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Growth and Yield Trial of Sixteen Rice Varieties under System of Rice Intensification

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A B S T R A C T

An experiment was conducted to evaluate the performance of sixteen rice varieties coded from V_1 to V_{16} under SRI. All parameters showed significant variation among rice varieties and all varieties showed early maturity under SRI. V_1 had maximum 23 days followed by V_2 (20 days) early maturity while V_{12} and V_{13} (3.0 days) showed minimum early maturity under SRI than standard management practice. Maximum yielded variety V_{11} had 4.0 days earlier under SRI than the standard management practice. V_{11} (5.7 t/ha) showed the maximum grain yield followed by V_{16} (5.6 t/ha) while minimum grain yield was found from V_4 (4.4 t/ha) but maximum biological yield was found from V_{12} (13.2 t/ha). V_1 and V_2 can be cultivated for early harvesting while V_{11} and V_{12} for more grain yield under SRI practice.

Key words: *Oryza sativa, SRI, early maturity, performance*

Introduction

Rice (Oryza sativa) is a semi aquatic annual plant and most important cereal crop in the world (Luh, 1991). It is the major staple food of nearly half of the world's population particularly in Asia where approx. 90% of world's rice is produced and consumed (Zeigler and Barclay, 2008; Khush, 2004). It is estimated that by the year 2025, the world's farmers need to be produced about 21% than at 2000 (Bhuiyan et al., 2002) and 60% (Fageria, 2007) more rice than at present to feed expected world population. International Rice Research Institute (IRRI) has been released more than 1000 modern rice varieties resulting rapid increase in rice yields and global rice production. Global production dropped sharply at the beginning of the 21st century, from 410 million tons in 2000 to 378 million tons in 2003 because of severe droughts in parts of Asia, but has recovered by growing 50 million tons between 2005 and 2011 (Rejesus et al., 2012). Most Asian countries won't be able to feed their projected population without irreversibly degrading their land resources even with high levels of management inputs (Beinroth et al., 2001). Densely populated and threatened by floods and storms, Bangladesh in one of the poorer countries of the world. In Bangladesh, although 78% of total cropped area is devoted to rice production but country is still suffering from a chronic shortage of food grain (BBS, 2008). The total production of rice in Bangladesh was 34.35 million metric tons from 11.35 million hectares of land in the fiscal year 2010-2011 (BBS, 2011). There is no opportunity to increase rice area so it will require adoption of new technology to increase yield. SRI is a technique that is a set of practices and a set of principles (Uphoff, 2004) for managing plants, soil, water of nutrient together in mutually beneficial ways, creating synergies (Laulanie, 1993). The most obvious advantage from SRI appears to be the yield increase in farmers field from 50% to 200% (Uphoff, 2005; Deichert and Yang, 2002; Wang et al., 2002) without any new seeds or chemical and mechanical inputs (Stoop et al., 2002). SRI is now proven technology that can increase productivity of irrigated rice cultivation by changing the management of plants, soil water and nutrients (Haden et al., 2007; Kabir and Uphoff, 2007; Mishra et al., 2006; Ceesay et al., 2006; Islam et al., 2009; Latif et al., 2005; Dobermann, 2004). Furthermore SRI is accessible for farmers which have small land holdings and need to get highest yields possible from their available land, higher outrun with fewer broken grains, ripening about 7 days sooner than regular crops of the same variety. The vision of the current study was to compare the performances of the 16 rice varieties under SRI and isolation of rice varieties responsive to SRI.

Materials And Method

Location, period, varieties, experimental design and plot size

The experiment was conducted at Agronomy field Laboratory, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh from December, 2011 to May, 2012. The experiment consisted sixteen variety viz. BR 3 (V_1), BR 14 (V_2), BR 16 (V_3), BRRI dhan 28 (V_4), BRRI dhan 29 (V_5), BRRI dhan 36 (V_6), BRRI dhan 45 (V_7), BRRI dhan 50 (V_8), BINA 6 (V_9), BINA 9 (V_{10}), BRRI hybrid dhan 1 (V_{11}), BRRI hybrid dhan 2 (V_{12}), BRRI hybrid dhan 3 (V_{13}), Chamak (V_{14}), Hira 1 (V_{15}) and Bhajan (V_{16}) following RCBD design with three replications. The size of unit plot was 3 m × 2.7 m. Distances between plot to plot and replication to replication were 0.75 m and 1.0 m respectively.

Seed collection

Seeds of V_1-V_8 and V_{11}-V_{13} were collected from Genetic Resources and Seed Division, BRRI, Joydebpur, Gazipur; V_9 and V_{10} from BINA, BAU, Maymensingh-2202; V_{14}-V_{16} was collected from Supreme Seed Co. Ltd., Amin Court 62-63, Motijheel, Bangladesh.

