration of about 152.83 days. Moreover, the positive relation noticed between grain yield and duration of different rice varieties in most of the cases. Pooled effect of cultivation tillage and rice varieties on grain yield w.r.t duration (days) (Table-3) showed that with the increase in duration among the different varieties, grain yield also increased. It is natural due to the reason that more photosynthates gets enough time to travel from source to sinks, again which inturn increases the yield attributes increasing grain yield (Yoshida, 1981).

Pests and diseases:

Among different insect pests, yellow stem borer (*Scirpophaga* sp.), leaf roller (*Cnaphalocrosis medinalis*) and rice bug (*Leptocoryza acuta*) were found in all the varieties in both of SRI and conventional condition. Similarly in case of diseases, bacterial leaf blight, rice blast and brown leaf spot were observed. Besides, attack of birds to grains was noticed during maturity in short duration early maturing variety under both of SRI and conventional condition that was above ETL. The infestation level of above mentioned insects and diseases were below ETL except rice bug. Its attack was relatively high in short duration varieties than long duration varieties. The reason behind the relatively high attack of birds and rice bugs in short duration varieties were due to because the surrounding paddy fields covering more area with relatively long duration varieties which flowered late, while all the nearby available birds and rice bugs had got chance to attack within a limited experimental area covering short duration varieties with early flowering opportunity.

Conclusion:

Present results showed that the combination of SRI practices out yielded currently recommended conventional rice cultivation practices. From the enlisted rice varieties Pratiksha have been found to have performed better than other varieties both in case of SRI and conventional and so, it can be recommended to adopt by the local farmers through SRI. Presently, most of the farmers of Tripura are growing paddy variety MTU 7029 which has about same crop duration but with less yield potentiality in comparison to variety Pratiksha.

Besides Pratiksha, farmers could also find other alternatives to MTU 7029 such as Ranjit and PAN-819 which have better yield potentiality with somewhat little bit more duration. On the other hand, in changing climate scenario under rainfed and irrigated condition in paddy based cropping system there is also need for promotion of short duration paddy variety also. Considering all these, under rainfed situation in *Kharif* season, farmers may grow short duration variety Banskathi and MTU 1010 instead of long duration enlisted paddy varieties those may face problem to survive with optimum yield under rainfed situation if long days dry spell prevail during *Kharif* season under changing climate scenario. Moreover, growing early winter vegetable or timely sowing of oilseeds/pulse crop after *Kharif* paady, there is urgent need to adopt short duration paddy variety Banskathi and MTU 1010 in *Kharif* season instead of long duration one.

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