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Yield and quality of aromatic fine rice as affected by variety and nutrient management

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, to study the yield and quality of aromatic fine rice as affected by variety and nutrient management during the period from June to December 2013. The experiment comprised three aromatic fine rice varieties viz. BRRI dhan34, BRRI dhan37 and BRRI dhan38, and eight nutrient managements viz. control (no manures and fertilizers), recommended dose of inorganic fertilizers, cowdung at 10 t ha^{-1}, poultry manure at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + 50% cowdung, 50% of recommended dose of inorganic fertilizers + 50% poultry manure, 75% of recommended dose of inorganic fertilizers + 50% cowdung and 75% of recommended dose of inorganic fertilizers + 50% poultry manure. The experiment was laid out in a randomized complete block design with three replications. The tallest plant (142.7 cm), the highest number of effective tillers $hill^{-1}$ (10.02), number of grains $panicle^{-1}$ (152.3), panicle length (22.71cm), 1000-grain weight (15.55g) and grain yield (3.71 t ha^{-1}) were recorded in BRRI dhan34. The highest grain protein content (8.17%) was found in BRRI dhan34 whereas the highest aroma was found in BRRI dhan37 and BRRI dhan38. The highest number of effective tillers $hill^{-1}$(11.59), number of grains $panicle^{-1}$ (157.6), panicle length (24.31 cm) and grain yield (3.97 t ha^{-1}) were recorded in the nutrient management of 75% recommended dose of inorganic fertilizers + 50% cowdung (5 t ha^{-1}). The treatment control (no manures and fertilizers) gave the lowest values for these parameters. The highest grain yield (4.18 t ha^{-1}) was found in BRRI dhan34 combined with 75% recommended dose of inorganic fertilizers + 50% cowdung, which was statistically identical to BRRI dhan34 combined with 75% of recommended dose of inorganic fertilizers + 50% poultry manure and the lowest grain yield (2.7 t ha^{-1}) was found in BRRI dhan37 in control (no manures and fertilizers). The highest grain protein content (10.9 %) was obtained in the interaction of BRRI dhan34 with recommended dose of inorganic fertilizers which was as good as that of BRRI dhan38 and 75% of recommended dose of inorganic fertilizers + 50% poultry manure. The highest aroma was found in BRRI dhan38 combined with 75% recommended dose of inorganic fertilizers + 50% cowdung.

Keywords: Nutrient management, Fine rice, Yield, Aroma, Protein content

Introduction

Rice (*Oryza sativa* L.) crop is interwoven in the cultural, social and economic lives of millions of Bangladeshis and it holds the key for food and nutritional security of the country. It is consumed as the staple food and has been given the highest priority in meeting the demands of its ever-increasing population in Bangladesh. In recent years, aromatic rice has been introduced to the global market. Aromatic rice has great potential to attract rice consumer for its taste and deliciousness, and high price to boost up the economic condition of the rice grower in the developing countries like Bangladesh. Because of its natural chemical compounds which give it a distinctive scent or aroma when cooked, aromatic rice commands a higher price than non-aromatic rice. In Bangladesh, a number of fine rice cultivars are grown by the farmers. Some of them have special appeal for their aroma. Such common cultivars are Chinisagar, Badshabhog, Kataribhog, Kalizira, Tulsimla, Dulabhog, Basmati, Banglamoti (BRRI dhan50), BRRI dhan34, BRRI dhan37 and BRRI dhan38.

Bangladesh has a bright prospect for export of fine rice thereby earning foreign exchange. The yield of fine rice is lower than that of coarse and medium rice varieties. Although the geographical, climatic and edaphic conditions of Bangladesh are favorable for year-round rice cultivation, the national average of rice yield is rather low (2.92 t ha^{-1}) (BBS, 2012). The reasons for low yield are mainly associated with selection of improved varieties and judicious fertilizer management especially of organic fertilizer like cowdung, poultry manure and/or their integration with inorganic fertilizers.