Seed Sprouting

Seeds selected by specific gravity method were immersed in water in a bucket for 24 hours. These were then taken out of water and kept tightly in gunny bags. The seeds started sprouting after 48 hours which were suitable for sowing in 72 hours.

Preparation of seedling

Sprouted seeds were sown as broadcast in 16 portable trays for 16 varieties containing soil and cow dung. Thin plastic sheets were placed at the base of trays to protect water loss. Trays were kept inside a room at night to protect the seedlings from freezing temperature of season and kept in sunlight at daytime for proper development of seedlings.

Seed Sowing: Seeds were sown in the portable trays on December 27, 2011.

Fertilization on the main field

Plot was fertilized with 110, 90, 76, 60, 7 kg ha^{-1} Urea, TSP, MP, Gypsum and Zinc Sulphate respectively. The entire amounts of TSP, MP, Gypsum and Zinc Sulphate were applied as basal dose at final land preparation. Urea was top-dressed in three equal installments viz. after seedling recovery, vegetation stage and 7 days before panicle initiation.

Uprooting and transplanting of seedlings

12 days old seedlings were uprooted from the trays and transplanted on January 7, 2011. The trays were brought to main field and seedlings were planted in prepared plot just after uprooting and this process was completed within one minutes.

Application of irrigation water

Alternate wetting and drying of crop field is desired in SRI method. Water level should be dried in such a level that hairline cracks should develop in field. Irrigation must be applied to such amount that field remains moist but not fully submerged. Field was allowed to dry for 4 to 5 days during panicle initiation period for better root growth that increases tillering. From panicle initiation (PI) to hard dough stage, a thin layer of water (2-3 cm) was kept on the plots. Again water was drained from the plots during ripening stage.

Data collection

Data were collected on growth, development and yield characters. Among these, leaf area index were estimated measuring length and average width of leaves and multiplying by 0.75 (Yoshida, 1981). Sub-samples of 2 hills/plot were uprooted from predetermined lines which were oven dried until constant level. From which weight of above ground dry matter were recorded at 30 days intervals and at harvest. Grain yield was determined from central area of each plot by adjusting 14% moisture. Grain moisture content was measured by using a digital moisture tester. Straw yield was determined from the central 6 m^2 area of each plot. After separating of grains, sub-sample was oven dried to a constant weight and finally converted to t/ha**.** Grain yield and straw yield were all together retarded as biological yield. Biological yield was calculated with the following formula.

Biological yield = Grain yield + Straw yield

It denotes the ratio of economic yield (grain yield) to biological yield and was calculated with following formula (Donald, 1963; Gardner et al., 1985).

Harvest index (%) = grain yield/biological yield × 100.

Statistical Analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique using MSTAT-C package and the mean difference were adjusted by LSD technique (Gomez and Gomez, 1984).

Results And Discussion

Crop growth and development character

Seedling mortality

V_4 had highest tiller mortality in both 7 DAT and 14 DAT (11.7 and 8.7 respectively) whereas lowest in V_1 and V_{12} (1.0) in 7 DAT and V_{16} (0.7) in 14 DAT (Table 1). BRRI dhan 28 has 11.86% higher tiller mortality compared to the variety Chamak and 8.89% higher tiller mortality rate compared to the variety Vajan in 14 DAT.

Plant height

Tallest plant was found from V_9 (107.7 cm) which was statistically identical with V_{11} **(**104.4 cm) while shortest plant was found from V_8 (78.2 cm) at harvest (Table 1). Similar significant variation in plant height was also found by Alam et al. (2009).

Table 1. Seedling mortality and plant height of rice varieties under SRI [X]

