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PERFORMANCE OF SYSTEM OF RICE INTENSIFICATION WITH CONVENTIONAL METHOD OF RICE CULTIVATION

A. P. Mondol, P. K. Biswas* and M. S. Islam

Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka- 1207
*Corresponding author, E-mail: parimalbiswas@hotmail.com

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Abstract

A field experiment was conducted in Sher-e-Bangla Agricultural University research field of Bangladesh during December 2012 to May 2013. This experiment was tested for two planting method consisting CM planting method (P_1) and System of Rice Intensification (SRI) planting method (P_2) against five rice (*Oryza sativa*) varieties named BR 16 (V_1), BRRI dhan29 (V_2), BRRI dhan50 (V_3), BRRI hybrid dhan2 (V_4) and Heera 4 (V_5). The experiment was laid out in split-plot design with three replications. All yield parameters showed the highest for SRI with higher effective tillers hill^{-1} (41.13), longer panicle (28.15 cm), higher total grains panicle^{-1} (216.89), number of filled grains panicle^{-1} (166.82) as a result 10.17and 12.5% higher grain yield and straw yield, respectively were observed in SRI than the conventional method.

Introduction

Most of the Asian countries accept rice as their staple food. Asian countries cover near about 75% of the world's rice supply (Cabangon *et al.*, 2002). SRI is a rice cultivation method developed in Madagascar which increase rice productivity with reducing the external inputs like fertilizers and herbicides (Thakur *et al.,* 2009 and Vermeule, 2009). Sustainable rice production would be possible by increasing yields on the same piece of land reducing the input like water, chemicals, fertilizers and labor (Bouman *et al.*, 2005; Mati and Nyamai, 2009). SRI consists of some principles including transplanting of younger seedlings (< 15 days) at wider spacing in square grid pattern, only one seedling hill^{-1}, water management with alternate wetting and drying, mechanical weeding and use of organic compost fertilizer instead of chemical fertilizer (Stoop *et al.*, 2002). Use of younger seedlings, wider spacing and a single seedling hill^{-1} facilitate the utilization of the resource to develop stronger individual plants in the rice field.Younger seedling in transplantation provide a longer vegetative growth period and single seedling reduce the competition and help to minimize the shading effect of lower leaves, as such lower leaves remain photosynthetically active for longer time and root activity remain higher for longer period as the supply of oxygen and carbohydrate to the root is increased (Horie *et al.*, 2005). Supply of Cytokinin to the lower leaves increase due to higher root activity, delay the senescence and help to maintain photosynthetic efficiency at the letter stage that result higher yield compared to CM (San-oh *et al.*, 2006). But as AWD is practiced in SRI, it enhanced the supply of oxygen to the root zone that reducing the arenchyma and causing stronger, healthier root system to maximize the nutrient uptake (Stoop *et al.*, 2002). Besides, the number of productive tiller is higher in SRI (217%) over the CM (Krishna *et al.*, 2008). As such, the experiment was conducted to find out the proper method of sowing of rice in SRI and compare to conventional method

Materials and Methods

This experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207 with three inbreed rice varieties viz., BR16, BRRI dhan29, BRRI dhan50 and two hybrid var. BRRI hybrid dhan4 and Heera4 in two planting system(SRI and CM). The experiment was accomplished in a split-plot design with three replications. A 34 day old seedlings were transplanted maintaining spacing 25 cm × 15 cm in CM with two seedlings hill^{-1}, where for SRI, 16 day old seedlings with one seedlings hill^{-1}. The unit plot size was 5m × 2.4m maintaining 30 cm × 30 cm spacing. Two hand weddings were done for conventional plots, first at 16 days after transplanting followed by second at 15 days after first weeding. In SRI plots, two hand rakings were done after hair line crack developed in the plots. In SRI plots, Alternate Wetting and Drying (AWD) was practiced and in conventional plots continues flood irrigation was applied as per need of plants. The 46 % N containing urea was top-dressed in three equal installments at the rate of 260 kg ha^{-1} and 266 kg ha^{-1} for inbreed and hybrid, respectively. The first one after seedling recovery, second at vegetation stage and another at 7 days before panicle initiation. Triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate, (100, 120, 110 and 10 kg ha^{-1}) for the inbreed varieties and 125, 120, 110, 15 kg ha^{-1} for the hybrid was applied as basal. All other intercultural operations were done as and when necessary.

Plants were infested with rice stem borer (*Scirphophaga incertolus*) and leaf hopper (*Nephotettix nigropictus*) to some extent which were successfully controlled by applying Diazinone @ 10 ml/10 liter of water for 5 decimal lands and by Furadan 5 G at the rate of 10 kg/ha. The grains were cleaned and sun dried to a moisture content of 14%. Straw was also sun dried properly. The collected data were analyzed by using MSTAT-C package and the mean differences were adjusted by LSD test.

Results and Discussion

Number of effective and ineffective tillers hill^{-1}

The highest number of effective tillers hill^{-1} was produced in the planting method of SRI than the conventional method (Table 1) which was 250.04% higher than conventional method. Among the variety, highest no. of effective tiller/plant was obtained from BR16 (V_1). In interaction showed that the variety BR16 with SRI gave highest tillers / plant than th other treatment.

