Effect of Number of Seedling Hill^{-1} on the Growth and Yield of Aromatic Fine Rice Varieties in Rain fed Condition

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Abstract: A field experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh, Bangladesh, during the rain fed condition in July to December, 2011, with a view to study the performance of aromatic fine rice under different number of seedling hill^{-1}. The experiment was carried out with four aromatic fine rice varieties (V_1= BRRI dhan34, V_2= Ukunimadhu, V_3= Basmati and V_4= Kataribhog) and four different number of seedling hill^{-1} (N_1= one number of seedling hill^{-1}, N_2= two number of seedling hill^{-1}, N_3= three number of seedling hill^{-1} and N_4= four number of seedling hill^{-1}). The experiment was laid out in split-plot design with three replications assigning variety in the main plot and the four different number of seedling hill^{-1}in the sub plot. Experimental result showed that aromatic fine rice varieties and number of seedling hill^{-1} individually had significant effect on the agronomic parameters except number of non-effective tiller hill^{-1}, number of unfilled spikelets panicle^{-1}, 1000-grain wt (g)**.** The highest grain yield (2.32 t ha^{-1}) was obtained in Kataribhog, which, was similar to Basmati (2.31 t ha^{-1}) followed by Ukunimadhu. The highest grain yield was (2.31 t ha^{-1}) with two number of seedling hill^{-1} which was statistically similar to three number of seedling hill^{-1} (1.96 t ha^{-1}) but different from single number of seedling hill^{-1} and four number of seedling hill^{-1}.The lowest grain yield were with one and four number of seedling hill^{-1} but straw yield (5.00 t ha^{-1}) was significeantly higher with four number of seedling hill^{-1}. Combined effect showed that two number of seedling hill^{-1} produced highest grain yield by all the variety. In later of number of four seedling hill^{-1} production of grain yield was decreased. BRRI dhan34, Ukunimadhu, Basmati and Kataribhog with two number of seedling hill^{-1} can be suggested in rainfed condition of Bangladesh.
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1. Introduction

Rice (*Oryza sativa* L.) is the staple food; of Bangladesh where it constitutes a major part of human diet.Bangladesh is an agro based country. Most of her economic activates depend on agriculture. The humid tropical climate of this country provides an excellent habitat for rice culture. Among the major rice growing countries of the world, Bangladesh ranks third in respect of growing area and fourth in rice production (Huke and Huke, 1990). The total area and production of rice in Bangladesh is about 11.65 million hectare and 33.5 million m. ton, respectively (BBS, 2011a). Although the geographical, climatic and ethnic conditions of Bangladesh are favorable for year-round rice cultivation, the national average of rice yield is rather low (2.91 ton ha^{-1}) compared to other rice growing countries (BBS, 2011b). The number of tillers is greatly affected both qualitatively and quantitatively by the number of seedlings hill^{-1}. Optimum number of seedlings hill^{-1} may enable the rice plant to grow properly both in its aerial and underground parts by utilizing maximum radiant emergy, nutrient, space and water and also could reduce the seedling cost. All these factors can be efficiently utilized and ultimately they would lead to bumper crop production if proper care is taken. Excess number of seedlings hill^{-1} may produce higher number of tillers hill^{-1} resulting in mutual shading and lodging and thus favours the production of more straw instead of grain. While the least number of seedlings hill^{-1} may cause insufficient number of tillers growth thus keeping air, space and nutrients unutilized in soils and at the end, total panicles unit^{-1} area will be reduced resulting in poor yield. Chowdhury *et al.,* (1993) reported that number of seedlings hill^{-1} was an important factor as it influenced the plant population unit^{-1} area, proper utilization of availability of sunlight, nutrients, photosynthesis and respiration, which ultimately influenced the yield and yield contributing characters