Variety	Tiller mortality at different DAT				Plant height (cm) at different DAT							
	7		14		30		60		90		harvest	
V_1	1.0	c	6.0	a-c	15.0	d	35.4	e	56.3	g	83.5	e-g
V_2	3.0	bc	5.7	a-c	17.0	a-d	45.1	a-d	80.7	a-c	97.2	bc
V_3	2.0	bc	5.3	a-c	19.1	a-d	41.9	b-e	62.5	fg	87.8	d-f
V_4	11.7	a	8.7	a	16.0	b-d	39.8	c-e	80.6	a-c	92.5	cd
V_5	5.3	bc	7.0	ab	15.5	cd	39.6	de	64.8	e-g	89.5	de
V_6	2.7	bc	5.7	a-c	19.5	a-d	47.2	ab	77.7	b-d	81.7	fg
V_7	5.3	bc	6.3	ab	19.1	a-d	43.1	b-e	88.7	a	89.6	de
V_8	2.3	bc	5.7	a-c	19.7	a-d	41.9	a-d	67.8	d-f	78.2	g
V_9	2.3	bc	4.0	a-c	18.0	a-d	43.9	a-d	74.4	c-e	107.7	a
V_{10}	3.3	bc	5.3	a-c	19.6	a-d	48.6	a	87.3	ab	98.9	bc
V_{11}	2.7	bc	6.7	ab	20.7	ab	45.6	a-d	75.2	c-e	104.4	ab
V_{12}	1.0	c	2.3	bc	20.9	a	45.0	a-d	77.5	b-d	93.7	cd
V_{13}	8.0	ab	5.7	a-c	17.0	a-d	43.6	a-d	72.5	c-f	94.7	cd
V_{14}	1.3	c	6.0	a-c	19.0	a-d	46.2	a-c	75.8	cd	97.5	bc
V_{15}	3.3	bc	2.0	bc	20.4	ab	45.9	a-d	79.4	a-c	98.1	bc
V_{16}	2.0	bc	0.7	c	20.2	a-c	43.8	a-d	73.4	c-e	94.2	cd
CV %	10.3		6.4		0.2		9.2		8.5		4.7	
LSD0.05	6.0		5.6		4.8		6.6		10.6		7.4	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Shoot and root length

Shoot and root length showed significant variation among the rice varieties under SRI. Tallest shoot was found from V_{11} (111.3 cm) which was statistically identical with V_9 (110.3 cm) while shortest was found from V_6 (81.0 cm) at harvest (Table 2). BRRI hybrid dhan 1 had 27.22% higher shoot length than BRRI dhan 36. SRI resulted in 84.0 cm shoot length compared to 67.5 cm shoot length resulted in SMP (standard management practices) i.e., (19.64% higher than SMP) in ripening stage (Thakur et al., 2011). Longest root was found from V_{11} (25.5 cm) which was statistically identical with V_9 (24.5 cm) while shortest from V_6 (16.3 cm) (Table 2). This is may be due to varieties reached their maturity at harvest and roots stopped growth and began to degrade that resulted the decreased root length. BRRI hybrid dhan 1 had 34.62 cm root length at 90 DAT (Islam et al., 2009). SRI had 38.5% increases in root length over SMP in early-ripening stage of development (Thakur et al., 2011). Plant root growth was markedly greater under SRI than traditional system (Longxing et al., 2002). Root depth was also more in SRI than SMP. Simplest way to increase rooting depth and root distribution of crops is to increase duration of vegetative period (Mishra et al., 2006). This may be achieved by sowing earlier or by delaying flowering. SRI practice recommends transplanting younger seedlings (15 day-old) with wider spacing which helps plants to prolong vegetative period along with better canopy growth by enhancing canopy photosynthesis through avoiding shade effects.

Table 2. Plant shoot and root length (cm) of rice varieties under SRI [X]

Varieties	Shoot length (cm) at different DAT								Root length (cm) at different DAT							
	30		60		90		harvest		30		60		90		harvest	
V_1	14.2	d	46.0	c	61.7	d	91.8	b-d	9.2	b	24.0	b-d	25.3	bc	22.3	ab
V_2	16.0	ca	59.1	a	88.3	ab	97.0	b-d	7.7	b	21.3	cd	16.7	b	18.5	bc
V_3	18.2	a-d	49.9	a-c	77.2	a-d	92.5	b-d	7.4	b	34.4	a	25.8	bc	18.3	bc
V_4	16.2	cd	52.9	a-c	93.0	a	92.3	b-d	7.2	b	19.9	d	23.9	ab	17.6	b
V_5	18.2	a-d	51.7	a-c	74.1	b-d	99.7	b	7.2	b	25.0	b-d	26.6	b	18.7	bc
V_6	18.7	a-d	58.5	a	83.7	ab	81.0	f	8.8	b	30.0	a-c	25.3	bc	16.3	b
V_7	19.2	a-d	48.4	a-c	91.0	ab	90.0	c-e	7.1	b	24.5	b-d	24.0	ab	16.5	b
V_8	22.6	ab	57.3	ab	81.8	ab	82.3	ef	8.2	b	26.6	a-d	29.1	ab	19.5	bc
V_9	17.7	b-d	50.9	a-c	80.5	a-c	110.3	a	9.0	b	30.3	ab	28.2	bc	24.5	a
V_{10}	16.2	cd	47.5	bc	93.1	a	97.0	b-d	9.6	ab	21.6	b-d	23.5	bc	19.0	bc
V_{11}	23.3	ab	53.3	a-c	82.0	ab	111.3	a	9.7	ab	26.6	a-d	34.6	a	25.5	a
V_{12}	22.6	ab	56.0	a-c	91.5	a	88.3	d-f	8.0	b	29.8	a-c	29.8	ab	19.2	bc
V_{13}	18.8	a-d	54.1	a-c	84.4	ab	94.3	b-d	9.3	b	25.3	b-d	27.2	ab	19.0	bc
V_{14}	21.1	a-c	52.1	a-c	89.2	ab	100.3	b	8.5	b	29.0	a-c	22.4	bc	18.2	bc
V_{15}	23.8	a	55.9	a-c	92.7	a	97.8	bc	12.0	a	28.7	a-d	27.7	ab	22.0	ab
V_{16}	22.3	ab	50.3	a-c	64.7	cd	95.0	b-d	8.8	b	26.4	a-d	27.6	ab	18.5	bc
CV (%)	18.4		12.4		12.3		5.6		13.4		2.4		9.4		13.5	
LSD0.05	5.9		10.9		17.0		8.9		3.4		9.0		8.4		4.4	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Root and shoot length ratio

