Optimizing Of Planting Density On The Growth And Yield Of Aromatic Fine Rice In Rainfed Condition

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Abstract: A field experiment was carried out at the Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh, Bangladesh during July to December, 2010, in view to find out the optimum plant spacing for the highest yield of aromatic fine rice grown in rain fed season. 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 plant spacings (S_1= 15cm×15cm, S_2= 20cm × 15cm, S_3= 20cm × 20cm, S_4= 20cm × 25cm). The experiment was laid out in split-plot design with three replications assigning variety in the main plot and the spacing in the sub plot. It was observed that almost all the plant characters and yield were significantly affected by the aromatic fine rice and plant spacing. Among the spacings tested against the four varieties, the highest grain yield was obtained at 20 cm × 15 cm and 20 cm × 20 cm spacing. The spacing 20 cm×15 cm and 20 cm × 20 cm were proven more appropriate because it produced more number of effective tillers hill^{-1} more number of grains panicle^{-1} and ultimately produced the higher grain yield than other two spacings. Among the varieties Kataribhog, Basmati and Ukunimadhu produced higher grain yield at 20 cm × 15 cm and 20 cm × 20 cm.
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Introduction

Rice (*Oryza sativa* L.) being the world's most widely consumed cereal grain play an unique role in combating global hunger (IRRI, 2004). 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). In Bangladesh 70-76% of the calorie and 66% protein come from rice (Greengield and Dowling, 1998; Dey *et al.,* 1996). 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 crop plants depend largely on temperature, solar radiation, moisture and soil fertility for their growth and nutritional requirements. A dense population of crop may play the negative role to have the maximum yield from the limited resources. It is, therefore, necessary to determine the optimum density of plant population per unit area for obtaining maximum yields. A number of researchers have reported that maintenance of a critical level of rice plant population in the field was necessary to maximize the grain yields. Counce (1987) suggested that population density ranging from 159 to 304 plants m^{-2} could produce maximum yield under a rained and flooded rice production systems. Optimum plant spacing produces optimum number of plants unit^{-1} area which enhances the performance of yield contributing characters and ultimately higher grain yield. Optimum plant spacing ensures plants to grow properly, utilizing more solar radiation and soil nutrients (Miah *et al.*, 1993). When the planting density exceeds the optimum level, competition among the plants for light and nutrients becomes severe. Consequently, the growth slows down and the grain yield decreases. 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). For this, it is very much necessary to maintain the optimum density for better rice yield.

Materials and Methods

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) farm Mymensingh, Bangladesh, during July to December, 2010 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 spacing treatment in the sub plot. The experiment was carried out with four aromatic fine rice (V_1= BRRI dhan34, V_2= Ukunimadhu , V_3= Basmati370 and V_4= Kataribhog) and four different plant spacing (S_1= 15cm×15cm , S_2= 20cm × 15cm, S_3= 20cm × 20cm, S_4= 20cm × 25cm). 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, 2010 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, 2010 was 42.01(cm) , 36.04(cm), 22.8(cm), 3.03(cm), Trce and 00.00(cm)**,** respectively. Only the selected healthy seedlings were transplanted according to the treatments in the well-puddled experimental plots on 20 August 2010. Spacings were 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 plots 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).

