International Journal of Plant & Soil Science
13(5): 1-8, 2016; Article no.IJPSS.30158
ISSN: 2320-7035

SCIENCEDOMAIN *international*
www.sciencedomain.org

Effect of Row Arrangement and Integrated Nutrient Management on the Yield of Aromatic Fine Rice (cv. BRRI dhan34)

R. Marzia[1], M. A. R. Sarkar[1] and S. K. Paul[1*]

[1]Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh.

Authors' contributions

This work was carried out in collaboration between all authors. Author RM designed the study, managed the experimental process and wrote the first draft of the manuscript. Author SKP analyzed the data and managed the literature searches. Author MARS added some sections and revised the final manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2016/30158
Editor(s):
(1) Mirza Hasanuzzaman, Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.
Reviewers:
(1) Afe Ade Isaac, Kwara State University, Nigeria.
(2) Omoregbee Osazuwa, University of Benin, Nigeria.
(3) Ronald Mandumbu, Bindura University of Science Education, Zimbabwe.
Complete Peer review History: http://www.sciencedomain.org/review-history/17248

Original Research Article

Received 21st October 2016
Accepted 26th November 2016
Published 16th December 2016

ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh from June to December 2014 to study the effect of row arrangement and integrated nutrient management on the yield of aromatic fine rice (cv. BRRI dhan34). The experiment comprised three row arrangements viz. single row (row spacing 25 cm), double row (row spacing 25-10-25 cm), triple row (row spacing 25-10-10-25 cm), and six nutrient managements viz. control (no manures and fertilizers), recommended dose of inorganic fertilizers (i.e. 150, 100, 70, 60 and 10 kg Urea, TSP, MoP, Gypsum and $ZnSO_4$, respectively ha^{-1}), 50% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}, 75% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1} and 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The tallest plant (120.65 cm), the highest number of total tillers $hill^{-1}$ (12.87), panicle length (25.49 cm), grains $panicle^{-1}$ (161.81) and grain yield (3.79 t ha^{-1}) were obtained from double

---

**Corresponding author: E-mail: skpaull@gmail.com;*

row arrangement. With respect to nutrient management 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1} gave the highest plant height (124.60 cm), number of total tillers $hill^{-1}$ (15.05), number of effective tillers $hill^{-1}$ (12.98), longest panicle (25.29 cm), grains $panicle^{-1}$ (155.66) and grain yield (3.89 t ha^{-1}). The control treatment (no manures and no fertilizers) gave the lowest values for these parameters. The highest grain yield (4.30 t ha^{-1}) was found in double row arrangement combined with 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}, which was statistically identical with the combined effect of double row and 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1} and the lowest grain yield (2.08 t ha^{-1}) was found in triple row arrangement in control (no manures and fertilizers). Therefore, double row arrangement combined with 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1} and 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1} appeared as the promising practice in aromatic fine rice (cv. BRRI dhan34) cultivation in terms of yield.

Keywords: Row arrangement; integrated nutrient management; aromatic fine rice; yield.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the most extensively cultivated crop in Bangladesh and it is the staple food for Bangladeshi people. In Bangladesh, agriculture is characterized by rice based cropping systems. Rice is the most important food crop and a primary food source for more than one-third of world's population [1]. Almost one-fourth of the calories consumed by the entire world population come from rice [2]. Rice is mainly produced and consumed in Asia which constitutes more than half of the global population [3]. In recent years, aromatic rice has been introduced to the global market. Aromatic rice is also named as fine rice, scented rice or fragrant rice. It is very popular in Asia and has recently gained wider acceptance in the United States and Europe [4]. The growth, development and yield of rice is directly related to different agronomic practices and environment. Planting arrangement of transplant *Aman* rice may have remarkable influence on growth and yield performance. Transplant *Aman* rice can be grown in both single and double row arrangement to obtain proper vegetative growth and yield [5]. Transplant *Aman* rice showed better performance over single and triple row. It should preferably be grown in double row arrangement to obtain highest grain yield [6,7,8,9]. Optimum planting arrangement ensures plants to grow properly and utilizing more solar radiation and nutrients. When the planting densities exceed an optimum level, competition among plants for light and nutrients become more severe. Hence, suitable row arrangement should be ensured for the proper growth of plants to give higher yield. Although the geographical, climatic and edaphic conditions of Bangladesh are favorable for year-round rice cultivation, the national average yield is rather low (3.00 t ha^{-1}) compared to other rice growing countries [10]. The reasons for low yields are mainly associated with poor knowledge on judicious fertilizer management especially organic fertilizer like cow dung, poultry manure and/or their integration with inorganic fertilizers. The organic fertilizer is traditionally an important source for supplying nutrients for rice cultivation in Bangladesh but use of inorganic fertilizers has increased dramatically, whereas utilization of organic fertilizers decreased [11]. Sarkar et al. [12] reported that aromatic fine rice BRRI dhan34 produced the highest grain yield compared to BRRI dhan37 and BRRI dhan38 when fertilized with 75% recommended dose of inorganic fertilizers + 50% cowdung (5 t ha^{-1}) which was as good as 75% recommended dose of inorganic fertilizers + 50% poultry manure (2.5 t ha^{-1}). Selection of potential variety, suitable planting arrangement and application of optimum amount of nutrient elements can play an important role to increase yield. 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 [13]. Among the cultural technologies, integrated nutrient management like application of cow dung, poultry manure along with other inorganic fertilizers and selection of right variety are the important ones. The efficient nutrient management increases crop yield and at the same time reduces fertilization cost. It is, therefore, essential to find out the suitable row arrangement and appropriate combination of inorganic fertilizers along with manures for efficient cultivation of aromatic fine rice.