Root and shoot length ratio showed a significant variation among the rice varieties. Maximum root-shoot length ratio was found from V_{14} (5.5) while minimum was found from V_1 (4.2) at harvest (Table 3). V_{14} had 24.9% higher ratio than V_1. BRRI hybrid dhan 1 resulted root-shoot length ratio of 3.24 in 50 DAT and 75 DAT compared to root-shoot length ratio of 2.483 at 90 DAT (Thakur et al., 2011).

Leaf area index (LAI)

Maximum LAI was found from V_{16} (4.4) while minimum was found from V_4 (2.5) (Table 3). This result is similar to the result found in an experiment done by Haque et al. (2006). Islam et al. (2009) found the leaf area index of BRRI hybrid dhan 1 at 75 DAT (105 days old plant) to be 1.0839.

Table 3. Root-shoot length ratio and leaf area index of rice varieties under SRI [X]

Verities	Root length : Shoot length at different DAT								Leaf area index (LAI) at different DAT							
	30		60		90		harvest		30		60		90		harvest	
V_1	1.5	d	1.9	c-e	2.5	d	4.2	e	0.03	b	1.0	ab	5.7	a	4.3	ab
V_2	2.1	cd	2.8	a	5.9	a	5.3	a-d	0.04	b	1.0	ab	4.1	a	2.6	de
V_3	2.5	a-c	1.6	e	4.2	b	5.1	a-e	0.06	ab	1.5	a	4.7	a	3.3	a-e
V_4	2.2	a-d	2.7	ab	4.0	bc	5.4	ab	0.02	b	0.9	b	4.1	a	2.5	e
V_5	2.6	a-c	2.1	cd	2.8	b-d	5.4	a-c	0.04	b	1.4	ab	5.3	a	4.0	a-c
V_6	2.1	cd	2.0	c-e	3.4	b-d	4.9	a-e	0.05	ab	1.4	ab	5.3	a	3.4	a-e
V_7	2.9	a	2.1	cd	3.8	b-d	5.5	ab	0.05	ab	1.3	ab	4.5	a	2.8	c-e
V_8	2.5	a-c	2.1	cd	2.8	b-d	4.4	de	0.05	ab	1.4	ab	4.6	a	2.9	c-e
V_9	2.2	b-d	1.7	de	2.9	b-d	4.6	a-e	0.04	b	1.4	ab	4.7	a	4.4	ab
V_{10}	1.7	d	2.3	bc	4.0	bc	5.1	a-e	0.07	ab	1.2	ab	4.6	a	2.8	c-e
V_{11}	2.5	a-c	2.0	c-e	2.5	cd	4.4	c-e	0.04	b	1.4	ab	4.5	a	4.0	a-c
V_{12}	2.8	ab	1.9	c-e	3.2	b-d	4.6	a-e	0.10	a	1.4	ab	4.8	a	2.8	c-e
V_{13}	2.0	cd	2.2	cd	3.2	b-d	5.0	a-e	0.03	b	1.0	ab	4.1	a	3.0	b-e
V_{14}	2.5	a-c	1.8	c-e	4.3	b	5.5	a	0.04	b	1.3	ab	4.9	a	3.4	a-e
V_{15}	2.0	cd	2.0	c-e	3.3	b-d	4.5	b-e	0.05	b	1.5	a	4.9	a	3.8	a-d
V_{16}	2.6	a-c	1.9	c-e	2.9	b-d	5.2	a-d	0.05	ab	1.3	ab	5.5	a	4.4	a
CV (%)	1.8		13.8		2.6		11.9		5.75		2.7		2.5		2.4	
LSD0.05	0.7		0.5		1.5		1.0		0.09		0.6		2.0		1.4	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Plant dry matter weight