Results and Discussion

Effect of growth parameters

At 30 DAT, the highest plant height (81.8 cm) was in V_2 which was statistically identical with V_1 at 30 DAT. Moreover, the lowest value (70.9cm) was found in V_3. At 60 DAT, the highest plant height (110.2 cm) was observed in V_2 and the lowest (89.5 cm) was found in V_3. Again at 90 DAT the maximum plant height (131.2 cm) was found in V_1 and the lowest plant height (94.0 cm) was recorded from V_3. At 30 DAT the tallest plant (76.1 cm) was recorded in S_3. At the same DAT, the lowest plant height value (72.6cm) was obtained from S_1. However, at 60 DAT, S_1 showed the highest plant height (101.3 cm) and the lowest plant height was (93.0 cm) in S_2. At 90 DAT, S_2 showed the highest plant height (120.2 cm) and the lowest plant height was (113.9 cm) in S_4. The highest plant height (87.6cm), (116.ocm) and (144.0 cm) were produced by $V_2 \times S_3$, $V_2 \times S_1$, and $V_1 \times S_4$ at 30 DAT, 60 DAT and 90 DAT, respectively. The lowest value (66.0 cm, 82.0 cm and 86.3 cm) were recorded from V_3 under S_2 and S_1 at 30 DAT, 60 DAT and 90 DAT (Table 2). The highest total dry matter (9.2 $ghill^{-1}$, 26.7 g $hill^{-1}$, and 31.6 g $hill^{-1}$) were found in V_3, V_2 and V_3 at 30 DAT, 60 DAT and 90 DAT respectively, which, were statistically identical. The lowest values (6.7 g $hill^{-1}$, 17.8 g $hill^{-1}$ and 27.4 g $hill^{-1}$) were observed in V_2 and V_1 at 30 DAT, 60 DAT and 90 DAT respectively, which were also statistically identical. The highest total dry matter (9.6 g $hill^{-1}$, 27.7 g $hill^{-1}$ and 32.4 g $hill^{-1}$) were found in S_4 at 30 DAT, 60 DAT and 90 DAT respectively, which, were statistically identical. The lowest values (7.0 g $hill^{-1}$, 21.1 g $hill^{-1}$ and 26.1 g $hill^{-1}$) were observed in S_2, S_1 at 30 DAT, 60 DAT and 90 DAT respectively (Table1). The highest total dry matter (10.5 g $hill^{-1}$, 32.1 g $hill^{-1}$ and 35.9 g hill-^{1}) were observed in V_4 and V_2 under S_4 at

30 DAT, 60 DAT and 90 DAT respectively, which, were statistically identical. The lowest total dry matter (4.1 g hill^{-1}, 12.7 g hill^{-1} and 22.1 g hill^{-1}) were found in V_3, V_1 and V_3 under S_1, S_4 and S_1 at 30 DAT, 60 DAT and 90 DAT respectively (Table 2). The highest Chlorophyll contains leaf^{1} (40.9 SPAD value, 36.5 SPAD value and 36.6 SPAD value) were found in V_4, V_2 and V_4 at 30 DAT, 60 DAT and 90 DAT respectively, which, were statistically identical. The lowest values (37.9 SPAD value, 34.5 SPAD value and 34.1 SPAD value) were observed in V_1, V_4 and V_3 at 30 DAT, 60 DAT and 90 DAT, respectively, which, were also statistically similar (Fig.1). At 30 DAT, the highest Chlorophyll content leaf^{1} (41.5 SPAD value) was found under S_4. The lowest Chlorophyll content leaf^{1} (38.7 SPAD value) was in S_1. In case of 60 DAT, spacing S_4 showed the Chlorophyll content leaf^{1} (38.1 SPAD value) and the lowest value (34.5 SPAD value) was found in S_3. However, At 90 DAT, the highest Chlorophyll contain leaf^{1} (37.4 SPAD value) was found in S_4 and the lowest Chlorophyll content leaf^{1} was (34.5 SPAD value) found in S_3 (Fig.2) The highest Chlorophyll contain leaf^{1} (43.1 SPAD value), (40.9 SPAD value) and (38.9 SPAD value) were observed in V_2,V_3 and V_1 under S_4 at 30 DAT, 60 DAT and 90 DAT respectively, which, were statistically identical. The lowest Chlorophyll contain leaf^{1} (36.2 SPAD value), (30.7 SPAD value) and (31.6 SPAD value) were found in V_1 under S_1 at 30 DAT, 60 DAT and 90 DAT respectively (Table 2).V_4 gave the highest leaf area hill^{-1} (583.2 cm^2), which, was statistically identical with V_3 at 30 DAT. The lowest value (366.1 cm^2) was recorded from V_2 (Table 1). It could be seen that at 60 DAT, the highest leaf area hill^{-1} (2097.5 cm^2) was produced by V_1 and the lowest leaf area hill^{-1} (1503.0 cm^2) was produced by V_2 which, was statistically identical to V_3. At 90 DAT, the highest leaf area hill^{-1} (1021.5cm^2) was found in V_4 and the lowest (754.9 cm^2) was observed in V_1. At 30DAT, the highest leaf area hill^{-1} (628.0cm^2) was observed in S_4 applied plots and the lowest leaf area hill-^{1} (404.0 cm^2) was recorded in S_2 applied plots. At 60 DAT, the highest leaf area hill^{-1} (19790.0cm^2) was found in S_4 applied plots and the lowest (1544.6cm^2) was observed in S_1 applied plots. At 90 DAT, the highest leaf area hill^{-1} (982.2cm^2) was found in S_2 applied plots and the lowest leaf area hill^{-1} (714.4 cm^2) was found in S_1 applied plots. It was observed that at 30 DAT, the highest leaf area hill^{-1} was (684.7cm2) produced in $V_4 \times S_4$. The lowest leaf area hill^{-1} (278.3cm^2) was found in $V_1 \times S_2$. At 60 DAT, the maximum leaf area hill^{-1} (2408.3cm^2) was found in $V_1 \times S_4$ and $V_3 \times S_1$ gave the lowest leaf area hill^{-1} (1276.6 cm^2). At 90 DAT, $V_4 \times S_2$ produced the highest leaf area hill^{-1} (1306.3 cm^2), which, was statistically identical to $V_1 \times S_4$ and the lowest (435.2 cm^2) recorded in $V_1 \times S_1$ (Table 2).