In all the agricultural systems there is inevitably a loss of plant nutrients. Nutrient mining, depletion of soil organic matter and reduction in soil aggregates have been identified as reasons of yield stagnation or decline in the productivity of crops (Rahman and Yakupitiyage, 2006). In Bangladesh, nutrient stresses of soils are increasing day by day. Use of fertilizer is an essential component of modern farming with about 50% of the world crop production (Prodhan, 1992). Among the cultural technologies, integrated nutrient management like application of cowdung, poultry manure along with other inorganic fertilizers and selection of right variety are the important ones in augmenting the yield of crop. The efficient nutrient management increases crop yield and at the same time reduces fertilization cost. Therefore, the present study was undertaken to evaluate the effects of variety and nutrient management on the yield and quality of aromatic fine rice.

Materials and Methods

The research work was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from June to December 2013. The experimental site belongs to the Sonatola series of the dark grey floodplain soil type under Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9). The field was a medium high land with well drained silty-loam texture having pH value 6.5 and 1.67% organic matter content. The experiment was laid out in a two factor randomized complete block design with three replications. The experiment comprised three aromatic fine rice varieties viz. BRRI dhan34, BRRI dhan37 and BRRI dhan38 and eight nutrient managements viz. control (no manures and fertilizers), recommended dose of inorganic fertilizers (i.e 150, 97, 70, 60 and 12 kg ha^{-1} urea, TSP, MoP, gypsum and zinc sulphate, respectively), cowdung at 10 t ha^{-1}, poultry manure at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + 50% cowdung, 50% of recommended dose of inorganic fertilizers + 50% poultry manure, 75% of recommended dose of inorganic fertilizers + 50% cowdung and 75% of recommended dose of inorganic fertilizers + 50% poultry manure. Seeds of the aromatic fine rice varieties were collected from the Bangladesh Rice Research Institute, Joydebpur, Gazipur. The nursery beds were puddled with country plough, cleaned and levelled with ladder. Then the sprouted seeds were sown in the nursery beds on 30 June 2013. At the time of final land preparation, respective unit plots were amended with organic and inorganic fertilizers according to treatment specification. Urea was applied in three equal splits at final land preparation, 30 days after transplanting (DAT) and 50 DAT. Full dose of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation. Thirty-day old seedlings were transplanted on 1 August 2013 with three seedlings $hill^{-1}$. Prior to harvest, five hills $plot^{-1}$ were randomly selected excluding border hills and central 1 m^2 area from each unit plot for recording data on yield components and yield. The crop was harvested at full maturity. BRRI dhan34 was harvested on 10 December and BRRI dhan37 and BRRI dhan38 were harvested on 18 December 2013. The harvested crop of central 1 m^2 area from each plot was separately bundled, properly tagged and then threshed. The grains were cleaned and sun dried to moisture content of 14%. Finally grain and straw yields $plot^{-1}$ were recorded and converted to t ha^{-1}. Estimation of protein (%) in grains was done by Micro-Kjeldahl Method (AOAC, 1984). Aroma of rice was detected by olfactory test following the method developed by Nagaraju *et al*. (1991). In this method, a panel of five judges estimated the intensity of aroma of the chemical treated rice samples by olfaction and gave a score individually for each sample according to the following Table.

Degree of Aroma	Score	Type of Quality
+	1	Good
++	2	Better
+++	3	Best

Their scores were averaged to obtain the numerical value of aroma for each treatment. The collected data were analyzed statistically using the "analysis of variance" technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using MSTAT- C computer program.