of rice. Among the improved cultural practices,number of seedling hill^{-1} can play important roles in boosting yield of rice. Number of seedlings hill^{-1} is another important factor for suceessful rice production because it influences the tiller formation, solar radiation interception, total sunshine reception, nutrient uptake, rate of photosynthesis and other physiological phenomena and ultimately affects the growth and devcloment of rice plant. In densely populated rice field the inter-specific competitions between the plants is high which sometimes results in gradual shading and lodging and thus favour increased production of stwaw instead of grain.It is, therefore, necessary to determine the optimum plant spacing and number of seeding hill^{-1} for high yield (Ghosh *et al.,* 1998; Hossain *et al*., 2003; Islam *et al.,* 2008; Bozongi *et al.,* 2012; Ehsanullah *et al., (*2012); Faisul-ur-Rasool *et al.,* 2013). The optimum seedlings per hill ensure the plants to grow in their both aerial and under ground parts through efficient utilization of solar radiation, water and nutrients (Miah *et al.,* 2004). When the planting densities exceed the optimum level, competition among plants becomes severe and consequently the plant growth slows down and the grain yield decreases. As the tiller production in T-aman rice is very low and most of them are low yielding. The rice economy in Bangladesh can be changed by improving production technologies of aromatic fine rice because of its high export potential, taste as well as better eating qualities. There are several special dishes like *polau, khir, firney, paish, chira, khoi, briany, jurda,* etc., which are prepared from this kind of milled rice. Aromatic rice varieties are rated best in quality and fetch much higher market price than non-aromatic rice. Among the rice varieties, scented or aromatic rice is popular in Asia and has gained wider acceptance in Europe and United States because of their good flavor and texture. Export of aromatic and fine rice from Bangladesh made a significant rise from 1100 tons in 2002 to 3300 tons in 2003, but the volume is still far below the potential demand of 4 million Bangladeshi living abroad. The export destinations are Middle-East countries, Malaysia, Korea, Japan, Australia, U.S.A, Canada, U.K., Italy and Sweden. The demand of aromatic rice for internal consumption and also for export is increasing day by day (Das and Baqui, 2000). Bangladesh used to export about 2000 tons of its aromatic rice annually in the past 2012 (http://www.oryza.com/content/bangladesh-resume). For this, it is very much necessary to maintain the optimum number of seedling hill^{-1} for better aromatic fine rice yield.

2. Material and Methods

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) farm Mymensingh, Bangladesh, during July to December, 2011 in the rainfed condition *(Aman* season). The experimental land was sandy loam in texture having soil pH 6.8. The unit plot size was 4.0 m × 3.0 m. The experiment was laid out in split-plot design with three replications assigning variety treatment in the main plot and the number of seedling hill^{-1} treatment in the sub plot. The experiment was carried out with four aromatic fine rice (V_1= BRRI dhan34, V_2= Ukunimadhu, V_3= Basmati and V_4= Kataribhog) and four different number of seedling hill^{-1} (N_1= one number of seedling hill^{-1}, N_2= two number of seedling hill^{-1}, N_3= three number of seedling hill^{-1} and N_4= four number of seedling hill^{-1}). A common procedure was followed for raising of seedling in seed bed. Seedlings of 40 days old were uprooted from the seed beds carefully. The plots of the experimental field were fertilized with N, P, K, S, and Zn at the rate of @126.9, 19.81, 65, 43.3 and 1.8 kg ha^{-1}, respectively according to the recommendation of BARC Fertilizer Recommendation Guide. (2005). The whole amounts of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied to the soil at the time of final land preparation. Urea was applied in three equal splits. One split of urea was applied with other fertilizers as basal dose and the other two splits were applied at 21 and 45 DAT. The average value of monthly maximum temperatures during the period of July to December, 2011 was 28.67^{o}C, 28.63^{o}C, 29.31^{o}C, 27.08^{o}C, 23.15^{o}C and 23.15^{o}C**,** respectively. The average value of monthly maximum total rainfall during the period of July to December, 2011 was 42.01(cm), 36.04(cm), 22.8(cm), 3.03(cm), Trce and 00.00(cm)**,** respectively(Source: Water Yard, Dept. of Irrigation and Water Management, Records of climatological observation (Monthly) station, Bangladesh Agricultural University, Mymensingh, Bangladesh).