Effect of yield and yield contributing characters

The highest plant height (150.33cm) was obtained by V_2 followed by V_4 (130.00cm). The wider spacing S_3 produced shortest plant (124.25cm) than closer S_1 spacing (125.58) (Table 3). On the other hand, interaction showed (Table 4) the highest plant height (133.00, 154.66, 100.33 and 131.66cm) were produced by $V_1 \times S_2$, $V_2 \times S_2$, $V_3 \times S_4$ and $V_4 \times S_1$, respectively. Among the varieties, V_1, V_2 and V_4 produced maximum number of effective tillers hill^{-1} (10.75, 10.25 and 9.66) which, was identical and V_3 produced the lowest number of effective tillers hill^{-1} (6.25) (Table 3). Among the spacing S_2 produced the highest number of effective tillers hill^{-1} (10.58) followed by S_3 (9.41) and wider spacing,S_4 (7.66) (Table 3). Combined effect showed that S_2 produced the highest number of effective tillers hill^{-1} (12.00) by V_1 and V_2. The lowest effective tillers hill^{-1} was found in (5.00) $V_3 \times S_4$ (Table 4).Numerically the highest non-effective tillers hill^{-1} (4.75) was observed in V_3 and the lowest non effective tillers hill^{-1} V_4, which, was 1.16. The highest number of non-effective tillers hill^{-1} (4.25) was obtained from S_4 spacing which, was followed by S_3 spacing (2.17). The lowest number of non -effective tillers hill^{-1} (1.75) was observed in S_1 spacing (Table 3). The highest number of non-effective tiller (11.00 was found in $V_3 \times S_4$ interaction and the lowest number of non-effective tillers hill^{-1} was found in (0.67) $V_4 \times S_2$ (Table 4). Among the varieties V_1, V_2 and V_4 Produced number of grains panicle^{-1} (86.63, 95.08, and 82.08), which, was identical and V_3 produced the lowest number of grains panicle^{-1}(69.16)(Table 3). Among the spacing S_2 produced the highest number of grains panicle^{-1} (104.25) followed by spacing, S_3 (91.00). The lowest number of grain panicle^{-1} (64.08) was obtained from S_4 spacing, which was statistically identical (73.63) to S_1 spacing (Table 3). The highest number of grains panicle^{-1} (140.0) was obtained from $V_1 \times S_2$ interaction and the lowest number of grains panicle^{-1} was obtained from (45.00) $V_1 \times S_4$ interaction (Table 4).The highest number of unfilled grains panicle^{-1} (39.25) was obtained by V_1 followed by V_4 (38.16). The lowest number of unfilled spikelets panicle^{-1} was found in V_3 (34.08)(Table3). In wider spacing S_2, the highest number of unfilled spikelets panicle^{-1} (38.66) was obtained from S_2.The lowest number of unfilled spikelets panicle^{-1}(34.16) was obtained from S_4 spacing which, was statistically identical (35.83) to S_3 spacing. (Table 3). The highest number of unfilled spikelets panicle^{-1} (47.33) was obtained from $V_3 \times S_2$ spacing, which, was statistically identical (45.66) to $V_1 \times S_2$, and the lowest number of unfilled spikelets panicle^{-1} was obtained from (27.00) $V_2 \times S_2$, interaction (Table 4).