Results and Discussion

Effect of variety

Variety influenced significantly crop characters, yield contributing characters and yield except harvest index (Table 1). The tallest plant (142.7 cm), the highest number of effective tillers hill^{-1}(10.02), the highest number of grains panicle^{-1} (152.3), grain yield (3.71 t ha^{-1}), straw yield (5.11 t ha^{-1}) and biological yield (8.83 t ha^{-1}) were recorded in BRRI dhan34. Similar results were found elsewhere (Tyeb *et al.*, 2013 and Islam *et al.,* 2012), who reported that variety exerted variable effect on yield and yield contributing characters of rice. The highest number of effective tillers hill^{-1} and the highest number of grains panicle^{-1} were mainly responsible for the highest grain yield. This confirms the report of Islam *et al.* (2013), who reported the variable effect of variety on the number of effective tillers hill^{-1}. The variation in plant height, number of effective tillers hill^{-1} and number of grains panicle^{-1} among the varieties were probably due to heredity or varietal characters. BRRI dhan34 also gave the lowest number of non-effective tillers hill^{-1} (1.63), sterile spikelets panicle^{-1} (25.01) and 1000-grain weight (11.26 g). Variety had significant effect on qualitative characters like grain protein content (%) and aroma. The highest grain protein content (8.18%) was found in BRRI dhan34 followed by BRRI dhan38 (7.98%) and the lowest one (7.75 %) was observed in BRRI dhan37. This result was consistent to Dutta *et al.*(1998) and Alam (2002) who recorded variable protein percentage among varieties. The highest aroma (1.81) was found in BRRI dhan38, which was similar to that of BRRI dhan37 (1.81). The lowest (1.76) aroma was observed in BRRI dhan34. Dutta *et al*. (1998) reported that aroma varied among the varieties.Varietal differences regarding grain protein content and aroma might be due to their difference in genetic make-up.

Table 1. Effect of variety on yield and yield contributing characters as well as quality of aromatic fine rice

Treatments	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)	Grain protein content (%)	Aroma (numerical)
BRRI dhan34	142.7a	11.44a	10.02a	1.63c	22.71a	152.3a	25.01c	11.26c	3.71a	5.11a	8.83a	42.02	8.18a	1.76b
BRRI dhan37	121.7c	10.60c	9.40c	1.86a	19.73c	118.0c	31.79a	14.60b	3.39c	4.70c	8.09c	41.84	7.75c	1.81a
BRRI dhan38	126.2b	10.86b	9.61b	1.70b	21.78b	126.2b	27.34b	15.55a	3.50b	4.86b	8.36b	41.77	7.98b	1.81a
$S\bar{x}$	0.838	0.072	0.037	0.017	0.180	0.829	0.237	0.138	0.017	0.027	0.039	0.203	0.068	0.018
Level of significance	**	**	**	**	**	**	**	**	**	**	**	NS	**	**
CV (%)	3.15	3.22	1.87	4.71	4.13	3.08	4.14	4.90	2.32	2.75	2.27	2.38	4.23	2.88

** =Significant at 1% level of probability
NS = Not-significant
In a column, figures with dissimilar letter differ significantly as per DMRT.

Crop characters, yield and yield contributing characters except 1000-grain weight were significantly influenced by nutrient management (Table 2). The application of 75% of recommended dose of inorganic fertilizers+ 50% cowdung showed superiority in terms of the highest plant height (139.5 cm), number of total tillers hill^{-1} (13.41), number of effective tillers hill^{-1}(11.59), panicle length (24.31 cm), number of grains panicle^{-1} (157.6), grain yield (3.97 t ha^{-1}), straw yield (5.49 t ha^{-1}) and biological yield (9.47 t ha^{-1}). Probably this treatment provided adequate nutrients to the plants and exhibited the best performance due to absorption of more nutrients, moisture. These results are in agreement with that of Sikdar (2000) and Kabir *et al.* (2004) who found differences in yield and yield contributing characters due to different levels of nutrient management. Hossain (2008) also reported that Kataribhog and Badshabhog produced yield of 2.30 and 2.12 tons ha^{-1}, respectively. The treatment control (no manures and fertilizers) gave the lowest values for the same parameters due to lack of proper nutrient uptake. The lowest number of non-effective tillers hill^{-1} (1.15) was found from the treatment 75% of recommended dose of inorganic fertilizers + 50% cowdung. The highest grain protein content (9.15 %) was found in the treatment of 75% of recommended dose of inorganic fertilizers + 50% poultry manure, which was similar (8.96 %) to that of recommended dose of inorganic fertilizers. This might be due to availability and uptake of adequate nitrogen from the soil. The highest aroma (2.46) was found in the treatment of 75% of recommended dose of inorganic

fertilizers + 50% cowdung. The lowest (1.00) aroma was observed in the control treatment**.** These findings are in conformity with the findings of Dutta *et al.* (1998).

