Response of Some Rice Varieties to Different Crop Management Practices towards Morphological and Yield Parameters

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Abstract- The present investigation was undertaken with seven rice varieties to assess their responses to three management practices, namely System of Rice Intensification (SRI), Recommended Practice (RP) and Traditional Practice (TP) towards morpho-physiological and yield parameters. The results indicated that all the cultivars under study performed better under SRI as compared to other two practices with respect to different morphological and yield traits including grain yield. All the cultivars exhibited delayed panicle initiation, increased leaf area, leaf area index and leaf area duration under SRI practice as compared to other two cultivation practices. Among the varieties, PAC 837 recorded the highest grain yield (7.83 t/ha), followed by Arize 6444 (6.55 t/ha) and IR-64 (5.07 t/ha) under SRI practice.

Index Terms- System of Rice Intensification(SRI), Recommended cultivation Practice(RP), Traditional cultivation Practice(TP)

I. INTRODUCTION

The ***System of Rice Intensification***, known as SRI -- *le Système de Riziculture Intensive* in French and *la Sistema Intensivo de Cultivo Arrocero* (SICA) in Spanish -- is an agro-ecological methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients.

Most simply, SRI is a set of concepts/ principles/insights/practices that change the management of plants, soil, water & nutrients: (a) to produce larger, more effective, longer-lived root systems , and (b) to enrich the life in the soil to achieve more productive, healthier phenotypes from any genotype.

System of rice intensification (SRI) is not a fixed package of technical specifications but a system of production with four main components viz. soil fertility management, planting method, weed control and water management.

SRI yields are highly variable -- both between countries and within countries. This is because of the four factors contributing to rice production, not just the first two usually cited as follows.

- Genetic potential,
- Resource inputs (quantitative),
- Management of inputs (qualitative), and
- The abundance and diversity of soil biota, and their response to SRI management

Keeping the above in view the present work was taken on SRI to assess its performance in comparison to other traditional cultivation practices in relation to the productivity of rice crop under varied cultivation practices vis a vis varied cultivars.

II. MATERIALS AND METHODS

The field experiment was conducted in the Research Farm of the Krishi Vigyan Kendra, Arunachal, Silchar in *Rabi* season , and the laboratory works were carried out in the Soil Testing Laboratory, Silchar , and in the Department of Ecology and Environmental Science, Assam University, Silchar. The materials for the investigation consisted of seven rice varieties, out of which one is a traditional cultivar (Koiya Boro), four HYVs (Luit, IR-64, Dichang and MTU 1010) and two hybrids (PAC 837 and Arize 6444). All the seven varieties were grown under three management practices, namely, SRI, RP and TP. The experiment was laid out in a split plot design with three replications with a plot size of 5m X 4m. Under SRI practice, seedlings of 12-day old were raised in the seed bed with high organic matter and were transplanted at a spacing of 25cm X 25cm, while under RP, 21-days old seedlings were raised in standard seed beds and transplanted at a spacing of 20cm X 15cm. On the other hand, 30-day old seedlings raised in normal seed beds were transplanted traditionally at relatively closer spacing under TP. Transplanting was done at the rate of 1, 2-3 and 3-4 seedlings per hill for SRI, RP and TP, respectively. The field was kept moist throughout the growing period in case of SRI, while 5-10 cm water depth was maintained upto flowering stage in the plots managed through RP and normal available water level was maintained in the plots managed through TP. Ten plants from each plot were randomly chosen for recording observations on the six growth parameters (i.e plant height, root length, root to shoot ratio and root volume, number of tillers/ hill and per cent tiller mortality), three physiological parameters (i.e. days to panicle initiation, leaf area index and leaf area duration) and four yield traits (i.e. number of panicles/ m^2, number of grains/ panicle, 1000-grain weight and grain yield/ha.etc)

Plant height was measured with the help of a meter scale from the ground level to the apex of main axis. Root length was measured from root/shoot demarcation point to root tip according to the method of Sirohi *et al.* (1978). Root to shoot ratio was

calculated from the data on root and shoot length (cm) at different stages of growth. Root volume was determined by water displacement method used by Raja and Bishnoi (1990). Total number of tillers per plant was counted at maximum tillering and flowering stages of growth. Percent tiller mortality was calculated by the following formula:

$$\text{Tiller mortality (\%)} = 100 - \frac{\text{Number of tillers at flowering stage}}{\text{Number of tillers at maximum tillering stage}} \times 100$$