Only the selected healthy seedlings were transplanted according to the treatments in the well-puddled experimental plots on 20 August 2011. Number of seedlings hill^{-1} was given as per treatment. Intercultural operations weeding and pesticide application were done as and when required. From each plot, 10 hills (excluding border hills) were selected from the inside rows for collecting different data at 30 DAT, 60 DAT and 90 DAT. Each plant sample was separated from leaf as their area was measured with the help of a protable leaf area meter (Model Fx-3000, Japan). Just after the transplantion10 hills were randomly selected and tagged for measuring plant height, total dry matter

production and chlorophyll contents, Chlorophyll content of leaves were determined with SPAD meter. During harvest 10 hills were again randomly selected from each plot for the collection data on yield contributing characters. Grain and straw were sun dried for having the yield (t ha^{-1}) and the weight of grains was adjusted to 12% moisture content. Data were analyzed statistically using "Analysis of Variance" technique and differences among treatments means were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

3. Results

Effect of growth parameters

Plant height

At 30 DAT, the highest plant height (70.4cm) was in Ukunimadhu. Moreover, the lowest value (55.7cm) was found in Basmati. At 60 DAT, the highest plant height (82.0cm) was observed in Ukunimadhu and the lowest (72.1cm) was found in Basmati. Again at 90 DAT the maximum plant height (112.0cm) was found in Ukunimadhu and the minimum value (97.6cm) was in Basmati. At 30 DAT, the highest plant height (65.3cm) was observed under three seedlings $hill^{-1}$ while the lowest plant height (59.5cm) was in two seedlings $hill^{-1}$. At 60 DAT, the highest plant height (81.0cm) was in three seedling $hill^{-1}$ and the lowest (73.7cm) was found in two seedlings $hill^{-1}$. The highest plant height (106.0cm) was in three seedlings $hill^{-1}$ and the lowest (103.1cm) was in one seeding $hill^{-1}$ at 90 DAT. At 30 DAT the highest plant height (81.0cm) was observed in Ukunimadhu under three seedlings $hill^{-1}$ and the lowest (53.6cm) was in Basmati under three seedlings $hill^{-1}$. But at 60 DAT, the highest plant height (93.0cm) was found in Ukunimadhu under three seedlings $hill^{-1}$. The lowest plant height (68.0cm) was found in Basmati under one seeding $hill^{-1}$. However, at 90 DAT, Ukunimadhu showed the highest plant height (118.3cm) under three seedlings $hill^{-1}$ and the lowest plant height was (94.3cm) Basmati under three seedlings $hill^{-1}$ (Table 1).

Total dry matter (g $hill^{-1}$)

Under variety performance, the highest total dry matter (9.4 g $hill^{-1}$) was observed in Kataribhog and the lowest (6.2 g $hill^{-1}$) was in BRRI dhan34 at 30DAT. But in case of 60DAT, the highest total dry matter (14.5 g $hill^{-1}$) was found in Basmati while the lowest value (11.8 g $hill^{-1}$) was observed in Ukunimadhu. The highest total dry matter (26.5g $hill^{-1}$) was in Basmati and the lowest (22.5g $hill^{-1}$) was in BRRI dhan34 at 90 DAT. The highest value of total dry matter (9.2 g $hill^{-1}$, 13.8 g $hill^{-1}$ and 25.0 g $hill^{-1}$) were found in three seedlings $hill^{-1}$, four seedlings $hill^{-1}$ and three seedlings $hill^{-1}$ at 30 DAT, 60 DAT and 90 DAT respectively, which, were statistically identical. The lowest values (6.8 g $hill^{-1}$, 0.7 g $hill^{-1}$ and 22.5 g $hill^{-1}$) were observed in one seedling $hill^{-1}$ at 30 DAT, 60 DAT and 90 DAT respectively, which were also statistically identical. The highest dry matter (11.9 g $hill^{-1}$, 18.4 g $hill^{-1}$ and 25.7 g $hill^{-1}$) were produced by Basmati, Kataribhog and Basmati in three seedlings $hill^{-1}$ at 30 DAT, 60 DAT and 90 DAT, respectively. The lowest value (5.0 g $hill^{-1}$, 9.0 g $hill^{-1}$ and 17.6 g $hill^{-1}$) were recorded from BRRI dhan34, and Basmati under one seedling $hill^{-1}$ at 30 DAT, 60 DAT and 90 DAT (Table 1).