Table 2. Effect of nutrient management on yield and yield contributing characters as well as quality of aromatic fine rice

Treatments	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)	Grain protein content (%)	Aroma (numerical)
T_1	116.6e	8.420f	8.070h	2.77a	17.72f	112.7g	17.53h	13.56	2.87g	4.30f	7.18g	40.04d	6.36f	1.00h
T_2	132.7b	12.16b	10.35c	1.49e	22.82b	139.4c	31.67c	13.79	3.80c	5.05c	8.85c	42.96ab	8.96a	2.36b
T_3	126.3d	9.633e	8.390g	2.11b	19.05e	117.1f	21.50g	13.64	3.06f	4.55e	7.61f	40.22d	7.46d	1.93d
T_4	127.8cd	9.823e	8.80f	1.76c	20.61d	122.0e	23.72f	13.67	3.31e	4.67e	7.98e	41.46c	7.01e	1.40f
T_5	130.2bd	10.57d	9.15e	1.65d	21.34cd	124.2e	26.95e	13.70	3.64d	4.84d	8.48d	42.91ab	8.42b	1.33g
T_6	131 bc	11.26c	9.96d	1.56e	21.94c	132.4d	29.75d	13.74	3.73c	4.88d	8.61d	43.30a	8.51b	1.65e
T_7	139.5a	13.41a	11.59a	1.15g	24.31a	157.6a	39.40a	14.45	3.97a	5.49a	9.47a	42.01bc	7.88c	2.46a
T_8	137.6a	12.46b	11.10b	1.37f	23.47b	151.7b	33.87b	13.86	3.89b	5.35b	9.24b	42.10bc	9.15a	2.21c
$S\bar{x}$	1.36	0.117	0.060	0.028	0.294	1.35	0.387	0.225	0.028	0.045	0.064	0.333	0.112	0.018
Level of significance	**	**	**	**	**	**	**	NS	**	**	**	**	**	**
CV (%)	3.15	3.22	1.87	4.71	4.13	3.08	4.14	4.90	2.32	2.75	2.27	2.38	4.23	2.88

** =Significant at 1% level of probability
NS = Not-significant
In a column, figures with dissimilar letter differ significantly as per DMRT.
T_1= control (no manures and fertilizers), T_2= recommended dose of inorganic fertilizers (i.e 150,97, 70,60 and 12 kg Urea, TSP, MoP, Gypsum and Zn respectively ha^{-1} , T_3=cowdung at 10 t ha^{-1}, T_4=poultry manure at 5 t ha^{-1}, T_5= 50% of recommended dose of inorganic fertilizers + 50% cowdung, T_6=50% of recommended dose of inorganic fertilizers + 50% poultry manure , T_7= 75% of recommended dose of inorganic fertilizers + 50% cowdung, T8= 75% of recommended dose of inorganic fertilizers + 50% poultry manure.