Days to panicle initiation was recorded as per the number of days taken for panicle initiation from the date of sowing. Leaf area index, which expresses the ratio of leaf surface (one side only) to the ground area occupied by the plant, was calculated using the formulae, suggested by Evans (1972). Similarly, Leaf area duration (LAD) was measured as leaf area index per unit of time and was calculated by Gardener *et al*. (1985)'s equation, LAD = LAI × M, where, M = Number of days (crop growth period). The data were analyzed following standard procedure (Kothari, 2004).

III. RESULTS AND DISCUSSION

Growth and morphological characters

Plant height, root length, root to shoot ratio and root volume recorded at 30 days after transplanting (DAP), 50 DAP and 70 DAP are presented in the Table 1. The results revealed that plant height was significantly lower in case of SRI practice at 30 DAP but it was significantly higher at 50 and 70 DAP in all the varieties. Similar results were also obtained in case of root length, root to shoot ratio and root volume. Among the varieties, Koiya Boro (a local variety) produced the tallest plants under SRI practice and exhibited minimum root to shoot ratio under TP. PAC 837, a hybrid variety recorded maximum root length and root volume, while, MTU 1010, a HYV recorded minimum root length and root volume under SRI and TP, respectively. Both the hybrids included in the present investigation exhibited highest root to shoot ratio under SRI practice. Observations recorded on number of tillers/ hill at two different stages, *viz.*, maximum tillering stage and flowering stage and on percent tiller mortality are presented in Table 2. Number of tillers per hill was found to be the highest for PAC 837 at both maximum tillering and flowering stages in all the three practices. However, the number of tillers was more in case of SRI practice as compared to other two practices for all the tested varieties. Per cent tiller mortality was found to be highest in case of var. Dichang under traditional practice and lowest in case of Koiya Boro and Arize 6444 under SRI. Sarath and Thilak (2004) also reported that the Dry weights of stem, leaf, and root and the total dry weight, leaf area and total root length per hill during the growing period and the tiller number per plant at heading were significantly higher in SRI compared to other treatments. Similar results were also reported by Zheng, 2004 for plant height and culm length and Krishna *et al*., 2008 for number of tillers per plant.

Physiological parameters

The observations made on the days to panicle initiation, leaf area index (LAI) and leaf area duration (LAD) are presented in the Table 3 . The results revealed that the panicle initiation was delayed significantly under SRI for all the tested varieties. Similarly leaf area index and leaf area duration were also found to be more in case of SRI followed by the recommended practice as compared to traditional practice. Variety wise PAC 837 exhibited delayed panicle initiation and maximum LAI and LAD under SRI practice, while, Dichang exhibited earliest panicle initiation, while Koiya Boro recorded minimum LAI and MTU 1010 recorded minimum LAD under traditional practice. Thakur *et al*., 2011 also reported significant improvements in the morphology of SRI plants in terms of root growth, plant/Culm height, tiller number per hill, tiller perimeter, leaf size and number, leaf area index (LAI), specific leaf weight (SLW), and open canopy structure.

Yield attributing traits

Observations on the major yield parameters like number of panicles/m^2, number of grains per panicle, 1000-grain weight and grain yield/ha are presented in Table 4. The results revealed that like the growth and physiological parameters, all the varieties showed better performance in terms of yield attributing traits including grain yield under SRI practice, followed by recommended practice. Among the varieties tested PAC 837 produced the boldest grains with maximum number of panicles/ m^2 and number of grains/ panicle. Highest grain yield was recorded with PAC 837 (7.83 t/ha), followed by Arize 6444 (6.05 t/ha), IR-64 (5.07 t/ha) under SRI practice, which could be attributed to their better performance in terms of yield attributing traits as well as growth and physiological parameters. Uphoff and Kassam (2009) reported that depending on their current yield levels, output per hectare was found to have increased usually by 50% or more, with increases of at least 20%, and sometimes 200% or more in case of SRI as compared to other practices. Kumar *et al*. (2010) also reported that significant differences were observed between the varieties under SRI. They observed that hybrids (4-42% yield advantage) performed better over the varieties (2-17%) under SRI as against ST. Since seed requirement is quite low in SRI, this could be the best method for cultivating hybrids, whose seed cost is relatively higher compared to HYVs. Lin *et al*. (2011) also reported that under intermittent water application as recommended with SRI management, grain yield increased by 10.5–11.3%, as compared to standard irrigation practice. The factor that contributed most to higher yield was increased number of grains per panicle under SRI treatment.