Chlorophyll content $leaf^{-1}$

The highest Chlorophyll contents $leaf^{-1}$ (34.5 SPAD value), (37.7 SPAD value) and (34.1 SPAD value) were found in Ukunimadhu and Basmati at 30 DAT, 60 DAT and 90 DAT respectively which, were statistically identical. The lowest Chlorophyll content $leaf^{-1}$ values (30.0 SPAD value, 33.4 SPAD value and 30.4 SPAD value) were observed in BRRI dhan34 at 30 DAT, 60 DAT and 90 DAT, respectively which, were also statistically identical (Table 1). At 30 DAT, the highest Chlorophyll content $leaf^{-1}$ (32.7 SPAD value) was found under three seedlings $hill^{-1}$. The lowest of Chlorophyll content $leaf^{-1}$ (31.5 SPAD value) was in two seedlings $hill^{-1}$.In case of 60 DAT, three seedlings $hill^{-1}$ showed the Chlorophyll contents $leaf^{-1}$ (36.2 SPAD value) and the lowest value (34.3 SPAD value) was found in one seedling $hill^{-1}$. However, at 90 DAT, the highest Chlorophyll content $leaf^{-1}$ (33.9 SPAD value) was found in four seedlings $hill^{-1}$ and lowest Chlorophyll content $leaf^{-1}$ (32.4 SPAD value) was found in two seedlings $hill^{-1}$ (Table 1). The highest Chlorophyll content $leaf^{-1}$ (34.9 SPAD value), (40.3 SPAD value) and (36.0 SPAD value) were observed in Ukunimadhu and Basmati under two seedlings $hill^{-1}$, one seedling $hill^{-1}$and four seedlings $hill^{-1}$ at 30 DAT,60 DAT and 90 DAT respectively which, were statistically identical. The lowest Chlorophyll content $leaf^{-1}$ (27.8 SPAD value), (31.1 SPAD value) and (27.9 SPAD value) were found BRRI dhan34 under one seedling $hill^{-1}$ and two seedlings $hill^{-1}$ at 30 DAT, 60 DAT and 90 DAT respectively (Table 1).

Leaf area $hill^{-1}$ ($cm2\ hill^{-1}$)

Basmati gave the highest leaf area $hill^{-1}$ (569.2 cm^{-2}), which, was statistically identical with Kataribhog at 30 DAT. However, the lowest leaf area $hill^{-1}$ value (392.4 cm^{-2}) was recorded from Ukunimadhu at 30 DAT. BRRI dhan34 gave the highest leaf area $hill^{-1}$ (769.2 cm^{-2}) and the lowest value of leaf area $hill^{-1}$ (689.0cm^{-2}) was found in Basmati at 60 DAT. At 90 DAT, BRRI dhan34 gave the highest leaf area $hill^{-1}$ (611.9cm^{-2}) while the lowest value (559.5cm^{2}) in Ukunimadhu. The highest leaf area $hill^{-1}$ (520.2cm^{-2}), (812.0cm^{-2}) and

(637.1cm^{-2}) were found in two seedlings hill^{-1}, four seedlings hill^{-1} and four seedlings hill^{-1} at 30 DAT, 60 DAT and 90 DAT respectively. The lowest values (411.1cm^{-2}), (651.0 cm^{-2}) and (529.0cm^{-2}) were observed in one seedling hill^{-1}, three seedlings hill^{-1} and three seedlings hill^{-1} at 30 DAT, 60 DAT and 90 DAT respectively.

The highest leaf area (704.8 cm^{-2}), (939.1 cm^{-2}) and (721.3 cm^{-2}) were observed in Basmati, and Kataribhog under two seedlings hill^{-1}and four seedlings hill^{-1} at 30 DAT, 60 DAT, 90 DAT respectively. The lowest leaf area hill^{-1} (297.6cm^{2}), (586.0cm^{2}) and (493.3cm^{2}) were found in BRRI dhan 34, Ukunimadhu and Basmati under one seedling hill^{-1} at 30 DAT, 60 DAT, 90 DAT respectively (Table 1).