Effect of interaction of variety and nutrient management

The interaction effect of variety and nutrient management was significant on yield and yield components of aromatic fine rice (Table 3). The highest plant height (149.9 cm), number of total tillers hill^{-1} (14.23), number of effective tillers hill^{-1} (12.03), panicle length (25.60 cm), number of grains panicle^{-1} (173), grain yield (4.18 t ha^{-1}), straw yield (5.88 t ha^{-1}) and biological yield (10.07 t ha^{-1}) were recorded in the interaction between BRRI dhan34 and 75% of recommended dose of inorganic fertilizers + 50% cowdung. The lowest values of these parameters were found in the interaction between BRRI dhan37 and control (no manures and fertilizers). But harvest index (44.06%) was found maximum in the interaction between BRRI dhan34 and 50% of recommended dose of inorganic fertilizers + 50% cowdung. Interaction of BRRI dhan34 with recommended dose of inorganic fertilizers produced the highest grain protein content (10.90%) which was as good as (10.87%) BRRI dhan38 with 75% of recommended dose of inorganic fertilizers + 50% poultry manure. The lowest grain protein content (6.28%) was observed in interaction of BRRI dhan37 × control, which was similar to that of BRRI dhan38 × control (6.34%), BRRI dhan37 × poultry manure at 5 t ha^{-1} (6.38%) and BRRI dhan34 × control (6.46%). The highest aroma (2.61) was found in BRRI dhan38 with 75% of recommended dose of inorganic fertilizers + 50% cowdung, which was similar to that of BRRI dhan38 × recommended dose of inorganic fertilizers. The lowest aroma was found in BRRI dhan34 × control (1.00) which was similar to aroma from the interactions of BRRI dhan37 × control (1.00), and BRRI dhan38 × control (1.00).

Table 3. Effect of interaction of variety and nutrient management on yield and yield contributing characters of aromatic fine rice

Interaction (V ×N)	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha$^{-1)}$	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)	Grain protein content (%)	Aroma (numerical)
$V_1 \times T_2$	148.1ab	12.90bc	10.43d	1.43hij	24.23abc	169.1a	28.81fg	11.30	3.92c	5.30c	9.22cd	42.50abcde	10.90a	2.11e
$V_1 \times T_3$	140.1cde	9.80hi	8.83h	2.07d	20.13hij	133.6fg	19.74k	11.16	3.22jk	4.75d	7.97jk	40.39fg	7.33e	1.72gh
$V_1 \times T_4$	141.9bcd	10.00ghi	9.23g	1.70fg	22.28defg	139.9ef	22.87ij	11.21	3.37hi	4.80d	8.17ij	41.23def	7.32e	1.27k
$V_1 \times T_5$	145abcd	10.83f	9.47fg	1.53h	23.13cde	140.7e	23.99hij	11.23	3.88cd	4.94d	8.82efg	43.99ab	9.01bc	1.55j
$V_1 \times T_6$	145.8abc	11.83e	10.33d	1.47hi	23.31cde	157.8b	25.34h	11.29	3.90c	4.95d	8.85efg	44.06a	9.04b	1.77g
$V_1 \times T_7$	149.9a	14.23a	12.03a	1.03k	25.60a	173.0a	32.89e	11.43	4.18a	5.88a	10.07a	41.56cdef	7.33e	2.44b
$V_1 \times T_8$	149.7a	13.37b	11.53b	1.30j	25.07ab	172.2a	29.95f	11.37	4.07ab	5.60b	9.67b	42.06bcdef	8.00d	2.27cd
$V_2 \times T_1$	110.1l	8.13j	7.97k	3.03a	17.47m	97.54n	18.68kl	14.28	2.70m	3.83f	6.53o	41.34def	6.28g	1.00m
$V_2 \times T_2$	123.7hijk	11.77e	10.23de	1.57gh	20.60hij	123.6ij	36.00cd	14.61	3.70ef	4.90d	8.60gh	43.02abcd	8.99bc	2.43b
$V_2 \times T_3$	116.7kl	9.50i	8.17k	2.20d	18.03lm	101.6n	22.87ij	14.34	2.89l	4.44e	7.33mn	39.40gh	8.04d	2.20de
$V_2 \times T_4$	118.1k	9.67i	8.50ij	1.87e	18.4klm	109.7lm	24.86hi	14.38	3.23ij	4.49e	7.72kl	41.86cdef	6.38g	1.66hi
$V_2 \times T_5$	121.6jk	10.4fgh	8.73hi	1.73ef	19.17jkl	114.6lm	32.52e	14.44	3.47gh	4.76d	8.23ij	42.16abcdef	7.99d	1.160l
$V_2 \times T_6$	122.7ijk	10.93f	9.60f	1.73ef	19.70ijk	117.0jkl	35.98cd	14.50	3.62f	4.78d	8.40hi	43.08abcd	8.41cd	1.61ij
$V_2 \times T_7$	130.8fgh	12.53cd	11.23b	1.37ij	23.23cde	146.1de	46.24a	15.56	3.80cde	5.25c	9.05cdef	41.99cdef	7.32e	2.33c
$V_2 \times T_8$	130.0ghi	11.83e	10.83c	1.45hij	21.27fghi	133.4fg	37.15c	14.68	3.73def	5.190c	8.92defg	41.82cdef	8.59bcd	2.11e
$V_3 \times T_1$	118.9jk	8.53j	7.97k	2.73b	17.77lm	109.0m	17.40lm	15.34	2.720m	4.36e	7.08n	38.41h	6.34g	1.00m
$V_3 \times T_2$	126.3ghij	11.80e	10.4d	1.47hi	23.63bcd	125.3hi	30.20f	15.45	3.80cde	4.96d	8.75fg	43.36abc	6.99ef	2.55a
$V_3 \times T_3$	122.0jk	9.60i	8.17k	2.07d	19.0jklm	116.0klm	21.89j	15.43	3.08k	4.46e	7.54lm	40.86efg	7.01ef	1.88f
$V_3 \times T_4$	123.5hijk	9.80hi	8.67hi	1.73f	21.16ghi	116.4jklm	23.43hij	15.43	3.33hij	4.74d	8.07ij	41.29def	7.32e	1.28k
$V_3 \times T_5$	124.1hijk	10.47fg	9.27g	1.70fg	21.72efgh	117.2jkl	24.33hi	15.44	3.58fg	4.83d	8.41hi	42.59abcde	8.24d	1.28k
$V_3 \times T_6$	124.3hijk	11.03f	9.97e	1.5hi	22.80cdef	122.3ijk	27.92g	15.44	3.67ef	4.91d	8.58gh	42.76abcde	8.06d	1.59ij
$V_3 \times T_7$	137.7def	13.47b	11.5b	1.07k	24.10abc	153.6bc	39.08b	16.35	3.95bc	5.35c	9.30c	42.47abcde	8.99bc	2.61a
$V_3 \times T_8$	133.1efg	12.1	10.93c	1.37ij	24.07abc	149.4cd	34.50de	15.53	3.88cd	5.27c	9.15cde	42.43abcde	10.87a	2.27cd
$S\bar{x}$	2.37	0.204	0.105	0.048	0.051	2.35	0.670	0.390	0.048	0.077	0.111	0.576	0.194	0.031
Level of significance	*	*	*	*	*	**	**	NS	**	**	**	*	**	**
CV (%)	3.15	3.22	1.87	4.71	4.13	3.08	4.14	4.90	2.32	2.75	2.27	2.38	4.23	2.88