Based on the result presented above it can be suggested that SRI is more effective agronomical practice for higher production of rice in comparison to Recommended and traditional cultivation practices. The Hybrid varieties under study are more responsive to SRI than RP &TP with respect to yield and other parameters.

Table 1. Variation in growth and morphological characters for all the seven varieties under SRI.

Stages	30 DAP			50 DAP			70 DAP		
	Plant height (cm)								
Variety	SRI	RP	TP	SRI	RP	TP	SRI	RP	TP
Luit	26.67	39.67	38.00	88.00	86.00	82.00	110.00	108.00	102.33
IR-64	29.33	40.33	35.00	89.00	88.33	74.67	114.00	113.33	108.00
Dichang	28.67	38.00	34.33	90.67	84.67	75.33	116.33	110.67	107.00
Arize 6444	25.00	36.00	36.00	85.00	77.67	70.33	105.00	105.00	107.67
PAC 837	28.33	38.33	36.67	93.00	80.67	83.00	117.33	105.67	104.33
MTU 1010	33.33	43.33	40.00	92.67	90.00	78.00	121.67	120.33	116.33
Koiya Boro	31.33	48.33	45.67	104.00	104.00	100.00	131.33	125.00	122.33
$CD_{0.05}$ (treat.)	**1.860**			**3.563**			**1.650**		
$CD_{0.05}$ (var.)	**1.418**			**1.800**			**3.128**		
	Root length (cm)								
Luit	8.00	12.33	11.33	17.33	15.00	14.00	22.00	21.00	20.00
IR-64	8.67	12.00	11.00	17.67	15.33	14.33	22.67	20.00	19.00
Dichang	9.00	13.00	11.67	18.00	16.33	13.33	22.67	19.33	17.67
Arize 6444	7.67	11.00	12.00	16.33	14.00	13.67	23.33	22.67	20.00
PAC 837	8.00	11.67	9.00	19.00	15.00	15.00	25.33	20.00	20.00
MTU 1010	8.33	9.67	9.67	18.00	14.00	12.00	24.00	19.33	17.33
Koiya Boro	8.00	11.33	10.00	21.67	13.67	11.67	28.00	19.00	17.67
$CD_{0.05}$ (treat.)	**0.714**			**0.701**			**1.252**		
$CD_{0.05}$ (var.)	**0.992**			-			-		
	Root to shoot ratio								
Luit	0.30	0.31	0.30	0.20	0.17	0.17	0.20	0.19	0.20
IR-64	0.30	0.30	0.31	0.20	0.17	0.19	0.20	0.18	0.18
Dichang	0.31	0.34	0.34	0.20	0.19	0.18	0.19	0.17	0.17
Arize 6444	0.31	0.31	0.33	0.19	0.18	0.19	0.22	0.22	0.19
PAC 837	0.28	0.31	0.25	0.20	0.19	0.18	0.22	0.19	0.19
MTU 1010	0.25	0.22	0.24	0.19	0.16	0.15	0.20	0.16	0.15
Koiya Boro	0.26	0.23	0.22	0.21	0.13	0.12	0.21	0.15	0.14
$CD_{0.05}$ (treat.)	-			**0.016**			**0.011**		
$CD_{0.05}$ (var.)	**0.03**			**0.018**			**0.015**		
	Root volume (cc)								
Luit	17.70	26.83	25.30	43.57	37.87	35.73	52.77	50.57	48.10
IR-64	19.17	26.50	24.30	44.17	38.40	35.80	54.43	47.97	45.63
Dichang	20.03	28.23	25.97	44.80	40.47	33.37	54.57	46.37	42.43
Arize 6444	16.97	24.37	26.63	41.30	35.60	33.97	55.90	51.10	48.03
PAC 837	17.83	25.77	20.03	47.50	37.57	36.73	60.63	48.10	48.03

MTU 1010	18.57	21.50	21.63	44.67	35.00	30.33	57.47	46.43	41.63
Koiya Boro	17.50	25.10	22.10	53.97	34.17	28.40	67.03	45.63	42.50
$CD_{0.05}$ (treat.)	**0.154**			**0.131**			**0.33**		
$CD_{0.05}$ (var.)	**0.211**			-			-		

Table 2. Variation in number of tillers/hill and percent tiller mortality at different stages of crop growth for all the seven varieties.