Plant dry matter weight showed significant variation among varieties at 30, 60 and 90 DAT but did not show significant variation at harvest. Maximum plant dry matter weight was found from V_5 (102.7 g) while minimum from V_7 (59.2 g) (Table 4). It was found 34.70 g total dry matter at 100 DAT by BRRI dhan 29 (Alam et al., 2009) and 59.58 g by BRRI hybrid dhan 1 (Islam et al., 2009) in SMP which is much lower than total dry matter production by BRRI dhan 29 and BRRI hybrid dhan 1 in SRI. Total dry matter production in rice farming was higher in SRI compared to farmers practice (Nissanka and Bandara, 2004).

Weed (Shama) population and dry matter

Maximum number of shama population was found from V_{14} (73.4/m^2) whereas minimum from V_{11} (14.3/m^2) at 60 DAT (Table 4). Maximum total dry weight was found from V_5 (24.15 g/m^2) while minimum from V_{11} (6.780 g/m^2) at 60 DAT (Table 4). BRRI dhan 29 had 71.93% higher weed dry matter that BRRI hybrid dhan 1. Satyanarayana et al. (2007) stated that weeding is a deterrent to SRI adoption.

Table 4. Plant dry matter weight, shama population number and total dry weight of shama population of rice varieties under SRI [X]

Verities	Plant dry matter weight (g) at different DAT								Shama population at different DAT number/m^2				total dry weight (g)			
	30		60		90		harvest		30		60		30		60	
V_1	0.2	ab	9.1	cd	46.8	ab	86.6	a	7.0	b-d	23.7	bc	1.4	d	18.1	ab
V_2	0.1	b	8.0	cd	52.7	ab	92.1	a	20.3	a-c	62.7	ab	4.6	a-d	19.5	ab
V_3	0.3	ab	13.7	b-d	53.4	ab	95.9	a	5.7	cd	22.7	bc	2.3	b-d	13.3	a-c
V_4	0.4	a	7.3	cd	43.9	ab	80.6	a	6.7	b-d	21.0	bc	1.7	cd	9.5	bc
V_5	0.2	ab	14.0	b-d	56.7	ab	102.7	a	14.7	a-d	32.0	a-c	5.1	ab	24.2	a
V_6	0.3	ab	21.7	ab	53.4	ab	95.8	a	12.0	b-d	28.0	a-c	2.2	b-d	12.4	bc
V_7	0.2	ab	10.2	cd	32.2	ab	59.2	a	21.3	ab	16.7	c	2.9	a-d	10.5	bc
V_8	0.3	ab	17.1	bc	42.9	ab	72.3	a	3.0	d	16.0	c	2.4	b-d	10.0	bc
V_9	0.2	b	11.3	cd	43.0	ab	81.6	a	14.3	a-d	47.7	a-c	2.6	a-d	10.4	bc
V_{10}	0.3	ab	6.5	d	28.8	ab	59.4	a	5.3	cd	21.0	bc	5.9	a	14.0	a-c
V_{11}	0.3	ab	27.5	a	59.6	a	97.3	a	7.7	b-d	14.3	c	2.5	b-d	6.8	c
V_{12}	0.4	a	17.5	a-c	51.5	ab	94.3	a	11.3	b-d	54.7	a-c	4.7	a-d	18.2	ab
V_{13}	0.2	ab	10.6	cd	38.7	ab	70.4	a	29.0	a	38.0	a-c	4.9	a-c	10.4	bc
V_{14}	0.3	ab	13.1	b-d	56.2	ab	91.6	a	13.0	b-d	73.7	a	4.3	a-d	18.4	ab
V_{15}	0.4	ab	16.2	b-d	50.5	ab	81.0	a	17.7	a-d	12.3	c	4.7	a-d	10.2	bc
V_{16}	0.3	ab	15.8	b-d	44.2	ab	80.9	a	11.0	b-d	22.7	bc	3.9	a-d	12.4	bc
CV %	5.6		4.5		3.6		3.5		7.3		8.7		0.6		0.5	
LSD0.05	0.3		10.3		28.5		48.8		15.2		45.9		3.3		11.2	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Root and shoot dry matter weight

Maximum root and shoot dry matter weight was found from V_5 (39.4 g) and V_2 (72.0 g) respectively whereas minimum root and shoot dry matter weight was found from V_{15} (17.0 g) and V_{10} (44.7 g) respectively at harvest (Table 5). Production of shoot dry matter (36.26 g) and root dry matter (18.14 g) at 50 DAT by BRRI hybrid dhan 1 in SMP (Islam et al., 2009) is lower than in SRI found from current study. Portioning of dry matter is much more in root than shoot which may be due to alternate wetting and drying of field that is an important character of SRI makes plant to generate more roots than shoot in vegetative period which is caused by portioning of dry matters to the root zone.