In a column, figures with dissimilar letter differ significantly as per DMRT

** =Significant at 1% level of probability.
* =Significant at 5% level of probability.
NS= Not-significant

V_1 = BRRI dhan34
V_2 = BRRI dhan37
V_3 = BRRI dhan38

T_1= control (no manures and fertilizers), T_2= recommended dose of inorganic fertilizers (i.e 150,97, 70,60 and 12 kg Urea, TSP, MoP, Gypsum and Zn respectively ha^{-1} , T_3= cowdung at 10 t ha^{-1}, T_4=poultry manure at 5 t ha^{-1}, T_5= 50% of recommended dose of inorganic fertilizers + 50% cowdung, T_6=50% of recommended dose of inorganic fertilizers + 50% poultry manure , T_7= 75% of recommended dose of inorganic fertilizers + 50% cowdung, T8= 75% of recommended dose of inorganic fertilizers + 50% poultry manure

Conclusion

From the present study, it can be concluded that aromatic fine rice cv.BRRI dhan34 combined with 75% of recommended dose of inorganic fertilizers + 50% cowdung performed better in terms of yield components and yield. On the other hand, grain protein content was higher in BRRI dhan34 with recommended dose of inorganic fertilizers and better aroma was found in BRRI dhan38 with 75% of recommended dose of inorganic fertilizers + 50% cowdung.

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