Krishna *et al.* (2008) was also found 217% higher number of effective tillers in SRI than CM. These might be due to use of tinny seedlings, wider spacing and efficient use of nutrients from the soil as the root system was well developed in SRI. Thakur *et al.* (2011) reported 38.5% increases in root length of SRI over CM. Wider spacing offered less interplant completion for resources. On the other hand, in SRI seedlings are transplanted at two leaves stage (at third phyllochron), first tillering start at the fourth phyllochron (Katayama,1951) that covers 40% of total tillering and get a chance of profuse tillering. As in CM transplanting is done after third phyllochron lead to a bigger loss in total tillers. Ginigaddara and Ranamukhaarachchi (2011) also supported that younger seedlings had ability to produce higher number of tillers hill^{-1} than older one. Number of ineffective tillers hill^{-1} was higher in SRI than the CM. This might be due to higher number of tertiary tillers in SRI and most of the tertiary tillers inactive for production.

Panicle length

SRI produced significantly longer panicle (28.15 cm) than the CM (25.77 cm). Panicle was 9.25% longer in SRI than the conventional system (Table 1). The V_2 produced the longest panicle in SRI (30.53 cm) that was followed by V_5 (29.12 cm) in SRI while V3 (23.52 cm) produced the shortest panicle in CM (Table 1). Among the interactions, P2V2 produced the longest panicle but all the five varieties produced longer panicle in SRI than CM.

Biswas *et al.* (2013); Thakur *et al.* (2011) and Latif *et al.* (2005) also revealed the similar findings of higher panicle length in SRI. Longer panicle of SRI might be due to higher dry matter accumulation in the plant, higher photosynthetic rate and better utilization of the nutrients. Integration of limited irrigation and mechanical weeding in SRI, increase the aeration by dissolving oxygen from the irrigation water enhancing the root: shoot ratio (Uphoff and Randriamiharisoa, 2002).

Total number of grains panicle^{-1}

The higher number of grains panicle^{-1} was produced in the planting method of SRI (216.89) than the CM (172.58). Which was 25.67% higher in SRI (Table 1). Each of the five varieties, V_1, V_2, V_3, V_4 and V_5 produced 17.19, 25.63, 37.31, 22.24 and 26.25% higher grains panicle^{-1} in SRI than CM (Table 1). Thakur *et al.* (2011) also agreed that SRI produced higher number of total grains panicle^{-1} than standard management practice. Bozorgi *et al.* (2011) suggested that wider spacing gave maximum number of grains panicle^{-1}.

Filled grains panicle^{-1}

SRI (166.82) produced significantly higher number of filled grains panicle^{-1} than the CM (124.41) (Table 1) which was 34.09% higher in SRI than the CM. Maximum number of filled grains panicle^{-1} were produced by V_5 (186.37) that was statistically similar with V_2 (166.80), V_3 (172.23) and V_4 (182.97) in SRI planting system followed by V_2 (157.70) and V_5 (133.77) in CM and minimum number of grains panicle^{-1} by V_3 (92.37) in CM. These result reveled that SRI produced higher filled grains panicle^{-1} than CM in respect of variety. Higher number of filled grins panice^{-1} in SRI might be due to maximum utilization of solar radiation, availability of nutrients on the root zone and better uptake of nutrients by the developed root system and long lasting lower leaves of each of the hill as photosynthetically active. Ali *et al.* (2013) observed higher number of filled grain panicle^{-1} from 15 day old seedling with intermittent irrigation, which was two important principle of SRI, than 30 day old seedling with continuous flooded plot. Thakur *et al.* (2011) also obtained the similar result of filled grain panicle^{-1} in SRI.

Weight of 1000- grains

The higher weight of 1000-grains (25.60 g) was obtained from CM and lower (24.13 g) from SRI (Table 1). The V_5 produced maximum 1000- grains weight in CM that was followed by V_5 (29.24 g) in SRI and V_4 (28.64 g) in CM. Minimum 1000- grains weight was recorded for V_3 (19.83 g) in CM that was statistically similar with V_2 (20.67 g) and V_3 (19.69 g) in SRI (Table 1). Mannan *et al.* (2009) also opined that heavier grain weight was found in early planted crop and grain weight decreased with the delayed transplanting.

Grain yield

SRI produced significantly higher (10.17%) yield (9.10 t ha^{-1}) than CM (8.26 t ha^{-1}) (Table 1). The V_1, V_2, V_3, V_4 and V_5 produced 14.29, 8.31, 8.57, 10.22 and 9.70% higher grain yield in SRI than the CM with the respective varieties (Table 1). In SRI, plant received longer growth duration as it was transplanted in very tiny stage whereas in CM transplanted in old aged with shorter time. Due to longer vegetative growth, tiller production was higher in SRI than CM that ultimately leads to lower yield in CM. On the other hand, number of effective tillers hill^{-1}, panicle length, number of total grains panicle^{-1}, number of filled grains panicle^{-1} was higher in SRI than CM which might be the reason of higher yield in SRI. Ginigaddara and Ranamukhaarachchi (2011) assured that the transplanting with younger seedlings in water saving rice production system produced more effective tillers hill^{-1}, filled grains plant^{-1}, panicle length compared to CM. Suganthi *et al.* (2003) suggested that delayed transplanting significantly reduced the number of productive tiller which reduced the grain yield. Better yielding performance of SRI might be due to higher net photosynthetic rate of the fully expanded leaves at mid-tillering and improved utilization of photosynthates in the grain-filling stage (Song *et al.,* 2013). Krishna *et al.* (2008) also observed that SRI produced 15.65% higher grain yield over traditional method.

