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Integrated nutrient management for fine rice following system of rice intensification (Sri) technique

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Abstract: A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July-December 2006 to evaluate the performance of some fine rice varieties under different nutrient management practices following System of Rice Intensification (SRI) technique. There were six fine rice varieties viz., BRRI dhan34, BRRI dhan38, Kalizira, Basmati, Kataribhog and Chiniguda and five different nutrient managements viz., i) Recommended fertilizer (RF), ii) 150% RF, iii) 15 ton cowdung ha^{-1} and iv) RF + 5 ton cowdung ha^{-1}, v) 50% RF + 10 ton cowdung ha^{-1}. The experiment was conducted in a randomized complete block design with three replications. BRRI dhan34 produced the highest grain yield (2.99 t ha^{-1}), which was statistically identical to BRRI dhan38 (2.80 t ha^{-1}). Kalizira produced the lowest yield (1.99 t ha^{-1}). The highest grain yield (2.76 t ha^{-1}) was obtained from RF + 5 ton cowdung ha^{-1} and the lowest (1.36 t ha^{-1}) was recorded from 15 ton cowdung ha^{-1}. BRRI dhan34 grown with RF (3.48 t ha^{-1}) or 150% RF (3.45 t ha^{-1}) or RF + 5 t cowdung ha^{-1} (2.98 t ha^{-1}), BRRI dhan38 grown with RF (3.48 t ha^{-1}) or 150% RF (3.14 t ha^{-1}) and Basmati grown with RF + 5 t cowdung ha^{-1} (3.08 t ha^{-1}) or 50% RF + 10 t cowdung ha^{-1} (3.15 t ha^{-1}) produced identical but highest grain yield.

Key words: Variety, Nutrient management, Grain yield, Fine rice.

Introduction

SRI (System of rice intensification) is originated in Madagascar and was first synthesized in 1983 by Fr. Henri De Laulanie, S.J., a French Jesuit priest (De Laulanie, 1983). It is a system where, less than 8-day old infant seedlings are transplanted gently within 30 minutes of uprooting and having spacing of not less than 25 × 25 sq.cm even up to 50 × 50 sq.cm in a square method of planting with just one seedling $hill^{-1}$. The main elements of SRI are to transplant young seedling that have the full genetic potential for producing more viable tillers and root growth, to give the plants wide spacing with single seedlings that can reduce competition among hills and kept the soil well aerated that can allow maximum uptake of nutrients (Uphoff, 1999). The SRI technique requires more labour and skill, but not more capital. Moreover, water requirements are reduced by about 50% because fields are not kept flooded during the entire period of vegetative growth. This reduces emission of methane by diminishing green house gases (USDA, 2000).

Almost all soils of Bangladesh are deficient in organic matter because of its rapid decomposition due to warm climate, intensive cropping, cultivation of high yielding varieties and the little or no adding of organic matter. Most of the soils of Bangladesh have less than 1.5% of organic matters and in some cases, it is less than 1%. Cowdung plays a vital role in soil fertility improvement as well as supplying primary and secondary and micronutrients for crop production. In addition, it can improve the physical, chemical and biological properties of soil and thus helps increase and conserve the soil productivity. In addition global environmental pollution can be controlled considerably by reducing the use of chemical fertilizers and increasing the use of manures like cowdung. Cultivation of fine rice is becoming very popular in Bangladesh due its remunerative prices and huge export potentiality (Gangaiak and Prasad, 1999). Fine rice varieties are preferred by some consumers despite their higher price and lower yield (Ratho, 1984).

In Bangladesh, work on SRI is still at the premative stage. This technology needs extensive verification at researcher's level under Bangladesh context before recommending for fine rice varieties in aman season. In the light of the above discussion, the present study was undertaken to see the effects of combination of cowdung with NPKS fertilizers for fine rice following the technique of system of rice intensification in transplant aman season.