Plant height

The longer plant height (154.9 cm) was observed in Ukunimadhu and shorter plant height (102.3cm) in Basmati (Table 2). The longest plant height (132.7cm) was found in the transplanting of one seedling hill^{-1} and the lowest of 128.5cm for four seedlings, which, was statistically identical to two seedlings hill^{-1} and three seedling hill^{-1} (table 2) The highest plant height (159.0cm) was observed in Ukunimadhu under one seedling hill^{-1} the lowest plant height (99.0 cm) was observed in Basmati under two seedling hill^{-1} (Table 3).

Number effective tillers hill^{-1}

The highest number of effective tillers hill^{-1} (9.3) was produced in Basmati and the lowest number of effective tillers hill^{-1} was produced in (6.5) Ukunimadhu, which, was statistically similar to BRRI dhan34 (7.1) and Kataribhog (7.4) (Table 2). Two seedlings hill^{-1} contributed to the highest number effective tillers hill^{-1} (8.9) and the lowest (6.8) in one seedling hill^{-1} (Table 2). The highest number of effective tillers hill^{-1} (12.1) was obtained from Basmati under two seedlings hill^{-1}. The lowest number of effective tillers hill^{-1} (6.2) was obtained from BRRI dhan34 under four seedlings hill^{-1} (Table 3).

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

The highest number of non- effective tillers hill^{-1}(1.73) was obtained from Kataribhog which, was followed by BRRI dhan34 (1.7).The lowest number of non-effective tillers hill^{-1}(1.1) was observed in Ukunimadhu (Table 2). The number of non-effective tillers hill^{-1} recorded the highest (1.1) in four seedlings hill^{-1}, which was statistically identical (1.11) to one seedlings hill^{-1} (Table 2). The highest number of non-effective tillers hill^{-1} (1.50) was found in Kataribhog × four seedlings hill^{-1} interaction and the lowest number of non-effective tillers hill^{-1} (0.46) was found in BRRIdhan 34 × two seedlings hill^{-1} (Table 3).

Number of grains paniele^{-1}

It was observed that BRRI dha34 produced the highest number of grains panicle^{-1} (82.4) and the lowest grains paniele^{-1} (43.0) was produced by Kataribhog (Table 2). Numerically the highest number of grains paniele^{-1}(66.3) was obtained from one seedling hill^{-1}, which, was followed by two seedlings hill^{-1} (65.9). The lowest number of grains panicle^{-1} (52.6) was obtained from four seedling hill^{-1} (Table 2). The highest number of grains paniele^{-1} (105.66) was obtained from BRRIdhan34 × one seedlings hill^{-1} and the lowest number of grains panicle^{-1} (37.66) was obtained from Kataribhog × three seedlings hill^{-1} (Table 3).

Number of unfilled spikelets panicle^{-1}

Numerically the higher unfilled grains panicle^{-1} (39.9) was observed in Basmati and the lowest unfilled grains panicle^{-1} Ukunimadhu was (28.6) (Table 2). The number of unfilled spikelets panicle^{-1} recorded the highest (43.4) in three seedlings hill^{-1} but the lowest of (5.0) in one seedling hill^{-1} (Table 2). The highest number unfilled spikelets paniele^{-1} (70.0) was obtained from BRRI dhan34 × two seedling hill^{-1} interaction and the lowest number of unfilled spikelets panicle^{-1} (15.33) was obtained from BRRI dhan34 × one seedling hill^{-1} interaction (Table 3).

1000-grain weight (g)

Basmati ranked first (19.78g) in respect of 1000- grains weight followed by Kataribhog. The lowest (10.48g) was produced by BRRIdhan34 (Table 2) The heaviest weight of 1000-grains (14.01g) was obtained from one seedling hill^{-1} and the highest weight (13.25g) 1000-grains was obtained from four seedlings hill^{-1} (Table 2).The heaviest weight of 100-grains was obtained (20.33g) from Basmati × two seedlings hill^{-1} and the lightest weight of 1000- grains (9.13g) was obtained from BRRI dhan34 × three seedlings hill^{-1} (Table 3).