Grain yield was obtained highest (3.43 t ha^{-1}) by V_4 (3.41 t ha^{-1}) by V_3 and (3.31 t ha^{-1}) by V_2 (2.95 t ha^{-1}), which, was statically identical. The lowest grain yield (2.55 t ha^{-1}) was obtained from V_1 (Table 3). The grain yield was obtained 2.98 t ha^{-1} 3.64 t ha^{-1}, 3.25 t ha^{-1} and 2.82 t ha^{-1} for S_1, S_2, S_3 and S_4, respectively (Table 3). Interaction effect showed that, in the S_2 spacing, V_1, V_2, V_3 and V_4 produced higher grain yield of 2.96 t ha^{-1}, 2.97 t ha^{-1}, 3.76 t ha^{-1} and 4.10 t ha^{-1} and 4.10 t ha^{-1}, respectively (Fig.3). Amir *et al.* (1984) stated that the highest grain yield was obtained at 20 cm × 20cm spacing. This result is similar to that of Kaven Limochi (2013), Hasanuzzamam *et. al*., (2009) Salahuddin *et al*., (2009) and Gautam *et al., (*2008). Same variations was also reported in the research findings of Bozorgi *et al*., (2011) the result showed that interaction level of 20cm × 20cm and 3 seedlings hill^{-1} was the highest grain yield. Uddin *et al*., (2011) also reported that among the spacings 15cm× 20cm performed better for grain yield. Mondal *et al.,(*2013) the results showed that the spacing of 20cm × 20cm may be recommended for cultivation of high yielding modern instead of recommended spacing of 20cm × 15cm. This result is similar to that of Rasool *et al*., (2013). On the basis of these results, it is concluded that the spacing of 20cm × 15cm and 20cm × 20cm between hills and rows most suitable for obtaining optimum grain yield in the rice crop. The higher straw yield of 5.34 t ha^{-1} was obtained in V_1 and the lower straw yield of 4.99 t ha^{-1} in V_3 (Table 3). The highest straw yield of 5.60 t ha^{-1} was obtained in S_1, spacing and the lowest (4.90 t ha^{-1}) in S_4 spacing (Table 3) The highest straw yield was obtained 5.80 t ha^{-1} in $V_1 \times S_1$ and the lowest 4.50 t ha^{-1} in $V_3 \times S_4$ (Table 4). Harvest index of (32.31%) was obtained by V_1 (38.24%) by V_2, (34.62%) by V_3 and (39.33%) by V_4 (Table 3) and S_2 spacing showed the highest harvest index (40.85%) and S_1 spacing obtained the lowest harvest index (34.73%) (Table 3) Interaction of variety with spacing showed higher harvest index in S_2 by all varieties (39.36%, 33.78%, 46.56 and 43.40% by V_1, V_2, V_3 and V_4 respectively except $V_3 \times S_3$ (Table 4). Higher value of harvest index in S_2 spacing might be due to the contribution of higher grain yield by different varieties.

