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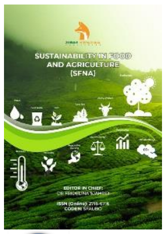

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RESEARCH ARTICLE

INTERACTION INFLUENCE OF ROW ARRANGEMENT AND NITROGEN LEVEL ON THE GROWTH AND YIELD OF TRANSPLANT AMAN RICE (BRRI DHAN34)

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University in 2015 to observe the effect of row arrangement and nitrogen level on the growth and yield of transplant *Aman* rice cv. BRRI dhan34. The experiment comprised three row arrangements viz. single, double and triple row arrangement and six nitrogen doses viz. 0, 40, 60, 80, 100 and 120 kg N ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The highest number of total tillers hill^{-1} (9.43), number of effective tillers hill^{-1} (6.44), number of grains panicle^{-1} (140.03), grain yield (4.68 t ha^{-1}), straw yield (7.28 t ha^{-1}), biological yield (11.96 t ha^{-1}) and harvest index (39.13%) were recorded in double row arrangement and the lowest grain yield (4.13 t ha^{-1}) was obtained in triple row arrangement. Application of nitrogen fertilizer showed significant differences in all yield components except 1000-grain weight. In case of interaction, the highest plant height (143 cm), number of total tillers hill^{-1} (10.5), number of effective tillers hill^{-1} (7.09), number of grains panicle^{-1} (150.10), grain yield (5.65 t ha^{-1}) and straw yield (8.17 t ha^{-1}) were recorded in double row arrangement fertilized with 80 kg N ha^{-1} and the lowest grain yield (3.12 t ha^{-1}) was obtained from the combination of triple row arrangement with 0 kg N ha^{-1}. So, cultivation of BRRI dhan34 in double row and fertilized with 60 kg N ha^{-1} is a promising technique to obtain the highest grain yield.

KEYWORDS

row arrangement, nitrogen fertilizer, tillers, panicles, grain & straw yield, BRRI dhan34.

1. INTRODUCTION

Agriculture of Bangladesh is dominated by rice (*Oryza sativa* L.) cultivation. Rice is the staple food of the people of Bangladesh as well as for nearly half of the world's population. Rice grows about everywhere in Bangladesh and it provides nearly 48% of rural employment and about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. In respect of area and production, Bangladesh ranks fourth among the rice producing countries of the world following China, India and Indonesia (FAO, 2011). About 75.61% of cropped area of Bangladesh is used for rice production, with annual production of 33.83 million tons from 11.41 million hectares of land (BBS, 2013). *Aman* production of financial year 2014-15 has been estimated around 1.4 crore metric tons, an increase of 1.3% compared to 1.3 crore metric tons in the same period a year earlier (BBS, 2015). Department of Agricultural Extension has set targets for *Aus* and *Aman* crop productions at 24 lakh tons and 1.34 crore tons respectively. *Aman*, the second largest rice crop in the country, production has been persistently higher since 2010. In respect to the volume of production, *Boro* tops the production though the area coverage of *Aman* is the largest as a single crop and *Boro* remains the second. The Bangladesh Rice Research Institute has released 76 modern varieties of rice suitable for cultivation in one or more rice growing seasons of Bangladesh (BRRI, 2016).

In Bangladesh, rice yield is far below than that of many other countries like China, Japan, Korea and Egypt where yield is 7.5, 5.9, 7.3 and 7.5 t ha^{-1}, respectively (FAO, 2009). The average yield of rice in Bangladesh is 2.92 t ha^{-1}, which is very much low (BBS, 2013). The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020 (BBS, 2011). On the other hand, agricultural land is decreasing day by day. The horizontal expansion of the rice growing area in Bangladesh is not possible due to high population pressure, rapid urbanization and industrialization. In Bangladesh, agriculture is characterized by rice based cropping systems. Rice is grown here in *Aus, Aman* and *Boro* seasons with production of 23.28, 131.90 and 190.07 lakh metric tons, respectively (BBS, 2015).Variety is the key component to produce higher yield of rice depending upon their differences in genotypic characters, input requirements and response, growth process and the prevailing environmental conditions during the growing season. The growth process of rice plants under a given agro-climatic condition differs with variety. BRRI (1991) reported that modern transplant *Aman* rice varieties produced grain yield up to 6.5 t ha^{-1}.

In recent year, aromatic rice has been introduced to the global market. Aromatic rice is also named as fine rice, scented rice or fragrance rice. It is very popular in Asia as well as in Southeast Asia and has recently gained wider acceptance in the United States and Europe (Weber *et al*., 2000). 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. Thus aromatic or scented rice plays a vital role in international rice trading. Bangladesh has a bright prospect for export of fine rice thereby earning foreign exchange.

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Row arrangement of transplant *Aman* rice may have a remarkable influence on its growth, yield components and yield. The rice production specialists opined that double row showed better performance over single and triple row (BRRI, 1991; Hossain *et al*., 1990). Transplant *Aman* rice can be grown in both single and double row arrangements in order to obtain proper vegetative growth and yield (Sakar *et al*., 2011). Paul *et al*. (2002) reported that transplant *Aman* rice should preferably be grown in double row arrangement to obtain the highest grain yield. Row arrangement of T. *Aman* rice may have a remarkable influence on the yield and yield components of rice. Information regarding row arrangements of transplant *Aman* rice is limited under Bangladesh perspective and hence there is wide scope to conduct research in this area.

Nitrogen is one of the major nutrients, which is required in adequate amount at early, mid tillering and panicle initiation stage for better grain development. Nitrogen is the element most often required for high yield of rice. Research results were reported elsewhere (Haque *et al*., 2012; Saha *et al*., 2012; Salahuddin *et al*., 2009). Nitrogen fertilizer increases tillering , vegetative growth, grain and straw yields. But application of excessive nitrogen tends to cause damage from crop lodging and encourages the attack of insects and diseases. On the other hand, deficiency of nitrogen also hampers the production of rice (Eaqub and Mian, 1981; Bhuiya *et al*., 1989; Hussain *et al*., 1989; Islam *et al*., 1990).

Almost all the soils of Bangladesh are low in organic matter and similar in the case for nitrogen. At present, the farmers of Bangladesh use increased amount of nitrogen fertilizer to get higher yield. Extensive research works are necessary to find out appropriate row arrangement and N dose to obtain satisfactory yield. Therefore, the present study was undertaken to achieve the following objectives;to find out the effect of row arrangement, optimum level of nitrogen and their interaction on the growth and yield of T. *Aman* rice cv. BRRI dhan34.

2. Materials and Methods

2.1 Location

The experimental site is located at 24°75' N latitude and 90°50' E longitude at an elevation of 18m above the mean sea level. The experimental area is characterized by non-calcareous dark grey floodplain soil belonging to the Sonatola Soil Series under the Old Brahmaputra Floodplain, (AEZ- 9) (UNDP and FAO, 1988).