2. MATERIALS AND METHODS

The research work was conducted at the Agronomy Field Laboratory, Bangladesh

Agricultural University, Mymensingh, Bangladesh from June to December 2014. The experimental site belongs to the Sonatola series of the non-calcareous dark gray floodplain soil under the Old Brahmaputra Floodplain Agro-ecological Zone (AEZ 9). The field was a medium high land with well drained silty-loam texture having pH 6.5, low in organic matter content (1.67%). The experiment was laid out in a randomized complete block design with three replications. The size of unit plot was 4.0 m × 2.5 m. The distances between blocks and plots were 1.0 m and 75 cm, respectively. The experiment comprised three row arrangements viz. single row (row spacing 25 cm), double row (row spacing 25-10-25 cm), triple row (row spacing 25-10-10-25 cm), and six nutrient managements viz. control (no manures and fertilizers), recommended dose of inorganic fertilizers (i.e 150, 100, 70, 60 and 10 kg ha^{-1} Urea, TSP, MoP, Gypsum and $ZnSO_4$, respectively) 50% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}, 75% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1} and 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1}. The land was puddled with country plough, cleaned and leveled with ladder. Then sprouted seeds of BRRI dhan34 were sown in the nursery beds on 7 July 2014. The main land was then puddled thoroughly by repeated ploughing and cross ploughing with a country plough and subsequently leveled by laddering. 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 15 days after transplanting (DAT), 30 DAT and 50 DAT. Full dose of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation as per treatment requirements. Thirty-day old seedlings were transplanted in the main field on 8 August 2014 in the well puddled plot. Three seedlings were transplanted in each hill maintaining single, double and triple row arrangement with 25 cm × 15 cm, 25-10-25 cm × 15 cm, 25-10-10-25 cm × 15 cm, spacing respectively. Prior to harvest five hills $plot^{-1}$ were randomly selected excluding border hills and central 5.0 m^2 area from each unit plot for recording data on yield components and yield respectively. The crop was harvested at full maturity on 8 December 2014. The harvested crop of central 5.0 m^2 from each plot was separately bundled, properly tagged brought to the threshing floor and then threshed. The grains were cleaned and sun dried to 14% moisture content. Straws were also sun dried properly. Finally grain and straw yields $plot^{-1}$ were recorded and converted to t ha^{-1}. The collected data were analyzed statistically using the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) [14] using a computer operated program MSTAT.