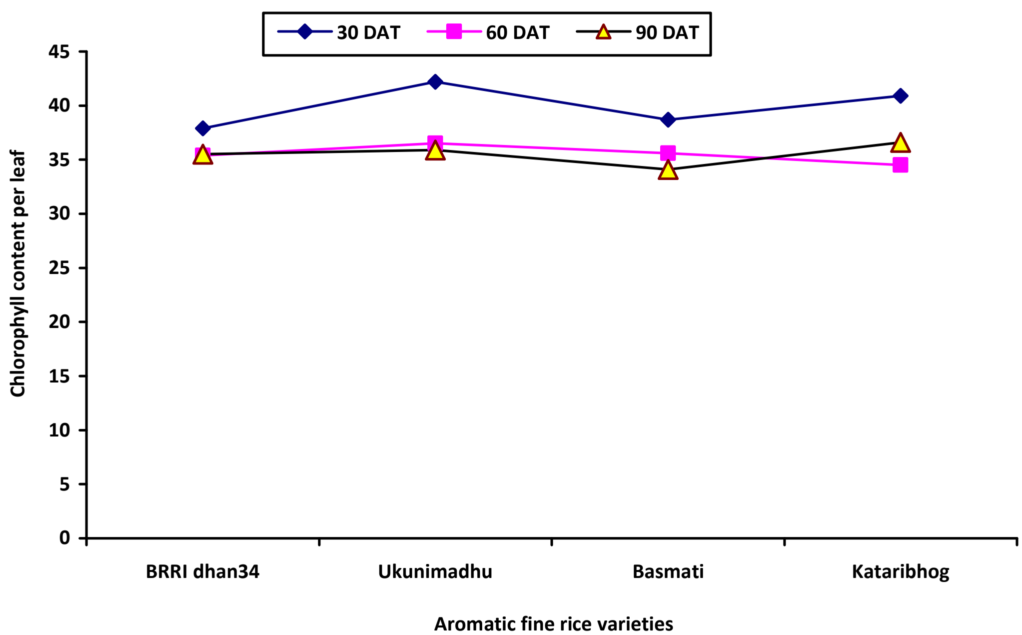

Fig. 1 Effect of aromatic fine rice varieties on Chlorophyll content leaf^{-1}

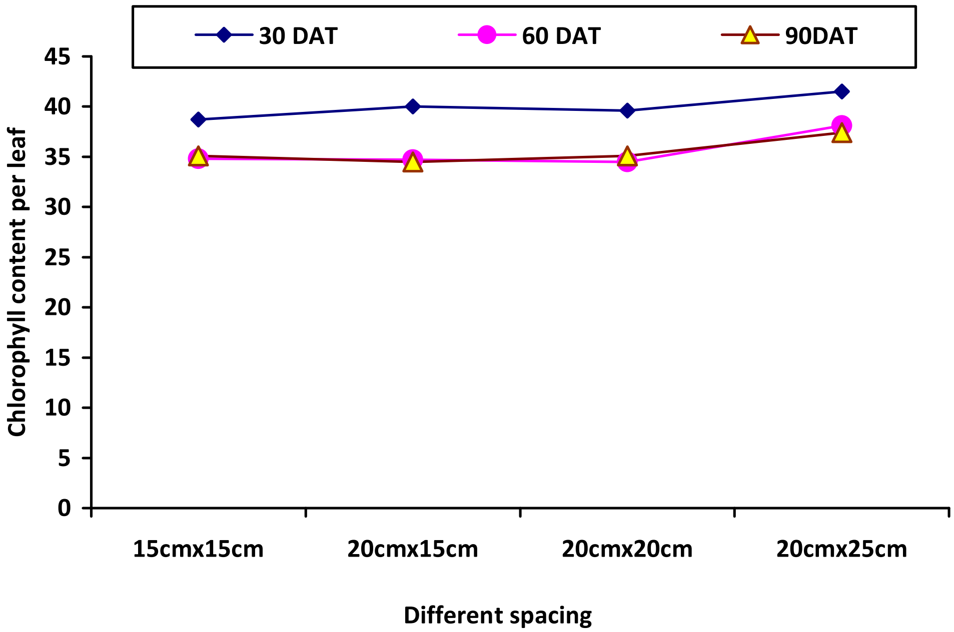

Fig. 2 Effect of different spacing on Chlorophyll content leaf^{-1}

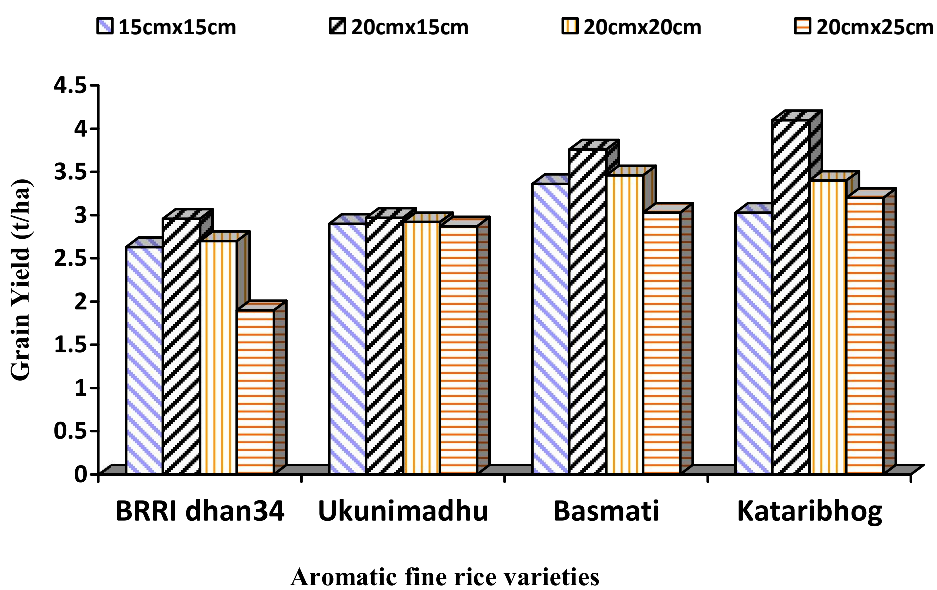

Fig 3. Combined effect of variety and spacing on the grain yield of aromatic fine rice in rainfed condition

Table 1. Effect of varieties and spacing on the growth contributing characters of aromatic fine rice in rainfed season

Treatments	Plant height(cm)			TDM(g) hill^{-1}			Leaf area hill^{-1}		
Variety	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT
V_1	72.7	97.2	131.2a	7.4	17.5	27.4	482.0	2097.5	754.9
V_2	81.8	110.2	121.8a	6.7	17.8	31.2	366.1	1503.0	848.8
V_3	70.9	89.5	94.0b	9.2	23.2	31.6	574.7	1637.6	969.3
V_4	72.8	95.4	118.5a	8.6	26.7	29.3b	583.2	1846.0	1021.5
$LSD_{0.05}$	8.278	1.802	14.49	1.357	3.372	2.846	91.55	399.8	118.6
Spacing									
S_1	72.6	101.3	115.2	7.4	21.1	26.0	483.5	1544.6	714.4
S_2	72.9	93.0	120.2	7.0	23.6	30.4	404.0	1636.6	982.2
S_3	76.1	98.4	116.1	7.8	23.2	30.7	490.6	1924.0	968.5
S_4	76.0	99.5	113.9	9.6	27.7	32.4	628.0	1979.0	929.3
$LSD_{0.05}$	NS	1.747	NS	0.724	2.672	4.389	46.96	259.3	172.1
CV(%)	7.04	1.56	5.46	7.91	9.78	12.84	8.2	12.82	16.77