Grain yield

Results revealed that Kataribhog produced the highest grain yield (2.32 t ha^{-1}) which was statistically identical to Basmati. The lowest grain yield was recorded in Ukunimadhu (1.60 t ha^{-1}) (Table 2). Numerically the highest grain yield of 2.31t ha^{-1} was obtained in two seedlings hill^{-1} and the lowest (1.66 t ha^{-1}) in one seedling hill^{-1} (Table 2). Interaction effect showed that, in the two seedling hill^{-1}, BRRI dhan34, Ukunimadhu, Basmati and Kataribhog produced higher grain yield 1.73 t ha^{-1}, 2.34 t ha^{-1}, 2.64 t ha^{-1} and 2.52 t ha^{-1}, respectively. Interaction effect showed that lower grains yield was obtained by BRRI dhan34 (1.50 tha^{-1}), Ukunimadhu (1.33 t ha^{-1}), Basmati (1.88 t ha^{-1}) and Katarilbhog (1.94 t ha-^{1}) in four seedlings hill^{-1} (Table 3).

4. Discussion

Number of seedling hill^{-1} had a major effect on morphological and physiological characters as well as yield. Although date of transplanting had significant effect on chlorophyll content but there had a trend to increase with increase 60 DAT. Leaf area hill^{-1} was higher in 60 DAT and lower in 90 DAT. This might be due to limitation of light, nutrients and water in densely date of transplanting plants and vice-versa. As a result, more tillers as well as leaf area were produced in 2-3 number of seedling hill^{-1} levels (medium Number of seedling hill^{-1}), which have capacity to capture more sunlight because of less mutual shading effect among the leaves and less competition for nutrients in N_2 and N_3 number of seedling hill^{-1} plants producing greater. Better yield performances in N_2, and N_3 might be due to the production of highest effective tillers hill^{-1} and grains panicle^{-1}. Islam *et al.,* (2010) also found the highest grain yield was with two seedling hill^{-1} which was statically similar to three number of seedling hill^{-1}. Faruk *et al*., (2009) also reported that among the number of two seedling hill^{-1} performed better for grain yield. HRIDESH SHARMA (2013) also report results showed that Mauawanpur-1 variety of rice when transplanted @ 2 seedling hill^{-1} yields the best than other combination at Sundarbazan. Hasanuzzaman *et al.,* (2009) also report that plant spaced at 20cmx 20cm coupled 2 seedlins hill-1 was observed the best treatment for grain yield of rice in the present study. The present study proves that aromatic fine rice could be cultivated at two seedling hill^{-1} and three seedling hill^{-1} for highest grain yield production in rainded condition.

Table 1. Effect of varieties, number of seedling hill^{-1} and interaction varieties and number of seedling hill^{-1} on the growth contributing characters of aromatic fine rice varieties in rain fed condition