3. RESULTS AND DISCUSSION

3.1 Effect of Row Arrangement

Row arrangement influenced significantly crop characters, yield and yield contributing characters except 1000-grain weight (Table 1). The tallest plant (120.65 cm) was obtained in single row arrangement followed by double row (119 cm) and the shortest plant (118.13 cm) was obtained in triple row arrangement. Similar results were reported by [5,6]. The highest plant height resulted due to optimum solar radiation in single row arrangement for better photosynthesis. The highest number of total tillers $hill^{-1}$ (12.87) and the highest number of effective tillers $hill^{-1}$ (9.81) were found in double row arrangement due to capturing more solar radiation. Reduction in the number of total tillers $hill^{-1}$ (10.72) and effective tillers $hill^{-1}$ (7.51) in triple row arrangement might be due to increased number of hills per unit area, which competed among themselves for space, air and nutrients. Similar results were reported elsewhere [6,7,15,16,17]. It was observed that triple row arrangement had the highest number of non-effective tillers $hill^{-1}$ (3.21) and the lowest number of non-effective $tillershill^{-1}$ was recorded in double row arrangement (2.06). The highest panicle length (25.49 cm) was observed in double row arrangement followed by single row (24.98 cm) and the shortest one (23.57 cm) was found in triple row arrangement. The highest number of grains $panicle^{-1}$ (161.81) was recorded in double row arrangement followed by single row arrangement (134.75) and the lowest number of grains $panicle^{-1}$ (127.27) was recorded in triple row arrangement. The highest number of sterile spikelets $panicle^{-1}$ (28.41) was recorded in triple row arrangement. The lowest of sterile spikelets $panicle^{-1}$ (21.35) was recorded in double row arrangement. The highest grain yield (3.79 t ha^{-1}) was recorded in double row arrangement followed by single row arrangement (3.43 t ha^{-1}) and the lowest grain yield (3.02 t ha^{-1}) was obtained from triple row arrangement.

The grain yield was higher in double row arrangement because of higher number of effective tillers hill^{-1} and grains panicle^{-1}. Similar results were also reported by Sarker [18] and Alam et al. [6]. They reported that double row arrangement produced the highest grain yield in rice. Results revealed that straw yield (4.69 t ha^{-1}) and biological yield (8.48 t ha^{-1}) were the highest in double row arrangement while single row arrangement produced the lowest straw yield (4.22 t ha^{-1}), which was statistically identical with triple row arrangement. Similar trend of results were also reported by Sarker [18] and Alam et al. [6]. They reported that double row arrangement produced the highest straw yield and biological yield in rice. The highest harvest index (44.73%) was obtained from single row arrangement, which was statistically identical (44.58%) with double row arrangement. The lowest harvest index (41.25%) was recorded in triple row arrangement (Table 1).

3.2 Effect of Integrated Nutrient Management

Nutrient management significantly influenced crop characters, yield and yield contributing characters except 1000-grain weight (Table 2). The application of 75% of recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1} showed superiority in terms of the highest plant height (124.60 cm), number of total tillers hill^{-1} (15.05), number of effective tillers hill^{-1} (12.98), panicle length (25.29 cm) and grains panicle^{-1} (155.66) while the lowest values were in control plots. The highest grain yield (3.89 t ha^{-1}), straw yield (4.68 t ha^{-1}), biological yield (8.57 t ha^{-1}) and harvest index (43.35%) were also obtained when the crop was fertilized with 75% of recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1} which were as good as 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1}, and sole application of recommended dose of inorganic fertilizers. Probably this treatment provided adequate nutrients to the plants and exhibited the best performance due to absorption of more nutrients. These results are in agreement with that of Sikdar [19] and Kabir et al. [20] who found differences in yield and yield contributing characters due to different levels of nutrient management. The treatment control (no manures and fertilizers) gave the lowest values for the same parameters due poor nutrient supply and plant uptake. The lowest number of non-effective tillers hill^{-1} (2.08) was found in treatment 75% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}. Application of 75% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1} improved the yield contributing characters of aromatic fine rice varieties viz. number of effective tillers hill^{-1} and number of grains panicle^{-1}, which ultimately resulted in the highest grain yield. Similar results were reported by Sarkar et al. [12]. The straw yield showed similar trend as that of grain yield due to nutrient management. Application of different doses of manures and fertilizers influenced the vegetative growth in terms of plant height and number of total tillers hill^{-1}, which resulted in differences of straw yield. The highest harvest index (45.35%) was found in 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1}. However, 75% recommended dose of inorganic fertilizer + poultry manure at 2.5 t ha^{-1} and sole application of recommended dose of inorganic fertilizers behaved in the similar manner as that of 75% recommended dose of inorganic fertilizer + cowdung at 5 t ha^{-1}. The lowest harvest index (39.78%) was found in the control treatment (no fertilizer and manure application).