2.2 Experimental soil

The soil of the experimental field was more or less neutral in reaction having pH 6.5, low in organic matter and fertility level. The land type was medium high with silty loam in texture. The morphological, physical and chemical characteristics of the soil of the experimental field have been presented in table 1.

Table 1: Morphological, physical and chemical characteristics of the experimental field

Morphological characteristics of the soil	
Constituents	**Characteristics**
Location	Agronomy field laboratory, BAU, Mymensingh
Soil tract	Old Brahmaputra Alluvium
Land type	Medium high land
General soil type	Non-calcareous dark gray floodplain
Soil series	Sonatala
Parent material	Brahmaputra river-brone deposits
Agro-ecological zone	Old Brahmaputra floodplain (AEZ-9)
Topography	Fairly level
Flood level	Dark grey
Soil color	Above flood level
Drainage	Moderate
Physical properties of the initial soil (0-15 cm depth)	
Constituents	**Result**
% sand (0.2-0.02) mm	32
% silt (0.02-0.002)	60
mm	08
% clay (‹0.002) mm	Silt loam
Textural class	1.35
Bulk density	46.67
Porosity	
Chemical characteristics of the initial soil (0-15 cm depth)	
Constituents	**Results****
pH	6.50
OM (%)	1.29
Total N (%)	0.10
Available P (ppm)	16.72
Exchangeable K	0.12
(me%)	14.2
Available S (ppm)	

**Results obtained from mechanical analysis of the initial soil sample done in the Department of Soil Science, BAU, Mymensingh.

2.3 Climate

The climate of the locality is tropical in nature and is characterized by high temperature and heavy rainfall during *Kharif* season (April to September) and scanty of rainfall associated with moderately low temperature during *Rabi* season (October to March). The climatic condition i.e. monthly average air temperature (°C), relative humidity (%), rainfall (mm) and sunshine (hour day^{-1}) during the period of experiment have been presented in table 2.

Table 2: Distribution of monthly temperature, relative humidity, sunshine hour and rainfall of the experimental site during the crop growth period

Year	Month	*Air temperature (°c)			*Rainfall (mm)	**Relative humidity (%)	*Sunshine (hrs)
		Maximum	Minimum	Average			
2015	July	31.9	26.3	29.2	387.9	85.1	100.6
	August	31.8	26.6	29.2	383.3	87.7	84.40
	September	32.4	26.1	29.3	287.5	86.1	138.5
	October	32.5	23.2	27.9	78.0	82.9	205.9
	November	30.0	18.1	23.4	4.3	82.2	200.0
	December	25.2	13.3	19.3	0.0	83.4	117.9

*Monthly total **Monthly average

Source: Weather Yard, Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh.

2.4 Experimental treatment

The experimental treatments were as follows:

Factor A: Row arrangement: 3

i. Single row (row spacing 25 cm x 15 cm) (R_1)
ii. Double row (row spacing 10 cm-25 cm x 15 cm) (R_2)
iii. Triple row (row spacing 10 cm-10 cm-25 cm x 15 cm) (R_3)

Factor B: Nitrogen dose: 6

i. 0 kg N ha^{-1} (N_0)
ii. 40 kg N ha^{-1} (N_1)
iii. 60 kg N ha^{-1} (N_2)
iv. 80 kg N ha^{-1} (N_3)
v. 100 kg N ha^{-1} (N_4)
vi. 120 kg N ha^{-1} (N_5)

2.5 Experimental design and layout

The experiment was laid out in a randomized complete block design. There were 18 treatment combinations. There were three replications of the treatment. Each replication was divided into 18 unit plots where the treatment combinations were allocated at random. Thus the total number of unit plots was 54. The size of each unit plot was 4.0 m × 2.5 m. Distance maintained between unit plots and replications were 0.75 m and 1 m, respectively.

2.6 Description of rice cultivar

A brief description of the rice variety used in the experiment is given below:

2.6.1 BRRI dhan34

BRRI dhan34 is a high yielding variety of *Aman* rice released by the Bangladesh Rice Research Institute (BRRI). It is an aromatic fine rice variety of Transplant *Aman* season. BRRI developed this variety by selection from the localy available genotype Khaskani from Jessore region in 1997. Grain size is short and bold. Its aroma is similar to kalizira. It is a photoperiod sensitive genotype. This variety takes about 135 days to mature. It attains a height of 117cm at maturity. The grains are fine with light golden husk and are white in color. The variety can give average grain yield of 3.5 t ha^{-1}.

2.7 Conduction of the experiment

2.7.1 Seed collection

Seeds were collected from the Agronomy field laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh.

2.7.2 Germination test

Before sowing, the seeds were tested for germination in the laboratory and the percentage of germination was found to be above 80.

2.7.3 Seed sprouting

Healthy seeds were selected by specific gravity method. Seeds were then immersed in water in bucket for 24 hours and immersed seeds were taken out of water and kept thickly in gunny bags. The seed sprouted after 48 hours and were sown after 72 hours of steeping.

2.7.4 Preparation of seedling nursery bed

Seedlings were raised in a medium high land. Seedling nursery was prepared by puddling the soil. Sprouted seeds were sown in the wet nursery bed on 19 July, 2015. Proper care was taken to raise the seedling in the nursery. No fertilizer was applied in the nursery bed.

2.7.5 Preparation of land for transplanting

The land was first opened with a tractor drawn disc plough and two ploughs were given. Another operation was done by power tiller. The land was puddled thoroughly by ploughing and cross ploughing four times with a country plough followed by laddering to level the soil. A good tilth was achieved. Weeds and stubble were removed from the field before transplanting seedling. The field layout was done on 17 August 2015 to suit the design immediately after land preparation.

2.7.6 Fertilizer application

The experimental plots were fertilized by Triple Super Phosphate (TSP), Muriate of Potas (MoP), Gypsum, and Zinc Sulphate (ZnSO4) during the final land preparation at the rates of 117, 62, 80 and 13 kg ha^{-1} respectively. Only urea was applied as top dressing in three equal splits at 15, 30 and 45 days after transplanting (DAT) as per specification of the treatment.

2.7.7 Uprooting seedlings

The nursery bed was made wet by application of water on the previous day before uprooting the seedlings. The seedlings were uprooted on 17 August 2015 without causing much mechanical injury to the roots and they were immediately transplanted in to the main field. Healthy and similar sized seedlings were selected for transplanting.

2.7.8 Transplanting of seedlings

Seedlings were transplanted in the main field as per experimental treatments on 17 August 2015 at the rate of three seedlings $hill^{-1}$ maintaining single, double and triple row arrangement with hill distance of 15cm.

2.7.9 Intercultural operation

Intercultural operation viz. weeding, irrigation, insect, pests and disease control were done as and when necessary.