Table 5. Root and shoot dry weight of boro rice at different days after transplanting [X]

Varieties	Dry matter weight (g) at 60 DAT				90 DAT				harvest			
	Root		Shoot		Root		Shoot		Root		Shoot	
V_1	3.8	cd	5.4	bc	16.0	d-e	31.0	a	29.7	a-c	57.0	a
V_2	2.8	d	5.2	bc	14.1	a-e	38.6	a	20.1	b-d	72.0	a
V_3	5.7	b-d	8.0	bc	22.9	ab	30.5	a	33.6	ab	62.3	a
V_4	2.3	d	4.9	bc	14.8	a-e	29.1	a	24.5	a-d	56.1	a
V_5	5.9	b-d	8.1	bc	23.4	a	33.3	a	39.4	a	63.3	a
V_6	11.3	ab	11.7	ab	18.5	a-d	38.4	a	24.8	a-d	71.0	a
V_7	4.2	cd	6.1	bc	8.1	e	24.1	a	10.4	d	48.8	a
V_8	6.1	b-d	11.0	a-c	13.7	b-e	29.1	a	21.3	b-d	50.9	a
V_9	4.7	cd	6.6	bc	15.1	a-e	27.9	a	25.9	a-d	55.8	a
V_{10}	2.6	d	4.0	c	8.1	e	20.7	a	14.7	cd	44.7	a
V_{11}	16.9	a	18.1	a	21.5	a-c	38.1	a	26.7	a-d	70.6	a
V_{12}	8.2	bc	8.6	bc	13.0	c-e	38.5	a	18.5	b-d	75.8	a
V_{13}	4.1	cd	6.5	bc	13.6	b-e	25.1	a	23.2	a-d	47.2	a
V_{14}	5.6	b-d	7.5	bc	15.6	a-e	40.6	a	24.8	a-d	66.7	a
V_{15}	6.6	b-d	9.5	bc	14.1	a-e	36.4	a	17.0	cd	64.0	a
V_{16}	7.6	b-d	8.2	bc	11.7	de	32.5	a	24.4	a-d	56.2	a
CV (%)	5.9		5.4		3.8		3.8		4.2		3.9	
LSD0.05	6.1		7.3		9.6		20.5		16.5		38.9	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Crop duration related characters

Days to first and 50% flowering

Days to first and 50% flowering of rice varieties showed significant difference. Early first and 50% flowering was found from V_7 (97.3 days and 102.7 days respectively) whereas late from V_5 (113.7 days and 118.7 days respectively) (Table 6). Rice plant completed 50% flowering as the age of the transplanted seedling gradually reduces irrespective of the spacing of transplantation (Krishna et al., 2009). Transplanting 8 days old seedling initiated flowers 8 days earlier than transplanting 25 days old seedlings. This is may be because aged seedlings required more days to panicle initiation due to the slow establishment of the seedlings in the main field unlike the younger seedlings (Reddy and Reddy, 1992). This result is similar to the findings under discussion in this experiment.

Days to harvesting

V_1 had the earliest maturity and harvest at 147 days compared to expected harvest time of 170 days. Similarly V_2, V_3, V_4, V_5, V_6, V_7, V_8, V_9, V_{10}, V_{11}, V_{12}, V_{13}, V_{14}, V_{15} and V_{16} had 20, 18, 7, 9, 7, 12, 17, 9-14, 17, 4, 3, 3, 14, 18 and 8 days early maturity and harvest under SRI than the maturity time recommended by the respective released organization under standard field practice.

Yield attributing characters

Panicle length

Longest panicle was found from V_{10} (45.6 cm) which was statistically identical with V_9 (42.5 cm) while shortest was found from V_6 (22.6 cm) (Table 6). BRRI dhan 29 had 24.48 cm panicle length in SRI practice, 24.12 cm in BRRI recommended practice and 22.32 cm in farmers practice in Vagurapara, Chandina. In Matiara, sadar panicle lengths were 24.89 cm, 24.14 cm and 22.28 cm in respectively SRI, BRRI recommended and farmers practice (Latif et al., 2005). SRI always resulted in higher panicle length than BRRI recommended and farmer's practices. SRI produced longest panicles than in SMP (Thakur et al., 2011). Panicle length of BRRI dhan 29 was 24.59 cm which is 5.69% higher than panicle length of BRRI dhan 29 in current study (Hossaen et al., 2011).