3.3 Effect of Interaction between Variety and Integrated Nutrient Management

The interaction effect of row arrangement and nutrient management was significant on yield and yield components of aromatic fine rice (Table 3). The longest plants (125.86 cm) were found in the interaction of single row arrangement and 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1}. The highest number of effective tillers hill^{-1} (14.20) was found in the treatment combination of double row arrangement and 75% recommended dose of inorganic fertilizer + poultry manure at 2.5 t ha^{-1}, which was statistically identical (13.07) with double row arrangement and 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1}. The results showed superiority in terms of highest number of total tillers hill^{-1} (16.44), grains panicle^{-1} (178.35), grain yield (4.30 t ha^{-1}), straw yield (4.96 t ha^{-1}), biological yield (9.17 t ha^{-1}), and harvest index (46.95%) in the combination of double row arrangement fertilized 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1}. Alam et al. [6] found that in *Aman* season BRRI dhan52 produced the highest number of effective tillers hill^{-1}, grains panicle and grain yield due to interaction effect of double row arrangement fertilized with 75 kg N ha^{-1}.

Table 1. Effect of row arrangement on crop characters, yield components and yield of aromatic fine rice cv. BRRI dhan34

Row arrangement	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 (%)
Single row	120.65a	11.38b	8.33b	3.05b	24.98b	134.75b	24.92b	11.90	3.43b	4.22b	7.65b	44.73a
Double row	119.00b	12.87a	9.81a	2.06 c	25.49a	161.81a	21.35c	12.18	3.79a	5.69a	8.48a	44.58ab
Triple row	118.13c	10.72c	7.51c	3.21a	23.57c	127.28c	28.41a	11.86	3.02c	4.26b	7.28c	41.25b
CV (%)	4.52	7.12	5.47	9.22	4.33	5.14	4.58	6.58	7.45	6.25	5.85	4.22
Level of sig	**	**	**	**	**	**	**	NS	**	**	**	**

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
*** = Significant at 1% level of probability; NS = Non-significant*

Table 2. Effect of integrated nutrient management on crop characters, yield components and yield of aromatic fine rice cv. BRRI dhan34

Fertilizer Management	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}	1000grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
F_0	115.11d	6.36d	2.71e	3.87a	23.56c	118.43e	35.26a	11.31	2.43d	3.68c	6.10d	39.73c
F_1	119.29bc	13.16b	9.89c	3.67b	24.89b	143.35c	24.58b	12.16	3.75a	4.57a	8.32a	45.06a
F_2	117.70c	10.77c	7.10d	3.65b	24.72b	135.98d	25.74b	12.18	3.38b	4.55a	7.94b	42.54b
F_3	124.60a	15.16a	12.98a	2.08d	25.29a	155.66a	19.49c	12.34	3.89a	5.68a	8.57a	45.35a
F_4	117.88c	10.36c	6.49d	3.28c	24.53b	146.56b	26.00b	11.80	3.21c	4.22b	7.43c	43.21b
F_5	120.96b	14.23a	12.14a	2.10d	25.10a	147.68b	19.29c	12.09	3.83a	4.62a	8.46a	45.23a
CV (%)	4.52	7.12	5.47	9.22	4.33	5.14	4.58	6.58	7.45	6.25	5.85	4.22
Level of sig.	**	**	**	**	**	**	**	NS	**	**	**	**

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
*** =Significant at 1% level of probability; NS = Non-significant; F_0= control (no manures and fertilizers),*
F_1= recommended dose of inorganic fertilizers (i.e 150,100, 70, 60 and 10 kg Urea, TSP, MoP, Gypsum and $ZnSO_4$ respectively ha^{-1},
F_2= 50% of recommended dose of inorganic fertilizers + cowdung at 5 t ha$^{-1;}$ F_3=75% of recommended dose of inorganic fertilizers + cowdung at 5 t ha^{-1}; F_4= 50% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1}; F_5= 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1}

Table 3. Effect of interaction between row arrangement and integrated nutrient management on yield and yield contributing characters of aromatic fine rice cv. BRRI dhan34