2.7.10 Harvesting and processing

The crop was harvested at full maturity (when 90% of the grain became golden color) on 26 November 2015. Before harvesting five hills from each unit plot (excluding border rows and central $1m^{-2}$ area) were randomly selected to record data on cop characters and yield components. The central $1m^{-2}$ area was harvested to record data on grain and straw yields. The harvested crop was threshed by pedal thresher and the fresh weight of grain and straw were recorded plot wise. The grains were cleaned and dried to a moisture content of 14%. Straws were also dried properly. Finally, grain and straw yields $plot^{-1}$ were recorded and converted to t ha^{-1}.

2.8 Procedure of data collection

2.8.1 Plant height (cm)

Plant height was measured from the base of the plant (ground level) to the tip of the longest panicle at reproductive stage. It was measured from five randomly selected hills excluding border rows and central $1m^2$ harvest area at 20 DAT, 35 DAT, 50 DAT, 65 DAT, 80 DAT at vegetative stage.

2.8.2 Number of total tillers hill-1

Tillers which had at least one visible leaf were counted including both panicle bearing and non-bearing tillers.

2.8.2 Number of effective tillers hill-1

The tillers which had at least one visible grain in the panicle were considered as effective tiller.

2.8.3 Leaf Area Index (LAI)

To determine leaf area index, leaf samples were collected from the plot at 60 DAT. Leaf blades were separated and leaf area was measured by using an Area Meter at the Professor Muhammad Hussain Central Laboratory, Bangladesh Agricultural University, Mymensingh. Finally, LAI was calculated by the following standard formula (Raford, 1967 and Hunt, 1978) as shown below:

$$LAI = \frac{\text{LA}}{\text{P}}$$

Where, LA = Leaf Area and P = Ground Area.

2.8.4 Total dry matter hill-1

Dry matter of above ground vegetative parts was recorded from three randomly selected hills from outside the harvest area and excluding border rows at 60 DAT.

2.8.5 Panicle length (cm)

Measurement was taken from basal node of the rachis to the apex of last grains of each panicle.

2.8.6 Number of grains panicle-1

Presence of any food material in the spikelet was considered as grain and such spikelet present on each panicle were counted.

2.8.7 Number of sterile spikelets panicle-1

The spikelet that lacked any food material inside was considered as sterile spikelet and such spikelet present on each panicle were counted.

2.8.8 1000-grain weight

One thousand clean dried grains were counted from the seed stock obtained from five sample hills of each plot and weighed by using an electric balance in g. The weight was adjusted at a seed moisture content of 14%.

2.8.9 Grain yield

Grains obtained from the central $1m^{-2}$ area were threshed, cleaned, dried and then weighed. The yield of grain was adjusted to 14% moisture content and then it was converted into t ha^{-1}.

2.8.10 Straw yield

Straws obtained from each unit plot including the straw of central $1m^{-2}$ areas of respective unit plot were sun dried and converted to t ha^{-1}.

2.8.11 Biological yield

Grain yield together with straw yield was regarded as biological yield and calculated with the following formula:

Biological yield = Grain yield + Straw yield.

2.8.12 Harvest index

It indicates the ratio of economic yield (grain yield) to biological yield (grain yield + straw yield) and was calculated by the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100.$$

2.8.13 Statistical analysis

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance (ANOVA) technique was done with the help of computer package, MSTAT. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

3. Results and Discussions

3.1 Growth parameters

3.1.1 Plant height

i) Effect of row arrangement

Plant height was significantly influenced by row arrangement up to 65 DAT. At 65 DAT, plant height was the highest (110.5 cm) in triple row arrangement. However double row (109.0 cm) exhibited similar plant height as that of triple row arrangements. The lowest (107.3 cm) plant height was found in single row arrangement. This result is supported by Ali (2008) who observed that the highest plant height (111.2cm) was found in double row arrangement. No difference in plant height at 80 DAT (Fig. 1).

ii) Effect of nitrogen dose

Plant height varied significantly due to different nitrogen doses. The maximum plant height (139.1 cm) was obtained from 80 kg N ha^{-1} .The minimum plant height (129.8 cm) was observed in the control treatment (Fig. 2). Fertilizer dose of nitrogen on plant height might be associated with the stimulating effect of nitrogen on various physiological processes including cell division and cell elongation of the plant. Similar findings were reported by Zhilin *et al.* (1997) who stated that plant height increased significantly due to nitrogen application.

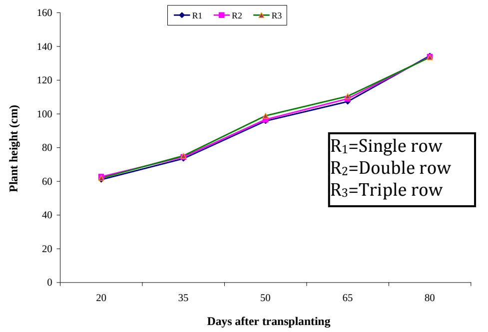

Figure 1: Effect of row arrangement on plant height at different days after transplanting (DAT) of transplant *Aman* rice cv. BRRI dhan34

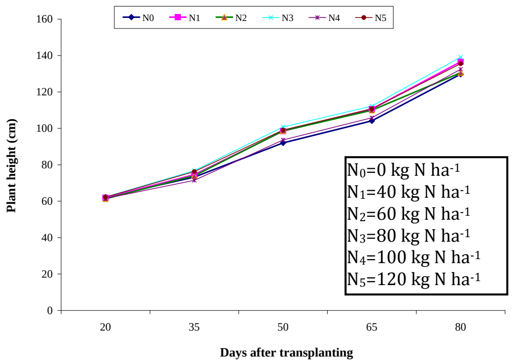

Figure 2: Effect of nitrogen dose on plant height at different DAT of transplant *Aman* rice cv. BRRI dhan34

Table 3: Interaction between row arrangement and rate of nitrogen on plant height at different days after transplanting of *Aman* rice cv. BRRI dhan34

Interaction (Row arrangement x Nitrogen)	Plant height (cm)				
	Days after transplanting				
	20	35	50	65	80
R_1 x N_0	59.87 cd	69.67 fg	86.80 c	99.27 d	125.7 cd
R_1 x N_1	60.13 cd	73.20 cdef	99.27 a	109.8 a	135.3 ab
R_1 x N_2	59.13 d	73.87 cdef	98.13 a	109.4 ab	134.1abc
R_1 x N_3	61.93abcd	77.00 abc	100.5 a	111.5 a	137.7 ab
R_1 x N_4	60.47cd	68.13 g	89.80bc	102.8 bcd	132.0 bcd
R_1 x N_5	64.67 ab	79.07 ab	100.2a	111.1 a	142.1 a
R_2 x N_0	62.13 abcd	70.40 efg	88.60 c	101.6 cd	124.5 d
R_2 x N_1	62.73 abc	74.67 bcde	97.53 a	109.9 a	137.2 ab
R_2 x N_2	65.27 a	73.40 cdef	97.33 a	108.2ab	131.8 bcd
R_2 x N_3	64.20 ab	80.07 a	102.1 a	113.3 a	142.3 a
R_2 x N_4	61.47 bcd	72.07 defg	95.67 ab	107.9 abc	133.3 abcd
R_2 x N_5	60.60 cd	76.20 abcd	98.87 a	112.8 a	134.2 abc
R_3 x N_0	64.67 ab	79.60 a	100.7 a	111.5 a	139.1 ab
R_3 x N_1	62.87 abc	75.73 abcd	98.73 a	112.2 a	137.2 ab
R_3 x N_2	59.53 cd	74.67 bcde	100.5 a	112.3 a	125.7 cd
R_3 x N_3	60.67 cd	73.33 cdef	99.80 a	111.8 a	137.2 ab
R_3 x N_4	62.53 abcd	74.13 cdef	95.47 ab	106.7 abc	132.0 bcd
R_3 x N_5	61.40 bcd	73.47 cdef	98.20 a	108.3 ab	130.3 bcd
CV (%)	2.82	3.34	3.75	3.28	3.58
Level of sig.	**	**	**	*	**

Figures in a column having the same letter do not differ significantly as per DMRT.