Materials and Methods

The research work was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July to December 2006 with a view to evaluating the performance of some fine rice varieties following SRI method under different integrated nutrient managements. The experimental field was a medium high land with silt loam texture. Soil pH, organic matter, total nitrogen, available sulphur, available phosphorus and exchangeable potassium content of the experimental soil were 6.50, 1.29%, 0.10%, 14.20 ppm, 16.72 ppm and 0.12me100g^{-1} soil, respectively. The experiment consisted of two factors (a) fine rice varieties viz., BRRI dhan34, BRRI dhan38, Kalizira, Basmati, Kataribhog and Chiniguda and (b) integrated nutrient managements viz., recommended fertilizer (RF); 150% RF; 15 ton cowdung ha^{-1}; RF + 5 ton cowdung ha^{-1} and 50% RF + 10 ton cowdung ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 10 m^2 (4.0 m × 2.5 m). The recommended fertilizers were applied though urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate @ 180, 100, 70, 60 and 10 kg ha^{-1}, respectively. Except urea, all the chemical fertilizers were applied before final land preparation. Urea was top dressed in three equal splits at 15, 30 and 45 DAT. Cowdung, where applicable, were incorporated into the soil just after first ploughing. Fifteen day old seedlings were transplanted on 3 August 2006 with 1 seedling $hill^{-1}$ following the spacing of 40 cm × 40 cm under SRI technique. Intercultural operations were done as and when necessary. Excess water was drained out from the plot during the vegetative stage of crop growth. During tillering, the field was left to dry out for 2 to 4 days. Watering was done when hairy cracks developed on the soil surface. Starting from panicle initiation a thin layer of water (2-3 cm) was kept on the soil surface. Again water was expelled out from the plots during the ripening stage. Ten hills excluding border rows from each plot were selected and uprooted prior to harvest for recording data on different crop characters. Different varieties were harvested on 10, 12 and 15 December 2006 depending on the maturity. Grains were threshed, cleaned, sun dried and the grain yield plot^{-1} was recorded at 14% moisture content. Straw was sun dried to recorded the straw yield plot^{-1}. Finally grain and straw yields were converted to t ha^{-1}. Data were analyzed statistically and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effect of variety: Variety significantly influenced all the crop characters of fine rice (Table 1). Among the varieties under study BRRI dhan34 ranked first in terms of grain yield (2.99 t ha^{-1}) which was mostly the out come of maximum number of grain panicle^{-1} (217.03) produced by the variety; BRRI dhan38 also produced statistically similar grain yield (2.80 t ha^{-1}) which was the consequence of the highest number of effective tillers hill^{-1} (18.05) obtained from that variety. Basmati produced the second highest grain yield of 2.49 t ha^{-1} which was mostly contributed by its highest 1000-grain weight (20.38 g). All the local fine rice varieties like Kalizira, Kataribhog and Chiniguda produced identical but the lowest grain yield (1.99, 2.00 and 2.20 t ha^{-1}, respectively). Variation in grain yield among the varieties has been also reported by Dwivedi (1997) and BRRI (2000). Yield retarding characters like number of effectives tillers hill^{-1} was found the highest (5.48) with Chiniguda variety and number of sterile spikelets panicle^{-1} also was recorded the highest (24.81) with the same variety. Kalizira variety produced the tallest plants (148.30 cm) and the lowest number of sterile spikelets panicle^{-1} (17.92). Yield and yield components of rice are varietal characteristics which are mostly governed by the genetic make up of the variety and to some extent by the environment and management practices.

Table 1. Effect of variety on different crop characters of fine rice

Variety	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain Yield (t ha^{-1})
BRRI dhan34	134.90c	20.38c	16.05b	4.33c	217.03a	22.84b	11.65d	2.99a
BRRI dhan38	118.97e	22.63b	18.05a	4.57bc	148.97b	22.58b	19.57b	2.80a
Kalizira	148.30a	22.37b	18.03a	4.35c	139.76c	17.92e	14.48c	1.99c
Basmoti	112.89f	19.39c	15.91b	3.48d	141.92c	19.56d	20.38a	2.49b
Kataribhog	136.80b	22.51b	17.49a	5.01ab	140.52c	21.19c	14.3c	2.00c
Chinigura	123.53d	23.98a	18.50a	5.48a	152.19b	24.81a	10.32e	2.20c
Level of significance	**	**	**	**	**	**	**	**

Mean values in a column having the same letter(s) or without letter do not differ significantly, whereas figures with dissimilar letter(s) differ significantly (as per DMRT).
** = Significant at 1% level of probability

Table 2. Effect of nutrient management on different crop characters of fine rice

Nutrient management	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain Yield (t ha^{-1})
F_1	124.31c	20.49b	16.27c	4.22c	145.34e	19.32d	14.88d	2.70a
F_2	135.25a	22.34a	17.42ab	4.92a	158.30b	20.34c	14.93cd	2.51b
F_3	129.13b	21.16b	16.82bc	4.33bc	175.04a	20.88c	15.13bc	1.36c
F_4	128.50b	22.70a	18.29a	4.41abc	154.54c	21.95b	15.27ab	2.76a
F_5	128.96b	22.69a	17.89a	4.80ab	150.45d	24.94a	15.37a	2.72a
Level of significance	**	**	**	*	**	**	**	**