Row arrangement × Nutrient management	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 (%)
$R_1 \times F_0$	123.03ab	5.50	2.40fg	4.67ab	23.42	118.43j	35.78b	11.36	2.22i	3.00h	5.22i	42.57cde
$R_1 \times F_1$	124.75a	15.00	13.07ab	1.93e	25.74	148.79e	18.42ij	12.47	3.94bcd	4.78abc	8.71abc	45.18a-d
$R_1 \times F_2$	115.85fg	11.04	7.37def	3.67a-d	24.86	125.36i	24.34fg	12.26	3.57ef	4.47a-f	8.04c-f	44.41a-e
$R_1 \times F_3$	120.49bcd	12.87	8.20d	3.10b-e	25.52	135.73gh	25.79ef	11.71	3.86cde	4.41b-f	8.27bcd	44.49a-e
$R_1 \times F_4$	120.39bcd	9.62	6.54efg	3.08b-e	24.58	141.78f	25.97def	11.87	3.34f	4.11d-g	7.45fg	44.99a-e
$R_1 \times F_5$	119.36cde	14.27	12.42b	3.16a-e	25.79	138.42fg	19.21hi	11.75	3.64def	4.54a-e	8.18b-e	44.47a-e
$R_2 \times F_0$	114.28g	7.90	3.49h	4.41ab	24.18	126.30i	28.87cd	11.15	2.98g	4.06efg	7.03g	42.17de
$R_2 \times F_1$	123.36ab	16.44	7.95de	2.25de	26.22	165.35c	14.94k	12.14	3.99bc	4.96a	8.82ab	45.92ab
$R_2 \times F_2$	118.23def	11.11	14.20a	2.63cde	25.65	157.68d	23.30fg	12.50	3.66def	4.58a-d	8.24bcd	44.49a-e
$R_2 \times F_3$	120.77bcd	14.20	11.57a	1.86e	25.99	178.35a	21.69gh	12.86	4.30a	4.82ab	9.17a	46.76a
$R_2 \times F_4$	114.57g	11.41	7.71h	3.70a-d	25.69	171.82b	23.31fg	12.14	3.61ef	4.84ab	8.45bcd	42.67cde
$R_2 \times F_5$	122.76abc	16.16	13.96b	2.20de	25.89	171.27b	15.97jk	12.28	4.21a	4.85ab	9.15a	46.95a
$R_3 \times F_0$	108.03h	5.67	2.24h	4.83a	23.09	110.57k	41.13a	11.41	2.08i	3.98fg	6.05h	34.44g
$R_3 \times F_1$	125.68a	13.72	11.67b	2.05de	23.91	139.85fg	22.12g	12.41	3.52f	4.30c-f	7.82def	44.96a-e
$R_3 \times F_2$	119.01def	10.17	6.00fg	4.17abc	23.65	124.90i	29.56c	11.79	2.92gh	4.62a-d	7.53efg	38.71f
$R_3 \times F_3$	116.63efg	12.43	9.90c	2.53cde	23.82	128.92i	26.26def	11.90	3.39f	4.48a-f	7.87def	43.12b-e
$R_3 \times F_4$	118.69def	10.03	5.20g	3.43a-e	23.32	126.07i	28.71cde	11.40	2.68h	3.71g	6.39h	41.97e
$R_3 \times F_5$	120.75bcd	12.27	10.04c	2.23de	23.62	133.36h	22.68g	12.24	3.56ef	4.48a-f	8.03c-f	44.26a-e
CV (%)	4.52	7.12	5.47	9.22	4.33	5.14	4.58	6.58	7.45	6.25	5.85	4.22
Level of sig	**	NS	**	**	NS	**	**	NS	**	**	**	**

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
*** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS= Non-significant.*
R_1 = Single row, R_2 = double row, R_3 = Triple row,.F_0= control (no manures and fertilizers), F_1= recommended dose of inorganic fertilizers (i.e 150,100, 70,60 and 10 kg Urea, TSP, MoP, Gypsum and $ZnSO_4$ respectively ha^{-1} , F_2= 50% of recommended dose of inorganic fertilizers + cowdung at 5 t ha^{-1}, F_3=75% of recommended dose of inorganic fertilizers + cowdung at 5 t ha^{-1}, F_4= 50% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1} , F_5= 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1}

The highest values of these parameters were statistically identical to the combination of double row arrangement and 75% recommended dose of inorganic fertilizer + poultry manure at 2.5 t ha^{-1} Sarkar et al. [12] reported that BRRI dhan34 fertilized with 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha^{-1} produced the highest grain yield. The interaction of triple row arrangement and control treatment (no manures and fertilizer) gave the lowest values in case of total tillers $hill^{-1}$ (8.6), effective tillers $hill^{-1}$ (2.24), grains $panicle^{-1}$ (110.57), and grain yield (2.08 t ha^{-1}) due to lack of proper nutrient supply and uptake. The lowest number of non-effective tillers $hill^{-1}$ (1.86) and the lowest number of sterile spikelets $panicle^{-1}$ (14.94) were found in the combination of double row arrangement and 75% of recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}.