** = Significant at 1% level of probability, * = Significant at 5% level of probability

iii) Effect of interaction between row arrangement and nitrogen dose

The interaction effect of row arrangement and level of nitrogen on plant height was significant at all the dates of sampling (Table 1). It was observed that the tallest plant (142.3 cm) was found in double row arrangement with 80 kg N ha^{-1} and the shortest plant (125.7 cm) was in triple row and single row arrangement with 0 kg N ha^{-1} (Table 1).

3.1.2 Number of total tillers hill^{-1}

i) Effect of row arrangement

Number of total tillers hill^{-1} was significantly influenced by row arrangement at 20 to 80 DAT. Single row produced the highest (8.88) number of total tillers hill^{-1} than double (7.58) and triple (7.26) row at 80 DAT. It was observed that at all the dates of observation, triple row produced the lowest number of total tillers hill^{-1} (Fig. 3). It might be due to high competition of plants for light, space and nutrients in triple row. These results are agreement with that of Paul *et al.* (2002) and Sarkar *et al.* (2003) who recorded the lowest number of total tillers hill^{-1} from triple row.

ii) Effect of nitrogen dose

The results showed that the number of total tillers hill^{-1} differed significantly at all the dates of sampling due to nitrogen management. The number of total tillers hill^{-1} increased progressively due to application of higher level of nitrogen up to 80 kg N ha^{-1}. The maximum number of total tillers hill^{-1} (8.53) was produced in 80 kg N ha^{-1}. The minimum number of total tillers hill^{-1} (6.64) was obtained from control treatment (Fig. 4). This result corroborated with that of Kamal *et al.* (1998) who reported that the highest rate of nitrogen fertilizer gave the maximum number of tillers hill^{-1}.

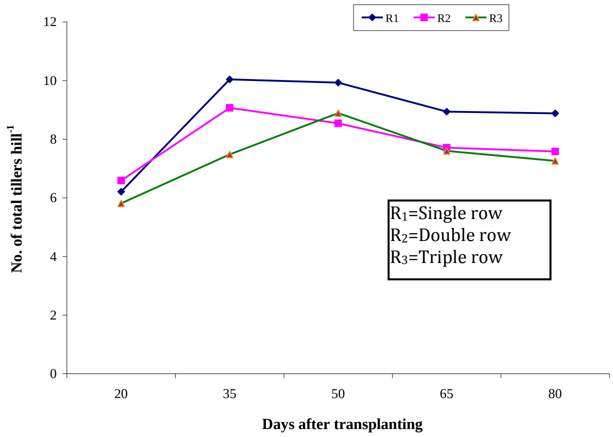

Figure 3: Effect of row arrangement on number of total tillers hill^{-1} at different DAT of transplant *Aman* rice cv. BRRI dhan34

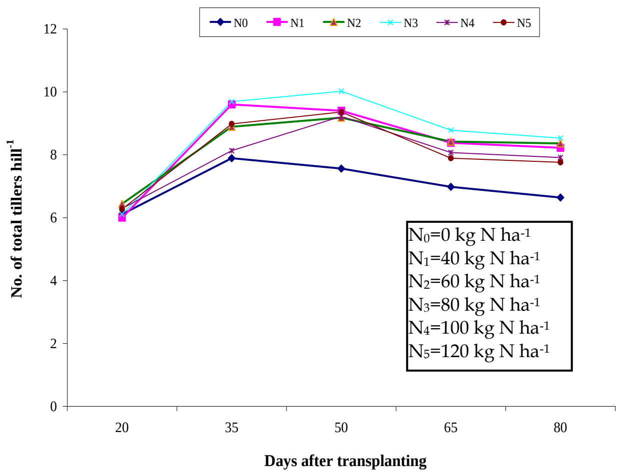

Figure 4: Effect of nitrogen dose on number of total tillers hill^{-1} at different DAT of transplant *Aman* rice cv. BRRI dhan34

Table 4: Interaction between row arrangement and rate of nitrogen on tiller production hill-1 at different days after transplanting of *Aman* rice cv. BRRI dhan34

Interaction (Row arrangement x Rate of nitrogen)	Tiller production hill-1				
	Days after transplanting (DAT)				
	20	35	50	65	80
$R_1 \times N_0$	6.00bcd	8.73cde	7.47ij	6.20 f	6.13 i
$R_1 \times N_1$	6.40abc	9.67 bc	9.66de	9.27abc	9.33ab
$R_1 \times N_2$	6.93a	10.2ab	10.5bc	9.86ab	9.86a
$R_1 \times N_3$	5.93bcd	11.10a	10.1cd	10.4a	10.4a
$R_1 \times N_4$	5.73 cd	9.40 bc	10.2cd	8.33bcde	8.20bcdef
$R_1 \times N_5$	6.26abcd	11.1a	11.5a	9.60abc	9.33ab
$R_2 \times N_0$	6.26abcd	7.86defg	7.20j	6.87 def	6.33 hi
$R_2 \times N_1$	6.06 bcd	11.1a	9.53def	8.60 bcd	8.53 bcd
$R_2 \times N_2$	6.93 a	8.87 cd	8.47gh	8.20 bcde	8.33 bcde
$R_2 \times N_3$	6.93 a	9.33 bc	8.86fg	8.00cde	8.06 bcdefg
$R_2 \times N_4$	6.47 abc	7.53 efg	8.60gh	7.26 def	6.93 fghi
$R_2 \times N_5$	6.87 a	9.66 bc	8.60gh	7.33 def	7.26 defghi
$R_3 \times N_0$	6.07 bcd	7.06 gh	8.00hi	7.87cdef	7.46 cdefgh
$R_3 \times N_1$	5.53 d	8.00defg	9.00efg	7.27 def	6.80 ghi
$R_3 \times N_2$	5.46 d	7.60 efg	8.53gh	7.20 def	6.86 ghi
$R_3 \times N_3$	5.46 d	8.60cdef	11.0ab	7.93cdef	7.13efghi
$R_3 \times N_4$	6.67 ab	7.46 fg	8.80fg	8.60 bcd	8.60 bc
$R_3 \times N_5$	5.67 cd	6.13 h	7.93hij	6.73 ef	6.66 hi
CV (%)	6.64	7.50	4.63	11.38	8.68
Level of sig.	**	**	**	**	**

Figures in a column having the same letter do not differ significantly as per DMRT.