	Maximum tillering stage			Flowering stage			Per cent tiller mortality		
Variety	SRI	RP	TP	SRI	RP	TP	SRI	RP	TP
Luit	27.33	24.00	20.33	21.00	16.67	16.00	23.15	30.53	21.00
IR-64	37.33	23.00	20.00	32.33	16.33	12.67	13.30	28.83	36.51
Dichang	28.00	24.33	19.67	23.33	17.00	12.33	16.86	30.18	37.14
Arize 6444	39.00	34.00	28.00	36.00	25.67	23.67	7.72	24.38	15.44
PAC 837	41.33	38.00	34.00	35.33	31.00	28.00	14.50	18.45	17.57
MTU 1010	37.67	23.33	18.33	29.33	16.33	12.67	21.74	29.90	30.90
Koiya Boro	22.33	20.33	18.67	17.33	17.00	15.00	5.36	16.48	19.36
$CD_{0.05}$ (treat.)	**2.032**			**1.606**			**4.257**		
$CD_{0.05}$ (var.)	**1.501**			**1.422**			**4.133**		

Table 3. Variation in physiological parameters like days to panicle initiation, LAI and leaf area duration for all the seven varieties.

	Days to panicle initiation			LAI at max. tillering stage			Leaf area duration		
Variety	SRI	RP	TP	SRI	RP	TP	SRI	RP	TP
Luit	69.00	66.33	64.67	1.64	1.61	1.58	172.35	164.27	158.24
IR-64	76.00	75.33	72.00	1.72	1.65	1.62	202.81	189.99	186.28
Dichang	63.00	62.33	61.67	1.68	1.66	1.58	158.21	154.78	145.51
Arize 6444	84.67	82.33	80.67	1.67	1.65	1.59	225.97	217.90	206.47
PAC 837	86.33	83.00	81.00	2.00	1.94	1.92	269.64	255.55	249.32
MTU 1010	65.67	66.67	64.33	1.40	1.39	1.36	153.95	149.78	142.66
Koiya Boro	85.67	86.00	84.67	1.35	1.31	1.29	189.16	179.20	174.38
$CD_{0.05}$ (treat.)	**1.928**			**0.026**			**2.627**		
$CD_{0.05}$ (var.)	**1.888**			**0.043**			**5.106**		

Table 4. Variation in yield attributing traits for all the seven varieties taken for experimentation.

Characters	No. of panicles/ sq.m.			No. of grains/ panicle			1000-grain weight (g)			Grain yield (t/ha)		
Variety	SRI	RP	TP	SRI	RP	TP	SRI	RP	TP	SRI	RP	TP
Luit	309.33	261.33	213.33	105.33	99.00	85.67	25.51	25.46	25.40	4.28	3.64	2.81
IR-64	442.67	229.33	181.33	111.67	98.00	90.67	26.52	25.43	25.31	5.07	4.08	3.55
Dichang	378.67	288.00	170.67	108.00	95.00	89.00	25.00	24.56	24.58	4.22	3.79	3.16
Arize 6444	490.67	298.67	272.00	128.67	115.00	106.33	26.98	25.68	25.76	6.05	5.03	4.56
PAC 837	544.00	293.33	266.67	130.67	117.33	106.67	28.24	27.03	26.89	7.83	6.29	5.70
MTU 1010	458.67	186.67	144.00	98.33	87.33	76.00	24.47	24.19	24.16	4.77	4.12	3.46
Koiya Boro	234.67	122.67	197.33	97.33	83.00	73.33	23.44	23.34	23.22	3.11	2.68	2.34
$CD_{0.05}$ (treat.)	**25.049**			**10.179**			**0.113**			**0.149**		
$CD_{0.05}$ (var.)	**19.686**			**5.665**			**0.159**			**0.215**		

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