Straw yield

Higher straw yield was produced in the planting method of SRI (9.48 tha^{-1}) than conventional method (8.85 tha^{-1}) (Table 1). The 12.19% higher straw yield was produced in SRI than conventional method. Among the interaction, V_4 (10.02 t ha^{-1}) produced maximum straw yield in SRI that was statistically similar for V_2 in SRI (9.80 t ha^{-1}) and CM (9.53 t ha^{-1}) followed by V_5 (9.36 t ha^{-1}) in SRI. The minimum straw yield was produced in CM by V_3 (8.38 t ha^{-1}) which was statistically similar for V_1 (8.64 t ha^{-1}), V_4 (8.83 t ha^{-1}) and V_5 (8.85 t ha^{-1}) in CM. The higher straw yield might be due to higher amount of biomass production in extended vegetative growth period than the late transplanting in CM (Mannan *et al.,* 2009). Das (2003) found 39 and 12% higher straw yield in SRI compared to the field practice.

Table 1. Effect of planting method on yield contributing character of inbred and hybrid rice

Treatments	Effective tillers (no. hill^{-1})	Ineffective tillers (no. hill^{-1})	Panicle length (cm)	Total grains panicle^{-1} (no.)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	1000-grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
P_1	11.75b	4.33b	25.77b	172.58b	124.41b	48.17	25.60a	8.26b	8.85b
P_2	41.13a	11.60a	28.15a	216.89a	166.82a	50.07	24.13b	9.10a	9.48a
LSD $_{(0.05)}$	2.267	5.359	0.4	15.98	9.751	ns	0.889	0.619	0.25
V_1	33.43a	6.67b	26.38 b	163.60c	123.30c	40.25b	25.97b	8.10d	8.87c
V_2	27.77c	4.17b	29.05a	229.40a	162.25a	67.10a	21.42c	8.64abc	9.67a
V_3	30.13b	6.00b	25.24c	173.00bc	132.30bc	40.70b	19.76d	8.52bc	8.75c
V_4	22.57d	7.83b	25.94bc	189.20b	150.17ab	39.05b	27.25b	9.16a	9.42ab
V_5	18.30e	15.17a	28.20a	218.60a	160.07a	58.48a	29.91a	8.97ab	9.11bc
LSD $_{(0.05)}$	2.169	4.897	0.8783	18.99	18.546	11.794	1.303	0.41	0.4596
P_1V_1	14.40e	3.67cd	25.72e	150.60ef	120.87d	29.73c	26.77c	7.56f	8.64ef
P_1V_2	11.67ef	0.67d	27.57c	203.30c	157.70bc	45.60b	22.16d	8.30de	9.53abc
P_1V_3	14.33e	8.00bc	23.52f	145.80f	92.37e	53.47b	19.83e	8.17e	8.38f
P_1V_4	9.47f	3.67cd	24.77e	170.10ef	117.37de	52.73b	28.64b	8.71cde	8.83def
P_1V_5	8.87f	5.67bcd	27.27c	193.10d	133.77cd	59.30b	30.58a	8.56cde	8.85def
P_2V_1	52.47a	9.67bc	27.04c	176.50d	125.73d	50.77b	25.17c	8.64cde	9.10cde
P_2V_2	43.87b	7.67bc	30.53a	255.40a	166.80ab	88.60a	20.67e	8.99bc	9.80ab
P_2V_3	45.93b	4.00cd	26.96d	200.20c	172.23ab	27.93c	19.69e	8.87bcd	9.12cde
P_2V_4	35.67c	12.00b	27.11c	208.30b	182.97ab	25.37c	25.86c	9.60a	10.02a
P_2V_5	27.73d	24.67a	29.12b	244.00 a	186.37a	57.67b	29.24b	9.39ab	9.36bcd
LSD $_{(0.05)}$	3.067	6.925	1.242	26.85	26.228	16.679	1.861	0.58	0.65

P_1 = Conventional method, P_2 = SRI, V_1 = BR 16, V_2 = BRRI dhan29, V_3 = BRRI dhan50, V_4 = BRRI hybrid dhan2, and V_5 = Heera 4

Conclusion

The present study showed that rice cultivation adopting SRI (single seedling hill^{-1} and wide spacing) produced 10.17 % higher yield over the conventional method. Moreover, in SRI technique as very tiny seedlings was used that could be maintained easily in dapog seedbed and ready for transplanting in short time where it require 20 to 25 more in conventional method. Besides, AWD in SRI was a water saving method with higher benefit.

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