** = Significant at 1% level of probability.

iii) Effect of interaction between row arrangement and nitrogen dose

The interaction effect of row arrangement and nitrogen level significantly affected the number of total tillers hill-1 (Table 2). At 20 DAT, the maximum number of total tillers hill-1 (6.93) was observed in double row arrangement with 80 kg N ha-1 and the minimum (6.07) was obtained from triple row arrangement with control treatment. At 65 DAT, the maximum number of total tillers hill-1 (10.4) was observed in single row arrangement with 80 kg N ha-1 and the minimum number of total tillers hill-1 (6.20) was found in single row arrangement with 0 kg N ha-1. Similar trend of tiller production was also found at 80 DAT though their number tended to be reduced compared to 65 DAT which might have occurred due to decaying of some of the tillers.

3.1.3 Leaf area index (LAI)

i) Effect of row arrangement

Leaf area index differed significantly due to row arrangement. It was found that single row produced the highest leaf area index (4.79) at 60 DAT. The lowest leaf area index (2.05) was found in triple row arrangement at 60 DAT and supported by Majumder *et al.* (1989) who reported that row spacing had significant effect on growth and yield of rice.

ii) Effect of nitrogen dose

Different nitrogen management levels had significant effect on leaf area index. It was observed that leaf area was the highest (4.22) with 120 kg N ha-1 and the lowest one (2.34) was with 0 kg N ha-1.

iii) Effect of interaction of row arrangement and nitrogen dose

The interaction between row arrangement and nitrogen level had significant effect on leaf area index at 60 DAT (Table 3). The interaction of single row arrangement with 120 kg N ha-1 produced the highest leaf area index (7.34) at 60 DAT. The lowest leaf area index (1.97) was found in triple row with control treatment.

Table 5: Interaction between row arrangement and rate of nitrogen on leaf area index and total dry matter hill-1 of transplant *Aman* rice cv. BRRI dhan34

Interaction(Row arrangement x Rate of nitrogen)	Leaf area index (LAI)	Total dry matter (g hill-1)
$R_1 \times N_0$	3.09 ef	12.79efgh
$R_1 \times N_1$	5.41 c	13.84cdef
$R_1 \times N_2$	5.91 b	19.51a
$R_1 \times N_3$	3.76 d	16.23bc
$R_1 \times N_4$	3.23 e	14.29cde
$R_1 \times N_5$	7.34a	17.11b
$R_2 \times N_0$	1.95 i	9.773i
$R_2 \times N_1$	2.79 fg	10.29hi
$R_2 \times N_2$	2.08 i	11.31fghi
$R_2 \times N_3$	3.28e	13.22defg
$R_2 \times N_4$	2.56 gh	13.67def
$R_2 \times N_5$	2.99ef	15.48bcd
$R_3 \times N_0$	1.97 i	12.76efgh
$R_3 \times N_1$	2.32hi	12.89efg
$R_3 \times N_2$	2.16 hi	12.57efgh
$R_3 \times N_3$	1.98 i	9.910i
$R_3 \times N_4$	1.53 j	11.57fghi
$R_3 \times N_5$	2.33hi	10.81ghi
CV (%)	7.49	10.26
Level of sig.	**	**

Figures in a column having the same letter do not differ significantly as per DMRT.

** = Significant at 1% level of probability.

3.1.4. Total dry matter (TDM)

i) Effect of row arrangement

Total dry matter production hill-1 was significantly influenced by row arrangement at 60. Results showed that the highest dry matter production (15.63 g) was obtained from single row arrangement and the lowest dry matter production (11.75 g) was obtained from triple row arrangement.

ii) Effect of nitrogen dose

Total dry matter production hill-1 varied significantly due to nitrogen dose at 60 DAT. The highest dry matter production (14.47 g) was obtained at 120 kg N ha-1, which was statistically identical to 60 kg N ha-1 (14.46) and the lowest dry matter production (11.78 g) was obtained at 0 kg N ha-1 at 60 DAT.

iii) Effect of interaction of row arrangement and nitrogen dose

Total dry matter was significantly influenced by the interaction of row arrangements and nitrogen dose. The highest total dry matter (19.51 g) was found in the single row arrangement with 60 kg N ha-1. The lowest total dry matter (9.77 g) was found in the double row arrangement with 0 kg N ha-1 (Table 3).

3.2 Yield and yield contributing characters of aromatic fine rice

3.2.1 Plant height

i) Effect of row arrangement

Plant height was not significantly influenced by row arrangement (Table 4). Numerically, the highest plant height (134.69 cm) was found in single row arrangement and the lowest plant height (133.98 cm) was found in triple row arrangement. Similar results were reported by Sarkar *et al*. (2011) and Alam *et al*. (2014). The highest plant height resulted due to optimum solar radiation in single row arrangement for better photosynthesis.

ii) Effect of nitrogen dose

Plant height was significantly influenced by nitrogen dose (Table 5). The highest plant height (139.3 cm) was found at 80 kg N ha-1. Fertilizer dose of nitrogen on plant height might be associated with the stimulating effect of nitrogen on various physiological processes including cell division and cell elongation of the plant.

iii) Effect of interaction of row arrangement and nitrogen dose

Plant height was significantly affected by row arrangement and nitrogen levels (Table 6). The highest plant height (143 cm) was found in double row arrangement with 80 kg N ha-1 and the lowest plant height (123.4 cm) was found in triple row arrangement with 0 kg N ha^{-1}.

3.2.2 Number of total tillers hill^{-1}

i) Effect of row arrangement

Row arrangement showed significant effect on total tillers hill^{-1} (Table 4). The highest number of total tillers hill^{-1} (9.43) was found in double row arrangement due to capturing more solar radiation. Similar results were reported by Paul *et al*. (2002), Dutta *et al*. (2002), Alam *et al*. (2014) and Marzia *et al*. (2016). The lowest number of total tillers hill^{-1} (6.17) was found in triple row arrangement. The reduction occurred due to increased number of hills unit^{-1} area. This increased number of hills unit^{-1} area increased competition among plants for nutrients and light that caused a reduction in the number of bearing tillers hill^{-1}. Sarker (2003) stated that row arrangement had significant effect on tillers hill^{-1}.

ii) Effect of nitrogen dose

Levels of nitrogen had significant effect on the number of total tillers hill^{-1}. The number of total tillers hill^{-1} increased progressively due to application of higher level of nitrogen up to 80 kg N ha^{-1}. The maximum number of total tillers hill^{-1} (9.04) was produced in 80 kg N ha^{-1} and the minimum number of total tillers hill^{-1} (6.41) was obtained from control treatment (Table 5). This result corroborates with that of Kamal *et al.* (1998) who reported that the highest rate of nitrogen fertilizer gave the maximum number of total tillers hill^{-1}.

iii) Effect of interaction of row arrangement and nitrogen dose

The interaction effect of row arrangement and nitrogen dose significantly affected the number of total tillers hill^{-1}. Double row arrangement gave the highest number of total tillers hill^{-1} (10.5) with 80 kg N ha^{-1} and triple row arrangement gave the lowest number of total tillers hill^{-1} (5.22) with 0 kg N ha^{-1} (Table 6).