Treatments	Plant height(cm)			TDM(g) hill^{-1}			Chlorophyll content leaf^{-1}			Leaf area hill^{-1}		
Variety	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT
V_1=BRRIdhan34	62.5	78.8	102.6	6.2	11.8	22.5	30.0	33.4	30.4	398.4	769.2	611.9
V_2= Ukunimadhu	70.4	82.0	112.0	7.8	11.0	22.6	34.5	37.7	33.5	392.4	679.3	559.5
V_3=Basmati	55.7	72.1	97.8	9.8	14.5	26.5	31.7	36.0	34.1	569.2	689.0	570.5
V_4=Kataribhog	60.5	79.8	103.0	9.4	13.5	25.5	32.5	35.0	33.5	511.2	703.2	569.8
$LSD_{0.05}$	5.953	5.069	3.614	0.8137	2.22	2.467	2.871	NS	1.673	131.9	NS	NS
Number of tillers hill^{-1}												
One(N_1)	60.8	77.0	103.1	6.8	10.7	22.5	32.3	34.3	32.5	411.1	673.7	560.9
Two(N_2)	59.5	73.7	102.5	8.9	12.7	23.0	31.5	35.8	32.4	520.2	704.1	584.8
Three(N_3)	65.3	81.0	106.0	9.2	12.8	25.0	32.7	36.2	32.7	516.4	651.0	529.0
Four(N_4)	63.6	79.0	103.9	8.4	13.8	24.2	32.2	35.7	33.9	429.6	812.0	637.1
$LSD_{0.05}$	4.065	NS	2.753	1.582	1.814	1.789	NS	NS	NS	92.5	80.82	56.32
CV(%)	7.74	9.24	2.32	16.57	12.67	11.41	13.64	8.55	9.24	23.47	9.97	11.56
Interaction: ((Variety x number of seedling hill^{-1})												
BRRIdhan34 :												
One	59.0	83.3	101.3	5.0	9.0	22.1	27.8	31.1	30.8	297.6	772.0	625.2
Two	64.3	75.3	102.0	6.4	11.7	22.6	28.4	34.6	27.9	465.5	854.1	668.2
Three	61.6	76.0	104.0	6.1	13.9	21.9	32.6	35.0	30.9	439.7	708.2	517.4
Four	65.3	80.6	103.3	7.3	12.6	23.4	31.5	33.0	32.0	390.9	742.6	636.7
Ukunimadhu :												
One	67.6	78.0	110.6	6.7	11.5	20.1	34.6	40.3	35.0	366.2	586.0	526.9
Two	60.6	73.3	107.3	8.6	11.3	23.4	34.9	39.3	32.6	306.9	763.3	510.3
Three	81.0	93.0	118.3	8.6	14.4	22.8	34.1	34.6	34.6	508.1	615.9	524.0
Four	72.3	84.0	111.6	7.3	14.8	24.3	34.4	36.6	31.6	388.3	752.1	721.3
Basmati :												
One	57.6	68.0	97.0	7.4	16.8	17.6	33.5	32.6	32.6	432.3	591.4	493.3
Two	53.6	72.6	95.3	10.9	15.2	17.9	31.6	36.3	35.3	704.8	606.1	628.0
Three	53.6	75.3	94.3	11.9	18.4	20.8	30.8	36.3	32.6	628.9	619.9	534.2
Four	58.d	78.0	104.6	9.1	15.6	22.0	30.8	38.6	36.0	510.8	939.1	582.6
Kataribhog :												
One	59.0	74.3	103.6	8.1	12.9	22.2	33.6	33.3	31.6	548.4	745.3	598.6
Two	59.3	78.3	105.3	9.6	13.7	25.2	31.2	33.0	34.0	603.5	592.8	532.6
Three	65.0	82.3	107.3	10.2	13.4	25.7	33.1	39.0	32.5	488.9	660.5	540.3
Four	59.0	76.3	96.0	9.8	13.9	25.5	32.1	34.8	36.0	404.2	814.4	607.6
$LSD_{0.05}$	8.13	NS	5.506	NS	NS	NS	NS	NS	NS	NS	161.6	112.6
CV(%)	7.74	9.24	2.32	16.57	11.41	11.41	13.64	8.55	9.24	23.47	9.97	11.56

In a column, figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. NS =Not Significant.

Table 2 Effect of variety and number of seedling hill^{-1} on yield and yield contributing characters of aromatic fine rice varieties in rain fed condition

Variety	Plant height (cm)	Effective tillers hill^{-1} (No.)	Non-effective tillers hill^{-1} (No.)	Grains panicle^{-1} (No.)	Unfilled spikelets panicle^{-1} (No.)	1000-grain wt (g)	Grain Yield (tha^{-1})	Straw Yield (tha^{-1})	Harvest index (%)
V_1=BRRIdhan34	134.6	7.1	0.7	82.4	38.9	10.48	1.62	4.43	26.77
V_2= Ukunimadhu	154.9	6.5	1.1	62.4	28.6	11.37	1.60	5.10	23.88
V_3=Basmati	102.3	9.3	1.2	52.4	39.9	19.78	2.31	4.84	32.30
V_4=Kataribhog	127.5	7.4	1.3	43.0	32.0	12.69	2.32	4.61	33.47
$LSD_{0.05}$	7.382	1.158	NS	19.93	NS	2.212	0.4490	0.3751	2.924
Number of seedling hill^{-1}									
One(N_1)	132.7	6.8	1.1	66.3	25.0	14.01	1.66	4.45	27.16
Two(N_2)	129.0	8.9	1.0	65.9	38.0	13.68	2.31	4.70	32.95
Three(N_3)	129.1	7.8	1.0	55.6	43.4	13.37	1.96	4.84	28.82
Four(N_4)	128.5	7.0	1.1	52.6	33.0	13.25	1.92	5.00	27.74
$LSD_{0.05}$	3.345	1.265	NS	NS	12.91	NS	0.3721	0.3387	4.491
CV (%)	3.06	19.68	51.95	31.08	43.94	7.89	22.44	6.25	13.56