4. CONCLUSION

It can be concluded that aromatic fine rice cv. BRRI dhan34 transplanted in double row arrangement fertilized with 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha^{-1}, and 75% of recommended dose of inorganic fertilizers + poultry manure at 2.5 t ha^{-1} appeared as the promising practice in terms of grain yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh Y, Singh US. Genetic diversity analysis in aromatic rice germplasm using agro- morphological traits. J. Pl. Genet. Resour. 2008;21(1):32-37.
2. Subudhi KKM, Sehgal J, Blum WE, Gojbhiya KS. Integrated use of organic manures and chemical fertilizer in red soils for sustainable agriculture. Red and Lateritic Soils. 2006;4(1):367-376.
3. Chakravarthi BK, Naravaneni R. SSR marker based DNA finger printing and diversity study in rice (*Oryza sativa* L). African J. Biotech. 2006;5(9):684-88.
4. Weber R, Charles W, Jeffrey, Lazo KK. The economic impacts of 296 agriculture-to-urban water transfers on the area of origin: A case study of the Arkansas River Valley in Colorado. American Journal of Agricultural Economics. 2000;1200-1204.
5. Sarkar MAR, Paul SK, Hossain MA. Effect of row arrangements, age of tiller seedling and number of seedlings hill on performance of transplant aman rice. J. Agril. Sci. 2011;6(2):59-68.
6. Alam A, Paul SK, Sarkar MAR, Islam SMM. Effect of row arrangement and nitrogen dose on the performance of transplant *Aman* rice. Intl. J. Sustain. Crop Prod. 2014;9(2):7-16.
7. Paul SK, Sarkar MAR, Ahmed M. Effect of row arrangement and tiller separation on the yield and yield components of transplant *Aman* rice. Pakistani J. Agron. 2002;1(1):9-11.
8. BRRI (Bangladesh Rice Research Institute) Annual Report for 1988. Bangladesh Rice Res. Inst., Joydebpur, Gazipur. 1991;10-13.
9. Hossain SMA, Salam MU, Islam MS. Effect of alternate row spacings on rice yield in relation to rice-fish culture. Intl. J. Trop. Agric. 1990;6:1-5.
10. BBS (Bangladesh Bureau of Statistics). Monthly statistical Bulletin of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning. Government of the people's Republic of Bangladesh. Dhaka. Bangladesh. 2014;53-57.
11. Hossain MF, Hasan MA, Fancy R. Majumder UK. Influence of cow dung, poultry litter and chemical fertilizers on the yield of modern aromatic rice varieties in *Aman* season. J. Agrofor. Environ. 2010;4(1):189-191.
12. Sarkar SK, Sarkar MAR, Islam N, Paul SK. Yield and quality of aromatic fine rice as affected by variety and nutrient management. J. Bangladesh Agril. Univ. 2014;12(2):279-284.
13. Rahman MM, Yakupitiyage A. Use of fishpond sediment for sustainable aquaculture-agriculture farming. International Journal of Sustainable Development and Planning. 2006;1:192-202.
14. Gomez KA, Gomez AA. Statistical procedure for agricultural research. Intl. Rice Res. Inst., Philippines, John Wiley and Sons. New York, Chichester, Brisbane, Toronto, Singapore. 1984;680.
15. Karmakar B, Sarkar MAR, Uddin MR, Biswas M. Effect of row arrangement, number of seedlings hill and nitrogen rates on yield and yield components of late transplant *Aman* rice. Bangladesh J. Agril. Sci. 2002;29(2):275-281.

16. Dutta D, Sarkar MAR, Samad MA, Paul SK. Effect of row arrangement and nitrogen level on the yield and yield components of transplant *Aman* rice. Online J. Biol. Sci. 2002;2(10):636-638.
17. Hossain MS, Sarkar MAR, Ahmed A. Performance of separated tillers of transplant aman rice at various management practices. Bangladesh J. Agril. Sci. 2003;30(1):1-7.
18. Sarker MJH. Effect of row arrangement and levels of nitrogen on the growth and yield of transplant *Aman* rice. M.S. Thesis. Dept. Agron, Bangladesh Agril. Univ. Mymensingh. 2003;46.
19. Sikdar MSI. Effect of spacing and nitrogen fertilizer level on the yield and quality of some varieties of aromatic rice. M. Sc. Dissertation. Bangladesh Agricultural University, Bangladesh. 2000;1-126.
20. Kabir ME, Kabir MR, Jahan MS, Das GG. Yield performance of three aromatic fine rice in a coastal medium high land. Asian Journal of Plant Science. 2004;3(5):561-563.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/17248