3.2.3 Number of effective tillers hill^{-1}

i) Effect of row arrangement

Row arrangement showed significant effect on the number of effective tillers hill^{-1}. The highest number of effective tillers hill^{-1} (6.44) was found in double row arrangement due to capturing more solar radiation. Reduction in the number of effective tillers hill^{-1} (4.69) in triple row arrangement might be due to increased number of hills unit^{-1} area (Table 4). This increased number of hills unit^{-1} area exerted competition among plants for nutrients and light that caused a reduction in the number of bearing tillers hill^{-1}. Sarker (2003) stated that row arrangement had significant effect on tillers hill^{-1}. Alam *et al.* (2014) and Marzia *et al*. (2016) stated that double row produced the highest number of effective tillers hill^{-1}.

ii) Effect of nitrogen dose

The levels of nitrogen had significant effect on the number of effective tillers hill^{-1}.The highest number of effective tillers hill^{-1} (6.40) was recorded in 80 kg N ha^{-1}. The lowest number of effective tillers hill^{-1} (4.67) was produced in control treatment (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

The number of effective tillers hill^{-1} was significantly influenced by interaction effect of row arrangement and nitrogen dose. Results revealed that the highest number of effective tillers hill^{-1} (7.09) was obtained from double row arrangement with 80 kg N ha^{-1} and the lowest number of effective tillers hill^{-1} (4.11) was obtained from triple row arrangement grown with 0 kg N ha^{-1} (Table 6).

3.2.4 Number of non-effective tillers hill^{-1}

i) Effect of row arrangement

Effect of row arrangement on the number of non-effective tillers hill^{-1} was significant (Table 4). It was observed that double row arrangement had the highest (2.98) number of non-effective tillers hill^{-1} and triple row arrangement had the lowest (1.48) number of non-effective tillers hill^{-1}.

ii) Effect of nitrogen dose

Effect of nitrogen dose on the number of non-effective tillers hill^{-1} was significant. The highest number of non-effective tillers hill^{-1} (2.64) was recorded in 80 kg N ha^{-1} and the lowest number of non-effective tillers hill^{-1} (1.74) was recorded in 0 kg N ha^{-1} (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

The non-effective tillers hill^{-1} was significantly affected by the interaction between row arrangement and nitrogen level. The highest number of non-effective tillers hill^{-1} (3.46) was found in the treatment combination of double row arrangement and 80 kg N ha^{-1}. The lowest number of non-effective tillers hill^{-1} (1.11) was found in the combination of triple row arrangement and 0 kg N ha^{-1} (Table 6).

3.2.5 Panicle length

i) Effect of row arrangement

Panicle length was not statistically influenced by the effect of row arrangement. The results showed that the highest panicle length (23.88) was found in triple row arrangement and the lowest one (23.58) was found in double row arrangement which was similar to single row arrangement (23.59) (Table 4).

ii) Effect of nitrogen dose

Panicle length was not statistically influenced by the effect of nitrogen dose. The highest panicle length (24.18) was found in the treatment where 40 kg N ha^{-1} was applied and lowest one (23.30) was found in the treatment where 60 kg N ha^{-1} was applied (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

Panicle length was not significantly influenced by the interaction between row arrangement and nitrogen dose. The highest panicle length (24.80) was found in the combination of triple row arrangement and 40 kg N ha^{-1} and the lowest panicle length (22.92) was found in the combination of double row arrangement and 60 kg N ha^{-1} (Table 6).

3.2.6 Number of grains panicle^{-1}

i) Effect of row arrangement

Variation in number of grains panicle^{-1} due to row arrangement was not statistically significant. However, visually the highest number of grains panicle^{-1} (140.03) was found in double row arrangement and the lowest number of grains panicle^{-1} (136.92) was found in triple row arrangement (Table 4). Similar results were reported by Alam *et al*. (2014) and Marzia *et al.* (2016).

ii) Effect of nitrogen dose

Number of grains panicle^{-1} varied significantly due to nitrogen dose. The highest number of grains panicle^{-1} (146.1) was found at 80 kg N ha^{-1} and the lowest number of grains panicle^{-1} (136.7) was found at 0 kg N ha^{-1} (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

Number of grains panicle^{-1} was statistically influenced by the interaction of row arrangement and nitrogen dose. The highest number of grains panicle^{-1} (150.10) was found in double row arrangement with 80 kg N ha^{-1} and the lowest number of grains panicle^{-1} (129.3) was found in triple row arrangement with 0 kg N ha^{-1}(Table 6).

3.2.7 No of sterile spikelets panicle^{-1}

i) Effect of row arrangement

Variation in number of sterile spikelets panicle^{-1} due to row arrangement was not significant. Numerically the highest number of sterile spikelets panicle^{-1} (26.41) was found in triple row arrangement and the lowest number of sterile spikelets panicle^{-1} (25.39) was found in single row arrangement (Table 4). This result is in agreement with that of Rahman (2005) who has reported that wider row arrangement showed lesser number of sterile spikelets panicle^{-1} while the closer spacing had produced higher number of sterile spikelets panicle^{-1}.

ii) Effect of nitrogen dose

The effect of different levels of N on the number of sterile spikelets panicle^{-1} was significant. The highest number of sterile spikelets panicle^{-1} was recorded with 40 kg N ha^{-1} and the lowest number of sterile spikelets panicle^{-1} was recorded with 80 kg N ha^{-1} (Table 5). This result showed that the number of sterile spikelets panicle^{-1} gradually decreased with the increasing level of nitrogen. This result is similar to the findings obtained by Islam (1995).

iii) Effect of interaction of row arrangement and nitrogen dose

The effect of interaction of variety and nitrogen dose on the number of sterile spikelets panicle^{-1} was significant. The highest number of sterile spikelets panicle^{-1} (29.62) was observed in triple row arrangement with

40 kg N ha^{-1}, which was statistically identical to triple row arrangement with 0kg N ha^{-1}(28.00). The lowest number of sterile spikelets panicle^{-1} (24.10) was found in single row arrangement with 80 kg N ha^{-1} (Table 6).

