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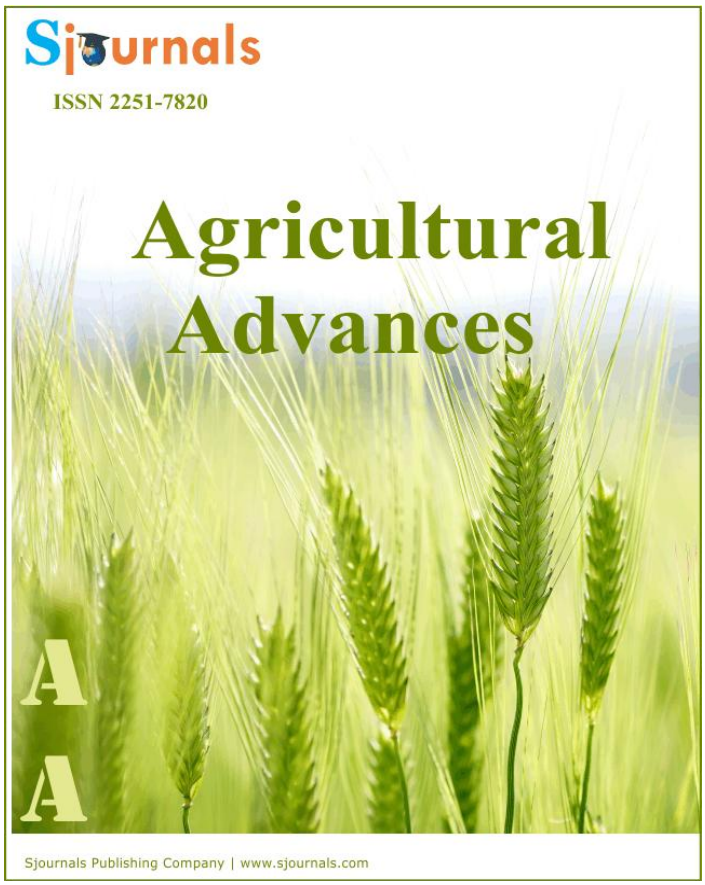

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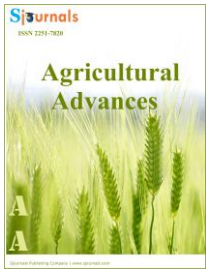

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Original article

Effect of planting geometry on yield and yield attributes of aromatic rice genotypes

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ABSTRACT

To evaluate the effects of plant spacing on the growth and yield of aromatic rice varieties, a field experiment was carried out at the Agronomy Filed Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh during aman season. Four plant spacings viz. 25cm x 25cm (S_1), 20cm x 20cm (S_2), 20cm x 15 cm (S_3) and 15 cm x 10cm (S_4) and four fine rice varieties viz. Basmoti 370 (V_1), BRRI dhan37 (V_2), BRRI dhan38 (V_3) and Kailijira (V_4) were used. As factorial arrangement the experiment was fitted in a randomized complete block design with three replications. All agronomic practices were applied as recommended for each cultivar. The result revealed that the BRRI dhan38 produced the highest 1000-grain weight (19.05g) as well as yield (3.62 t ha^{-1}). Oppositely, the V_2 produced the maximum tillers $hill^{-1}$ (11.7), effective tillers $hill^{-1}$ (9.5) but the poorest 1000 grain weight (14.81g) compared to V_3 resulting in the second highest grain yield (3.30 t ha^{-1}). The highest number of spikelets $panicle^{-1}$ (175.0), grain panicle-1 (126.6) and sterile spikelets (48.6) but the lowest number of effective tillers $hill^{-1}$ (7.4) and minimum 1000 grain weight (10.25g) were recorded at Kailijira (V4) resulting

the lowest grain yield (2.27 t ha^{-1}) at Kailijira. The results that the widest spacing S_1 produced the tallest plant stature (147.5cm), the highest number of tillers $hill^{-1}$ (14.0), effective tillers $hill^{-1}$ (11.0), total spikelets $panicle^{-1}$ (124.2), filled grain $panicle^{-1}$ (102.0) while the lowest number of sterile spikelets (22.4). In terms of m^{-2} basis, all the characteristics were lowered compared to the spacing of 20cm x 15 cm resulting in the lowest grain yield (2.66 t ha^{-1}). The variety BRRI dhan38 at the spacing of 20cm x 15cm produced significantly the highest grain yield (4.27 t ha-1) and the second highest grain yield was (4.00 t ha-1) recorded in BRRI dhan37 with the same spacing.

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1. Introduction

Bangladesh is an agro-based country. Agroecological conditions of Bangladesh are favorable for rice cultivation. Globally, rice is the second most important crop next to wheat in terms of area but as food rice is number one as it provides more calorie than any other cereals. Among the top rice producing countries, the position of Bangladesh is the six next to China, India, Indonesia, Vietnam and Thailand (FAOSTAT, 2016). The FAO statistics show that Bangladesh is in fourth position with annual rice consumption per head (160 kilograms) after Brunei Darussalam (245 kilograms), Vietnam (166 kilograms) and Laos (163 kilograms) (FAOSTAT, 2016). At present, farmers are growing high yielding coarse grain varieties to meet up their demand instead of fine rice. The aromatic fine quality rice has more demand both in internal and external markets (Sood, 1978). These varieties are the highly valued rice commodity in Bangladesh agricultural trade market due to having small grain, pleasant aroma and soft texture upon cooking (Dutta et al., 1998). Aromatic rice is used in many ways like polau, biriani, khir, finny, jarda etc. Its export can bring a considerable amount of foreign exchange for the nation.