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.
V_1=BRRI dhan34,V_2=Ukunimadhu,V_3=Basmati,V_4=Kataribhog
S_1=15cm×15cm,S_2=20cm×15cm,S_3=20cm×20cm,S_4=20cm×25cm

Table 2. Combined effect of varieties and spacing on the growth contributing characters aromatic finerice in rainfed condition

Treatments	Plant height(cm)			TDM(g) hill^{-1}			Chlorophyll **content** leaf^{-1}			Leaf area hill^{-1}		
Interaction (Variety x spacing)	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT
V_1S_1	68.3	97.3	123.3	9.2	15.6	22.1	36.2	30.7	31.6	561.5	1944.3	435.2
V_1S_2	71.3	95.3	126.3	4.5	17.8	28.6	37.1	35.6	34.1	278.3	1949.6	617.3
V_1S_3	74.0	99.3	131.3	7.6	14.0	30.7	36.4	34.5	37.9	469.1	2088.0	726.7
V_1S_4	77.3	97.0	144.0	8.2	12.7	28.4	41.9	40.7	38.9	619.4	2408.3	1240.7
V_2S_1	80.6	116.0	132.0	8.2	22.4	30.5	41.7	36.3	35.7	298.0	1390.0	1086.1
V_2S_2	80.0	107.3	140.3	10.0	23.5	26.8	42.3	32.6	32.8	298.1	1582.3	806.3
V_2S_3	87.6	106.0	107.6	8.7	25.1	33.2	41.7	35.2	33.9	312.2	1788.6	1211.
V_2S_4	79.0	111.6	107.3	9.9	24.8	35.9	43.1	38.3	34.2	556.4	1789.6	773.2
V_3S_1	67.6	96.6	86.3	4.1	14.3	26.8	38.0	35.2	36.5	547.3	1276.6	606.6
V_3S_2	66.6	82.0	95.0	5.9	14.7	33.9	37.4	36.1	35.1	547.9	1338.3	1189.0
V_3S_3	70.6	89.6	98.3	9.7	18.1	28.3	37.8	33.9	33.6	536.8	1799.3	692.3
V_3S_4	77.3	90.6	96.3	9.7	22.1	35.6	41.7	40.9	38.4	563.1	1598.0	907.2
V_4S_1	74.0	96.3	119.3	8.3	21.9	24.7	39.0	37.0	36.5	527.2	1567.6	729.9
V_4S_2	73.6	87.6	119.3	7.6	25.3	32.3	43.1	34.1	36.2	502.9	1676.3	1316.3
V_4S_3	72.3	98.6	127.3	7.9	27.6	30.5	42.4	34.3	35.5	618.0	2020.0	1243.6
V_4S_4	71.3	99.0	108.0	10.5	32.1	29.8	39.2	32.4	38.2	684.7	2120.3	796.2
$LSD_{0.05}$	NS	3.493	20.85	1.448	NS	NS	3.018	5.015	3.904	93.93	518.5	344.2
CV(%)	7.04	1.56	5.46	7.91	9.78	12.84	3.31	6.18	4.81	8.2	12.82	16.77

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.
V_1=BRRI dhan34, V_2=Ukunimadhu, V_3=Basmati, V_4=Kataribhog,
S_1=15cm×15cm, S_2=20cm×15cm, S_3=20cm×20cm, S_4=20cm×25cm