3.2.8 1000-grain weight

i) Effect of row arrangement

The weight of 1000 grains was not significantly influenced by row arrangement. Numerically, the highest 1000-grain weight (22.24 g) was recorded from triple row arrangement and the lowest one (21.92 g) was recorded from double row arrangement (Table 4).

ii) Effect of nitrogen dose

Nitrogen levels had no significant effect on 1000-grain weight of the variety under study. Numerically, the maximum 1000-grain weight (22.60 g) was found from the application of nitrogen @ 120 kg N ha^{-1} and the minimum 1000-grain weight (21.91 g) was found from the control treatment (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

The interaction between row arrangement and nitrogen fertilizer management was not significant. The highest 1000-grain weight (23.28 g) was obtained from the combination of triple row arrangement with 120 kg N ha^{-1}. The lowest 1000-grain weight (21.77 g) was found from the combination of double row arrangement with 0 kg N ha^{-1} (Table 6).

3.2.9 Grain yield

i) Effect of row arrangement

The effect of row arrangement on grain yield was significant (Table 4). The highest grain yield (4.68 t ha^{-1}) was recorded in double row arrangement followed by single row arrangement (4.47 t ha^{-1}) and the lowest grain yield (4.13 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 (2003), Alam *et al*. (2014) and Marzia *et al*. (2016) in rice who found that double row arrangement produced the highest grain yield in rice.

ii) Effect of nitrogen dose

Nitrogen levels had highly significant effect on grain yield. Grain yield increased with the increase in nitrogen levels up to 80 kg N ha^{-1}. Increment of grain yield by the application of nitrogen up to a certain level was reported by Maskina *et al*. (1986). The highest grain yield (5.36 t ha^{-1}) was obtained from 80 kg N ha^{-1} and the lowest one (3.42 t ha^{-1}) from 0 kg N ha^{-1} (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

The effect of interaction of row arrangement and nitrogen levels on grain yield was significant. The highest grain yield (5.65 t ha^{-1}) was obtained from the combination of double row arrangement with 80 kg N ha^{-1} and the lowest grain yield (3.12 t ha^{-1}) was obtained from the combination of triple row arrangement with 0 kg N ha^{-1} (Table 6).

3.2.10 Straw yield

i) Effect of row arrangement

Effect of row arrangement on straw yield was statistically significant. Results revealed that straw yield was the highest (7.28 t ha^{-1}) in double row arrangement and the lowest one (6.77 t ha^{-1}) was found in triple row arrangement (Table 4). Similar result was also reported by Sarker (2003) in rice who found that double row arrangement produced the highest straw yield of rice.

ii) Effect of nitrogen dose

Straw yield was significantly influenced by nitrogen levels. Straw yield was found to increase with increased nitrogen levels up to 80 kg N ha^{-1}. The highest straw yield (7.97 t ha^{-1}) was produced at 80 kg N ha^{-1}, which was statistically identical with 60 kg N ha^{-1} (7.63 t ha^{-1}). The lowest one (6.00 t ha^{-1}) was produced by the control treatment (Table 5). Similar trend of the effect of nitrogen level on straw yield was also reported by Khanda and Dixit (1996). Nitrogen influenced vegetative growth in terms of plant height and number of tillers hill^{-1}, which resulted in increased straw yield.

iii) Effect of interaction of row arrangement and nitrogen dose

Straw yield was significantly influenced by the interaction between row arrangement and nitrogen dose. The highest straw yield (8.17 t ha^{-1}) was found in double row arrangement with 80 kg N ha^{-1} which was statistically identical with double row arrangement with 60 kg N ha^{-1} (8.00 t ha^{-1}). The lowest straw yield (5.74 t ha^{-1}) was found in triple row arrangement with 0 kg N ha^{-1} (Table 6).

3.2.11 Biological yield

i) Effect of row arrangement

Effect of row arrangement on biological yield was statistically significant. The highest biological yield (11.96 t ha^{-1}) was found in double row arrangement and the lowest biological yield (10.90 t ha^{-1}) was found in triple row arrangement (Table 4).

ii) Effect of nitrogen dose

The effect of nitrogen fertilizer management on the biological yield was significant. The highest biological yield (13.34 t ha^{-1}) was found from 80 kg N ha^{-1} which was statistically identical to 60 kg N ha^{-1} (12.82). The lowest biological yield (9.42 t ha^{-1}) was found from 0 kg N ha^{-1} (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

Biological yield was not statistically influenced by interaction effect of row arrangement and nitrogen level. The highest biological yield (13.82 t ha^{-1}) was found in the combination of double row arrangement with 80 kg N ha^{-1} which is similar to the biological yield (13.48 t ha^{-1}), found in double row arrangement with 60 kg N ha^{-1}. The lowest biological yield (8.86 t ha^{-1}) was found in triple row arrangement with 0 kg N ha^{-1} (Table 6).

3.2.12 Harvest index (%)

i) Effect of row arrangement

The effect of row arrangement was significant for harvest index. The highest harvest index (39.13%) was obtained from double row arrangement, which was statistically identical with single row arrangement (38.81%). The lowest harvest index (37.92%) was found in triple row arrangement (Table 4).

ii) Effect of nitrogen dose

The effect of nitrogen dose showed significant effect on harvest index. Harvest index increased with the increase in nitrogen level up to 60 kg N ha^{-1}. The highest harvest index (40.48%) was found at 60 kg N ha^{-1} and the lowest harvest index (36.31%) was found at 0 kg N ha^{-1} (Table 5).

iii) Effect of interaction of row arrangement and nitrogen dose

Harvest index was statistically influenced by the interaction between row arrangement and nitrogen dose. The highest harvest index (41.43%) was found in single row arrangement with 60 kg N ha^{-1} which was statistically identical with the harvest index (40.88%), which was found in double row arrangement with 80 kg N ha^{-1}. The lowest harvest index (35.21%) was recorded in triple row arrangement with 0 kg N ha^{-1} (Table 6).

Table 6: Effect of row arrangement on yield and yield contributing characters of transplant Aman rice (BRRI dhan34)

Row arrangement	Plant height (cm)	No of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Length of panicle (cm)	No. of grains penicle^{-1}	No. 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	134.69	7.87 b	5.50 b	2.37 b	23.59	139.64	25.39	22.12	4.47 b	7.05 b	11.52 b	38.81ab
R_2	134.02	9.43 a	6.44 a	2.98 a	23.58	140.03	26.27	21.92	4.68 a	7.28 a	11.96 a	39.13 a
R_3	133.98	6.17 c	4.69 c	1.48 c	23.88	136.92	26.41	22.24	4.13 c	6.77c	10.90 c	37.92 b
CV (%)	3.02	5.19	6.64	11.27	3.29	3.07	5.13	3.65	3.62	1.82	4.84	3.14
Level of significance	NS	**	**	**	NS	NS	NS	NS	**	**	**	*

Figures in a column having the same letter do not differ significantly as per DMRT.