Number of total grains

Maximum number of total grains was found from V_9 (222.7/panicle) while minimum was found from V_3 (127.4/panicle) (Table 6). BRRI dhan 28 produced 171.0 grains/panicle and BRRI dhan 29 produced 217.67 grains/panicle incase of in continuous submergence of soil with irrigation water (Oliver et al., 2008). Both varieties produced higher number of total grains/panicle in SRI compared to SMP. Thakur et al. (2011) found 151.6 total grains/panicle in SRI which was 28.83% higher that 107.9 total grains/panicle in SMP.

Table 6. Crop durability, panicle length and total number of grain of rice varieties under SRI [X]

Verities	Days to flowering				Days to harvesting		Early maturity (days)	Panicle length (cm)		Total number of grains/panicle	
	first		50%		expected[@]	under SRI					
V_1	109.7	c	115.3	bc	170.0	147.0	23.0	25.5	g-i	134.4	hi
V_2	104.0	efg	112.3	de	160.0	142.0	20.0	30.7	ef	167.5	c-g
V_3	109.3	c	114.0	cd	165.0	147.0	18.0	23.5	hi	127.4	i
V_4	99.3	ij	106.0	g	140.0	133.0	7.0	23.2	hi	159.0	e-i
V_5	113.7	a	118.7	a	160.0	151.0	9.0	23.2	hi	202.0	ab
V_6	100.0	hi	109.3	f	140.0	133.0	7.0	22.6	i	149.8	f-i
V_7	97.3	j	102.7	h	145.0	133.0	12.0	27.7	f-i	136.5	g-i
V_8	106.0	de	112.3	de	155.0	138.0	17.0	27.9	f-h	156.5	e-i
V_9	112.3	ab	116.3	b	160-165	151.0	9.0-14.0	42.5	ab	222.7	a
V_{10}	102.0	gh	111.0	ef	150.0	133.0	17.0	45.6	a	206.0	ab
V_{11}	106.7	d	112.3	de	155.0	151.0	4.0	32.5	d-f	179.0	b-f
V_{12}	105.0	def	111.7	e	145.0	142.0	3.0	37.9	bc	187.6	b-e
V_{13}	103.0	fg	111.7	e	145.0	142.0	3.0	29.3	e-g	164.7	d-h
V_{14}	106.0	de	111.7	e	160.0	142.0	18.0	29.3	e-g	169.3	c-f
V_{15}	105.0	def	111.7	e	160.0	142.0	18.0	36.2	cd	193.7	a-d
V_{16}	110.0	bc	115.7	bc	155.0	147.0	8.0	34.1	c-e	199.2	a-c
CV %	1.4		1.1					10.9		11.2	
LSD0.05	2.4		2.0					5.2		32.3	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance [@]from the released organization by standard field practice

Number of filled and unfilled grains

Maximum number of filled grain was found from V_9 (191.0/panicle) while minimum from V_7 (115.6/panicle) (Table 7). Cultivation in SRI produced 89.6% filled grains over 79.3% filled grain produced in SMP (Thakur et al., 2011). Minimum number of unfilled grain was found from V_3 (7.7/panicle) which was statistically identical with V_1 (11.7/panicle) and V_4 (13.7/panicle) whereas maximum was found from V_{10} (51.7/panicle) which was statistically identical with V_{15} (45.3/panicle) (Table 7). BRRI dhan 28 produced highest number of unfilled grains/panicle (8.67 and 9.33 respectively) when water level fell 30 cm bellow ground level and when the water level fell 10 and 20 cm bellow ground level (Oliver et al., 2008). Cultivation in SRI produced 10.4% filled grains over 20.7% filled grain produced in standard management practices (Thakur et al., 2011).

Weight of 1000 grains

Maximum 1000-grains weight was found from V_1 and V_2 (30.6 g) while minimum from V_5 (21.3 g) which was statistically identical with V_4 (22.1 g) (Table 7). BRRI dhan 28 produced 27.0 g, 20.0 g, 40.0 g 1000-grain weight in SRI and 20.0 g, 19.0 g and 22.0 g in traditional method respectively in Gaibandha, Lalmonirhat and Kurigram (Miah et al., 2008). SRI produced 24.7 g 1000-grain weight while 24.0 g produced in standard management practice (Thakur et al., 2011).