** = Significant at 1% level of probability , * = Significant at 5% level of probability , F_1 = Recommended Fertilizer (RF), F_2 = 150% RF
F_3 = 15 ton cowdung ha^{-1}, F_4 = RF + 5 ton cowdung ha^{-1}, F_5 = 50% RF + 10 ton cowdung ha^{-1}

Table 3. Interaction effect between variety and nutrient management on different crop characters of fine rice

Interaction (Variety × Nutrient management) (V×F)	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain Yield (t ha^{-1})
$V_1 \times F_1$	123.75hi	19.73hi	15.27gh	4.47c-h	238.63b	22.37f-i	11.41	3.45a
$V_1 \times F_2$	153.83b	16.67j	13.33h	3.33gh	191.88d	20.95hi	11.48	3.48a
$V_1 \times F_3$	143.50d	18.63ij	15.50gh	3.13h	248.76a	22.12f-i	11.79	2.21g-k
$V_1 \times F_4$	120.31i	19.80hi	15.80e-h	4.00e-h	210.80c	21.88g-i	11.79	2.98a-d
$V_1 \times F_5$	133.10f	27.07b-d	20.33a-c	6.73ab	195.08d	26.90ab	11.77	2.85b-e
$V_2 \times F_1$	114.83j	23.80e-g	19.27bc	4.53c-h	132.87 l-o	21.37hi	19.19	3.48a
$V_2 \times F_2$	121.65i	18.80ij	15.33gh	3.47f-h	161.08gh	21.93g-i	19.33	3.14ab
$V_2 \times F_3$	114.25j	24.33d-g	19.00c	5.33c-e	174.89ef	25.39bc	19.94	2.14h-k
$V_2 \times F_4$	122.57i	24.07e-g	18.53cd	5.53b-d	146.47ij	21.57hi	19.81	2.74b-g
$V_2 \times F_5$	121.53i	22.13f-h	18.13c-f	4.00e-h	129.55m-p	22.65e-h	19.58	2.48d-j
$V_3 \times F_1$	128.27g	20.07hi	16.40d-g	3.67f-h	119.36q	14.47 l	14.50	2.29f-k
$V_3 \times F_2$	154.22b	20.33hi	16.27d-g	4.07e-h	125.45 o-q	16.47k	14.10	2.06 jk
$V_3 \times F_3$	147.50cd	19.13h-j	15.47gh	3.67f-h	160.40gh	17.45jk	14.29	0.79 l
$V_3 \times F_4$	150.23bc	25.07c-f	20.53a-c	4.53c-h	140.07j-l	16.99jk	14.49	2.36e-k
$V_3 \times F_5$	161.27a	27.27bc	21.47ab	5.80bc	153.52hi	24.23c-e	15.04	2.46d-j
$V_4 \times F_1$	114.63j	18.73ij	15.53g-h	3.20h	121.41pq	17.04jk	20.28	2.65b-h
$V_4 \times F_2$	111.33jk	18.87ij	15.47g-h	3.40f-h	167.27fg	18.28j	20.35	2.41 e-j
$V_4 \times F_3$	109.43k	20.07hi	16.53d-g	3.53f-h	135.9k-n	17.09jk	20.16	1.18 l
$V_4 \times F_4$	119.28i	19.87hi	16.33d-g	3.53f-h	146.76ij	20.72i	20.69	3.08a-c
$V_4 \times F_5$	109.78k	19.40h-j	15.67f-h	3.73f-h	138.27j-m	24.66cd	20.41	3.15ab
$V_5 \times F_1$	143.33d	21.67g-i	16.47d-g	5.20c-e	124.24 o-q	17.99jk	13.81	2.01jk
$V_5 \times F_2$	150.80bc	29.13ab	21.60ab	7.53a	127.59n-q	20.75i	14.12	1.87k
$V_5 \times F_3$	129.70fg	20.67hi	16.07d-g	4.60c-h	164.11g	17.51jk	14.41	0.91 l
$V_5 \times F_4$	138.87e	22.20f-h	18.20c-e	4.00e-h	139.33j-l	26.31ab	14.48	2.61c-i
$V_5 \times F_5$	121.30i	18.87ij	15.13gh	3.73f-h	147.33ij	23.43d-g	14.67	2.61c-i
$V_6 \times F_1$	121.03i	18.93ij	14.67gh	4.26d-h	135.52k-n	22.65e-h	10.11	2.34e-k
$V_6 \times F_2$	119.63i	30.27a	22.53a	7.73a	176.51e	23.67d-f	10.22	2.11 i-k
$V_6 \times F_3$	130.40fg	24.10e-g	18.37cd	5.73bc	166.17fg	25.73bc	10.18	0.94 l
$V_6 \times F_4$	119.77i	25.20c-e	20.33a-c	4.87c-f	143.84jk	24.23c-e	10.36	2.81b-f
$V_6 \times F_5$	126.80gh	21.40g-i	16.60d-g	4.80c-g	138.93j-m	27.75a	10.74	2.81b-f
$S\bar{x}$	1.42	0.91	0.74	0.43	2.95	0.53	0.18	0.15
Level of significance	**	**	**	**	**	**	NS	**