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

R_1 = Single row (25 cm x 15 cm), R_2 = Double row (10 cm - 25 cm x 15 cm), R_3 = Triple row (10 cm-10 cm - 25 cm x 15 cm)

Table 7: Effect of rate of nitrogen on yield and yield contributing characters of transplant Aman rice (BRRI dhan34)

Rate of nitrogen (kg N ha^{-1})	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Length of panicle (cm)	No. of grains Panicle^{-1}	No. 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 (%)
N_0	130.6 b	6.41 e	4.67 e	1.74 d	23.64	136.7 b	25.95 bc	21.91	3.42 f	6.00 f	9.42 d	36.31 d
N_1	137.3 a	7.18 d	5.11 d	2.07 c	24.18	137.0 b	27.94 a	22.03	3.76 e	6.47 e	10.24 c	36.75 cd
N_2	131.6 b	8.37 b	5.96 b	2.40 ab	23.30	137.1 b	25.38 bc	22.08	5.19 b	7.63 b	12.82 a	40.48 a
N_3	139.3 a	9.04 a	6.40 a	2.64 a	23.74	146.1 a	24.72 c	22.05	5.36 a	7.97 a	13.34 a	40.21 ab
N_4	129.9 b	8.22 b	5.70 bc	2.52 ab	23.49	139.3 b	26.53 b	21.91	4.77 c	7.39 c	12.17 b	39.23 b
N_5	136.6 a	7.70 c	5.41 cd	2.30 bc	23.77	137.0 b	25.61 bc	22.60	4.05 d	6.71 d	10.77 c	37.64 c
CV (%)	3.02	5.19	6.64	11.27	3.29	3.07	5.13	3.65	3.62	1.82	4.84	3.14
Level of significance	**	**	**	**	NS	**	**	NS	**	**	**	**

Figures in a column having the same letter do not differ significantly as per DMRT.

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

N_0 = 0 (control), N_1 = 40 kg N ha^{-1}, N_2 = 60 kg N ha^{-1}, N_3 = 80 kg N ha^{-1}, N_4 = 100 kg N ha^{-1} N_5 = 120 kg N ha^{-1}

Table 8: Effect of interaction between row arrangement and rate of nitrogen on yield and yield contributing characters of transplant *Aman* rice (BRRI dhan34)

Interaction (Row arrangement x Rate of nitrogen)	Plant height (cm)	No of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Length of panicle (cm)	No. of grains panicle^{-1}	No. 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 x N_0	140.7ab	6.88gh	4.89fgh	1.99efg	23.14	134.9efgh	25.47bcdef	21.95	3.37j	6.11i	9.483	35.55gh
R_1 x N_1	139.6abc	7.33efg	5.00efgh	2.33cdef	23.76	138.6cdefg	27.18bc	22.17	3.73hi	6.41h	10.14	36.79fgh
R_1 x N_2	127.6 ef	8.22cd	5.78cd	2.44bcde	23.70	143.1abcde	24.10f	22.27	4.32e	7.52de	12.84	41.43a
R_1 x N_3	135.7abcd	9.11b	6.55ab	2.55bcd	23.59	145.7abc	24.10f	21.96	4.57e	7.96ab	13.53	41.17a
R_1 x N_4	132.3cde	7.89de	5.66cde	2.22cdef	23.47	137.2defgh	26.75bcde	21.88	4.04de	7.39ef	12.23	39.57abcde
R_1 x N_5	132.3cde	7.78def	5.11efg	2.66bc	23.86	136.8defgh	24.72cdef	22.49	4.00gh	6.91g	10.91	36.66fgh
R_2 x N_0	127.8ef	7.11fgh	5.00efgh	2.11def	23.46	136.8defgh	24.39ef	21.77	3.77hi	6.15i	9.925	38.00def
R_2 x N_1	138.8abc	8.89bc	6.00bc	2.89b	23.97	143.9abcd	27.02bcd	22.19	3.92ghi	6.79g	10.71	36.60fgh
R_2 x N_2	129.3def	10.3a	7.00a	3.33a	22.92	146.9ab	26.43bcdef	21.79	5.48ab	8.00ab	13.48	40.65abc
R_2 x N_3	143.0a	10.5a	7.09a	3.46a	23.99	150.10a	25.65bcdef	22.03	5.65a	8.17a	13.82	40.88ab
R_2 x N_4	129.6def	10.2a	6.78a	3.44a	23.21	138.9bcdef	26.74bcde	21.75	5.08cd	7.63cd	12.71	39.97abcd
R_2 x N_5	135.7abcd	9.44b	6.78a	2.67bc	23.94	130.6gh	27.40ab	22.03	4.19fg	6.95g	11.14	37.61efg
R_3 x N_0	123.4f	5.22j	4.11i	1.11ij	24.30	129.3 h	28.00ab	22.00	3.12j	5.74j	8.860	35.21h
R_3 x N_1	133.7bcde	5.33j	4.33hi	1.00j	24.80	131.2fgh	29.62a	21.72	3.65i	6.23hi	9.880	36.94fgh
R_3 x N_2	138.0abc	6.55hi	5.11defg	1.44hij	23.27	134.8efgh	25.62bcdef	22.17	4.77e	7.37ef	12.14	39.29abcde
R_3 x N_3	139.3abc	7.44efg	5.55cdef	1.89fgh	23.64	142.5abcde	24.42def	22.17	4.88de	7.79bc	12.67	38.52cdef
R_3 x N_4	127.8ef	6.55hi	4.66ghi	1.88fgh	23.77	141.7bcde	26.11bcdef	22.11	4.40f	7.17f	11.57	38.03def
R_3 x N_5	141.7a	5.89ij	4.34hi	1.55ghi	23.50	136.4defgh	24.70cdef	23.28	3.97gh	6.29hi	10.26	38.69bcdef
CV (%)	3.02	5.19	6.64	11.27	3.29	3.07	5.13	3.65	3.62	1.82	4.84	3.14
Level of significance	**	**	*	**	NS	**	**	NS	**	*	NS	*

Figures in a column having the same letter do not differ significantly as per DMRT. ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

4. Conclusion

Experimental results revealed that, double row arrangement showed best performance considering most of the yield contributing characters. Among the different nitrogen levels, 80 kg N ha^{-1} showed the best performance. The highest grain yield (5.65 t ha^{-1}) was found in double row arrangement combined with 80 kg N ha^{-1}, which was statistically identical with the yield (5.48 t ha^{-1}) from the interaction of double row arrangement and 60 kg N ha^{-1}. The lowest grain yield (3.12 t ha^{-1}) was found in triple row arrangement in control (0 kg N ha^{-1}). Finally, it can be concluded that double row arrangement combined with 60 kg N ha^{-1} appeared as the promising practice in transplant *Aman* aromatic fine rice cv. BRRI dhan34 cultivation in terms of growth and yield. It is recommended to maintain double row arrangement combined with 60 kg N ha^{-1} for better performance of rice production. Further experiment should be conducted for more confirmation of the study.

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Conflict of Interest

The authors declared that they have no competing interests in this section.

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