In a column, figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
NS =Not Significant.

Table 3 Effect of interaction variety and number of seedling hill^{-1} on yield and yield contributing characters of aromatic fine rice varieties in rain fed condition

Interaction (Variety × number of seedling hill^{-1})	Plant height (cm)	Effective tillers hill^{-1} (No.)	Non-effective tillers hill^{-1} (No.)	Grains panicle^{-1} (No.)	Unfilled spikelets panicle^{-1} (No.)	1000-grain wt (g)	Grain yield (tha^{-1})	Straw Yield (tha^{-1})	Harvest index (%)
BRRIdhan34 :									
One	136.3	6.6	0.80	105.66	15.33	12.46	1.71	4.13	29.28
Two	133.3	8.7	0.46	85.66	70.00	10.60	1.73	4.46	27.90
Three	131.0	6.9	1.26	77.66	38.66	9.13	1.55	4.40	26.05
Four	138.0	6.2	0.96	60.66	31.66	9.73	1.50	4.73	24.07
Ukunimadhu :									
One	159.0	6.4	1.33	63.66	22.00	11.53	1.38	5.00	21.63
Two	156.0	6.8	1.13	59.33	26.00	11.60	2.34	5.03	31.75
Three	155.3	6.5	0.66	62.00	35.33	11.23	1.34	5.13	20.71
Four	149.3	6.5	1.13	64.66	31.33	11.13	1.33	5.26	20.18
Basmati :									
One	104.3	9.4	1.10	53.00	39.33	19.93	2.24	4.33	34.09
Two	99.0	12.1	1.46	69.66	26.66	20.33	2.64	4.90	35.01
Three	104.6	7.6	1.17	45.33	67.00	19.23	2.47	5.03	32.93
Four	101.3	8.1	0.90	43.00	26.66	19.63	1.88	5.10	26.93
Kataribhog :									
One	131.3	7.9	1.26	43.00	23.33	12.13	2.35	4.33	35.17
Two	127.6	7.9	1.10	49.00	29.33	12.20	2.52	4.43	36.25
Three	125.6	7.6	1.03	37.66	32.66	13.90	2.48	4.80	34.06
Four	125.3	6.4	1.50	42.33	42.66	12.53	1.94	4.90	28.30
$LSD_{0.05}$	NS	NS	NS	NS	25.83	NS	NS	NS	NS
CV (%)	3.06	19.68	51.95	31.08	43.94	7.89	22.44	6.25	13.56

In a column, figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. NS =Not Significant.

It could be concludes that BRRI dhan34, Ukunimadhu, Basmati and Kataribhog of the study performed better in most of the evaluating trails like grain yield and number of effective tillers hill^{-1}. However plants at number of seeding hill^{-1} two number of seedling hill^{-1} gave, more number of effective tillers hill^{-1} ultimately produced highest grain yield. Among the combination of aromatic fine rice variety and number of seeding hill^{-1}, BRRI dhan34, Ukunimadhu, Basmati and Kataribhog produced higher grain yield at number of seedling hill^{-1} of two number of seedling hill^{-1}. So, BRRI dhan34, Ukunimadhu, Basmati and Kataribhog with number of seeding hill^{-1} two number of seedling hill^{-1} can be suggested as profitable growing in rain-fed condition of Bangladesh.

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