Mean values in a column having the same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter(s) differ significantly (as per DMRT).
** = Significant at 1% level of probability
V_1 = BRRI Dhan34, V_2 = BRRI Dhan38, V_3 = Kalizira, V_4 = Basmoti, V_5 = Katrivhog, V_6 = Chiniguda.
F_1 = Recommended Fertilizer (RF), F_2 = 150% RF, F_3 = 15 ton cowdung ha^{-1}, F_4 = RF + 5 ton cowdung ha^{-1}, F_5 = 50% RF + 10 ton cowdung ha^{-1}

Effect of nutrient management: Nutrient management practice exerted significant influence on all the crop character of fine rice including grain yield (Table 2). Results of the experiment reveal that the highest grain yield (2.76 t ha^{-1}) was produced when crop received recommended fertilizer (RF) + 5 t cowdung ha^{-1} and it was statistically similar to 50% RF + 10 t cowdung ha^{-1} (2.72 t ha^{-1}) and RF (2.70 t ha^{-1}). Crop receiving RF + 5 t cowdung ha^{-1} produced the highest number of effective tillers hill^{-1} (18.29) and highest 1000-grain weight (15.27 g) which resulted in the highest grain yield. On the other hand, crop receiving only organic manure i.e. 15 t cowdung ha^{-1} but no chemical fertilizer produced the lowest grain yield 1.36 t ha^{-1}. The tallest plant was recoded from the crop receiving 150% RF, but the highest number of total tillers hill^{-1} was obtained from the crop receiving RF + 5 t ha^{-1} which was statistically similar to 50% RF + 10 t cowdung ha^{-1} and 150% RF. Hasan *et al.* (2004), Singha *et al.* (2004), Haq *et al.* (2005) and Sharma *et al.* (2006) also opined that organic nutrient management involving cowdung or FYM or poultry manure and NPKS fertilizer is a must for sustainable rice yield. Yield retarding character like non effective tillers hill^{-1} was recorded the highest incase of 150% RF which was statistically identical with 50% RF + 10 t cowdung and RF + 5 t cowdung ha^{-1}, and the highest number of sterile spikelets panicle^{-1} was found when crop received 50% RF + 10 t cowdung ha^{-1}.

Effect of interaction: Interaction between variety and nutrient management significantly affected all the parameters except 1000-grain weight (Table 3). Results show that seven different interactions produced statistically similar and the highest grain yield. BRRI dhan34 interacted favorably with Recommend Fertilizer (RF) or 150% RF or RF + 5 t cowdung ha^{-1} to produce the highest grain yield (3.48, 3.45 and 2.98 t ha^{-1}, respectively). While BRRI dhan38 produced the same when grown with RF (3.48 t ha^{-1}) or 150% RF (3.14 t ha^{-1}) and Basmati yielded the highest when fertilized with RF + 5 t cowdung ha^{-1} (3.08 t ha^{-1}) or 50% RF + 10 t cowdung ha^{-1} (3.15 t ha^{-1}). On the other hand, the lowest grain yield was recorded with only the local varieties like Kalizira (0.79 t ha^{-1}), Basmati (1.18

t ha^{-1}), Kataribhog (0.91 t ha^{-1}) and Chiniguda (0.94 t ha^{-1}) when grown organically (10 t cowdung ha^{-1}). It is interesting to note that high yielding fine rice varieties like BRRI dhan34 and BRRI dhan38 also failed to perform better when grown organically producing only 2.21 and 2.14 t grain ha^{-1}, respectively.

The results of the present study thus indicate that for obtaining higher grain yield from fine rice, high yielding variety BRRI dhan34 or BRRI dhan38 should be grown with recommended fertilizer and Basmati with recommended fertilizer + 5 t cowdung ha^{-1} or 50% RF + 10 t cowdung ha^{-1}. However the latter one i.e. integrated nutrient management approach may be considered as a viable option so far soil fertility is of our great concern.

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