Table 3. Effect of variety and spacing on the of yield and yield contributing characters of aromatic fine rice in rainfed 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.)	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Harvest index (%)
V_1	129.66	10.75	3.50	86.63	39.25	2.55	5.34	32.31
V_2	150.33	10.25	1.83	95.08	35.66	2.95	5.57	34.62
V_3	95.75	6.25	4.75	69.16	34.08	3.41	4.99	40.59
V_4	130.00	9.66	1.16	82.08	38.16	3.43	5.29	39.33
$LSD_{0.05}$	8.185	3.233	0.547	NS	NS	0.4749	NS	3.694
Spacing								
S_1	125.58	9.25	1.75	73.63	38.50	2.98	5.60	34.73
S_2	128.16	10.58	2.17	104.25	38.66	3.64	5.27	40.85
S_3	124.25	9.41	2.17	91.00	35.83	3.25	5.05	39.15
S_4	127.75	7.66	4.25	64.08	34.16	2.82	4.90	36.52
$LSD_{0.05}$	NS	1.369	NS	16.55	NS	0.4481	0.3787	4.234
CV(%)	3.91	17.60	95.75	17.41	13.76	12.36	6.38	10.06

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.
V_1=BRRIdhan34, V_2=Ukunimadhu, V_3=Basmati, V_4=Kataribhog,
S_1=15cm×15cm, S_2=20cm×15cm, S_3=20cm×20cm, S_4=20cm×25cm

Table 4. Combined effect of variety and spacing on the yield and yield contributing characters of aromatic fine rice rainfed condition

Interaction (V xS)	Plant height (cm)	Effective tillers hill^{-1} (No.)	Non-effective tillers hill^{-1} (No.)	Grains panicle^{-1} (No.)	Unfilled spikelets panicle^{-1} (No.)	Straw yield (tha^{-1})	Harvest index (%)
V_1S_1	128.33	11.00	2.00	66.53	45.66	5.80	31.19
V_1S_2	133.00	12.00	2.00	145.00	42.33	5.53	34.86
V_1S_3	124.66	11.00	3.00	90.00	39.00	5.00	35.06
V_1S_4	132.66	9.00	7.00	45.00	30.00	5.03	27.29
V_2S_1	145.00	10.00	3.00	86.00	38.00	5.33	35.23
V_2S_2	154.66	12.00	1.00	109.00	27.00	5.82	33.78
V_2S_3	152.00	11.00	2.33	107.00	37.33	5.87	33.21
V_2S_4	149.66	8.00	1.00	78.33	40.33	5.36	34.91
V_3 S_1	97.33	6.00	1.00	71.00	29.00	5.63	37.37
V_3 S_2	95.33	8.00	5.00	72.66	47.33	5.16	42.15
V_3 S_3	90.00	6.00	2.00	72.00	30.00	4.66	42.61
V_3 S_4	100.33	5.00	11.00	61.00	30.00	4.50	40.23
V_4S_1	131.66	10.00	1.00	71.00	41.33	5.63	34.98
V_4S_2	129.66	10.33	0.67	90.33	38.00	5.33	43.47
V_4S_3	130.33	9.66	1.33	95.00	37.00	5.16	39.71
V_4S_4	128.33	8.66	1.66	72.00	36.33	5.03	38.82
$LSD_{0.05}$	-	-	-	33.09	11.56	-	6.249
CV(%)	3.91	17.60	95.75	17.41	13.76	6.38	10.06

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.
V_1=BRRIdhan34,V_2=Ukunimadhu,V_3=Basmati,V_4=Kataribhog,
S_1=15cm×15cm,S_2=20cm×15cm,S_3=20cm×20cm,S_4=20cm×25cm

Conclusion

It could be concluded that Ukunimadhu, Basmati and Kataribhog performed better in most of the trails based on grain yield, straw yield, number of effective tillers hill^{-1} and number of grains panicle^{-1}. However plants at medium spacing 20 cm×15 cm and 20 cm × 20cm gave more number of effective tillers hill^{-1} and more number of grains panicle^{-1} and ultimately produced the highest grain yield. Among the combination of aromatic fine rice variety and spacing, Ukunimadhu, Basmati and Kataribhog produced higher grain yield at spacing of 20 cm×15 cm and 20 cm × 20cm. So, Ukunimadhu, Basmati and Kataribhog with medium spacing 20 cm×15 cm and 20 cm × 20cm.can be suggested as profitable growing in rain-fed condition of Bangladesh.

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