Grain yield

Maximum grain yield was found from V_{11} (5.7 t/ha) while minimum from V_4 (4.4 t/ha) (Table 7). Miah et al. (2008) conducted an experiment to compare yield of BRRI dhan 28 in SRI and traditional methods and found that 7.70 t/ha, 7.5 t/ha and 7.00 t/ha yield in SRI whereas 5.80 t/ha 5.60 t/ha, 5.10 t/ha in traditional method in Kurigram, Gaibandha and Lalmonirhat respectively. Thakur et al. (2011) observed that SRI gave 6.51 t/ha grain yield over 4.40 t/ha of grain yield in SMP.

Straw yield

Maximum straw yield was found from V_{12} (7.7 t/ha) while minimum was found from V_4 (5.0 t/ha) (Table 7). SRI gave more straw (12%) compared to the hay produced in the field practice (Das, 2003). Hussain et al. (2003) conducted SRI trial in two Upazilas of Noakhali district and found 39% higher straw yield in SRI compared to traditional methods. Thakur et al. (2011) found that SRI produced 7.28 t/ha straw yield compared to the 9.17 t/ha straw yield produced in standard management practices.

Biological yield

Maximum biological yield was found from V_{12} (13.2 t/ha) while minimum from V_4 (9.4 t/ha) (Table 7). BRRI hybrid dhan had 21.81% higher biological yield than BRRI dhan 28. Biological yield of BRRI dhan 29 in SRI (11.82 t/ha) was slightly higher than in SMP (11.41 t/ha) (Uddin et al., 2012). SRI produced 13.79 t/ha biological yield compared to 13.57 t/ha of biological yield produced in SMP (Thakur et al., 2011). All though grain yield was much higher in SRI compared to SMP and incase of straw yield it was vise versa.

Harvest index

Maximum harvest index was found from V_8 (49.3%) while minimum from V_{14} (39.1%) (Table 7). BRRI dhan 50 was 20.63% higher in harvest index than Chamak. Harvest index in SRI (47.21%) was higher than SMP (32.42%) (Thakur et al., 2011).

Table 7. Different yield attributing characters of sixteen rice varieties under SRI [X]

Varieties	Number of filled grains/ panicle		Number of unfilled grains /panicle		Weight of 1000 grains (g)		Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (%)	
V_1	122.7	d-f	11.7	h	30.6	a	5.1	a-c	6.2	b-e	11.3	a-e	45.0	a-c
V_2	130.0	d-f	37.6	bc	30.6	a	5.1	a-c	6.3	a-e	11.3	a-e	44.9	a-c
V_3	119.7	ef	7.7	h	28.0	cd	5.0	a-c	6.0	c-e	11.0	b-e	45.0	a-c
V_4	131.3	d-f	13.7	gh	22.1	i	4.4	c	5.0	e	9.4	e	46.5	ab
V_5	180.1	ab	21.3	f	21.3	i	5.1	a-c	6.3	a-e	11.4	a-e	44.2	a-c
V_6	121.6	d-f	28.2	d-f	26.2	gh	4.9	a-c	6.5	a-e	11.4	a-e	43.0	a-c
V_7	115.6	f	20.9	fg	28.8	bc	4.5	bc	6.0	c-e	10.4	c-e	43.0	a-c
V_8	120.7	ef	35.7	cd	19.1	j	5.5	a-c	5.7	c-e	11.3	a-e	49.3	a
V_9	191.0	a	31.6	c-e	25.5	h	5.2	a-c	7.1	a-c	12.4	a-c	43.0	a-c
V_{10}	154.3	b-d	51.7	a	29.3	b	4.5	a-c	5.3	de	9.9	de	46.0	ab
V_{11}	151.7	b-e	27.3	ef	27.0	e-g	5.7	a	6.9	a-d	12.5	a-c	45.8	ab
V_{12}	151.0	b-e	36.6	c	27.1	ef	5.4	a-c	7.7	a	13.2	a	41.1	bc
V_{13}	135.0	d-f	30.7	c-e	28.2	cd	5.1	a-c	7.1	a-c	12.3	a-c	42.1	bc
V_{14}	143.5	c-f	25.8	ef	28.3	bc	4.6	a-c	7.2	a-c	11.8	a-d	39.1	c
V_{15}	148.4	b-f	45.3	ab	27.7	de	5.4	a-c	7.6	ab	13.0	ab	41.7	bc
V_{16}	172.7	a-c	26.5	ef	26.8	fg	5.6	ab	6.5	a-e	12.1	a-d	46.6	ab
CV %	13.9		16.6		1.9		13.8		14.3		11.8		8.6	
LSD 0.05	33.1		7.8		0.8		1.2		1.5		2.2		6.3	

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Conclusion

SRI practice is more beneficial than the standard management practice for the rice cultivation in Bangladesh. V_4 was not found to be suitable under SRI practice. Rest all of the varieties are suitable for cultivation under SRI. However, further study is needed with this aspect for more authentications.

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