A number of fine rice cultivars are grown by the farmers but many of them are not known to have been studied to their yield and yield contributing attributes. Such commonly grown fine rice cultivars as Kalijira, Bashmoti-370, BRRI dhan37 and BRRI dhan38 require detailed study for their different agronomic traits and for worth information regarding yield and possibilities for varietal improvement. About 11.42 million hectares of land were used for rice cultivation in 2014-2015, producing 34.86 million metric tons among which transplanted aman rice covered 5.53 million ha with a yield of 2.38 t ha^{-1} which is also lower than the national average (3.05 t ha^{-1}) (AIS, 2016), much below the potential yield level compared to other leading rice growing countries. The lower yield of transplanted aman rice has been attributed to several reasons, one of them being improper population density, which is vital as optimum plant population can increase rice yield by 61% (Islam et al., 1994). The yield and yield components of rice are greatly influenced by plant spacing (Khalil, 2001; Islam et al., 2008). Miah et al. (1990) opined that optimum plant spacing ensures the plants to grow properly with their aerial and underground parts utilizing more solar radiation, water and nutrients. It is also reported that plants compete severely for light in above ground parts and for nutrients in below the ground parts when the planting densities exceed the optimum level and consequently the plant growth slows down and the grain yield decreases (Islam et al., 2008). Therefore, selection of potential variety and optimum planting geometry can play an important role to increase yield. A large number of experiments have so far been carried out throughout the world to find out the optimum planting geometry in rice. However, sufficient research works have not yet been done on different plant density, especially with modern and local aromatic *aman* rice varieties in Bangladesh. Therefore, the present piece of research work was undertaken to select the potential fine rice varieties and to find out optimum planting density for obtaining maximum yield under Mymensingh-a famed area for growing aromatic rice in Bangladesh.

2. Materials and methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during Aman season. Geographically, the experimental area is located at 24^{o} 75` N to $90^{o}$ 50` E and is

characterized by Non-Calcareous Dark Grey Floodplain soil belonging to the Old Brahmaputra Floodplain (FAO and UNDP, 1988). The experimental field was slightly loamy with a pH of 6.32 and having 0.10 and 1.78 % of total nitrogen and organic matter contents, respectively.

The experiment consisted of our fine rice varieties viz. Basmoti 370 (V_1), BRRI dhan37 (V_2), BRRI dhan38 (V_3) and Kailijira (V_4) coupled with four spacings viz. 25cm x 25cm (S_1), 20cm x 20cm (S_2), 20cm x 15 cm (S_3) and 15 cm x 10cm (S_4). The experiment followed a randomized complete block design (RCBD) with three replications and it laid out following unit plot size of 3m x 3m. The experimental field was puddle as necessary to obtain a desirable tilth and fertilized the plots at the rate of 120, 100, 70, 60, and 10 kg ha^{-1} of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. All fertilizers except urea were applied at the time of final land preparation and urea was top-dressed into three equal splits each at 15, 30 and 45 days after transplanting (DAT). Thirty (30) days old seedlings were uprooted carefully and transplanted in the experimental plots using three seedlings per hill. All intercultural operations were done as necessary. Five hills were randomly selected at maturity (when 80% of the grains became golden yellow) and uprooted from each unit plot prior to harvest for recording data. The grains were threshed, cleaned and sun dried (adjusted to 12% moisture content) to record grain yield $plot^{-1}$. Straws were also sun-dried to record its yield $plot^{-1}$ and both grain and straw yields $plot^{-1}$ were then converted to t ha^{-1}.

The recorded data of different parameters were tabulated in proper form for statistical analysis and analysed with the help of computer package MSTAT. The Analysis of Variance and mean differences among the treatments were tested with Duncan's Multiple Range Test (Gomez and Gomez, 1984).

3. Results and discussion

3.1. Performance of varieties for yield and yield attributes

3.1.1. Plant height

The table 1 shows that V_1 produced the tallest plant stature (147.50 cm) followed by V_2 (140.8cm) and V_4 (140.5cm). The shortest plant stature was in V_3 (137.33 cm). The V_2 and V_4 were statistically identical, but significantly different with V_1 and V_3. This confirms the report of Hossain et al. (1991) and BINA (1993) that plant height differed from variety to variety. Plant height was greatly influenced by different varieties possibly due to the reason that the height of the plant is a varietal trait which is primarily influenced by genetic make up.

3.1.2. Total number of tillers $hill^{-1}$

The rice varieties did not influence the total number of tillers $hill^{-1}$ in this experiment. The variety V2 produced the maximum mean values of number of tillers $hill^{-1}$ (11.7) while that was minimum (9.7) in the variety V4 (Table 1). Similar results were also obtained for the total number of tillers $hill^{-1}$ by BINA (1993).

3.1.3. Number of effective tillers $hill^{-1}$

The rice varieties significantly influenced the number of effective tillers $hill^{-1}$ (Table 1). The variety V_2 produced the maximum number of effective tillers $hill^{-1}$ (9.5). On the other hand, V_4 produced the minimum (7.4). Both V_3 and V_1 produced medium number of effective tillers $hill^{-1}$ (8.8 and 8.3, respectively) that was statistically identical to each other. The probable reason of variation in producing the number of effective tillers $hill^{-1}$ is the genetic make up of the varieties which are primarily influenced by heredity. These results were in agreement with the findings of BINA (1993) in which rice varieties significantly influenced for the number of effective tillers $hill^{-1}$.

3.1.4. Number of non- effective tillers $hill^{-1}$

Varieties did not influence statistically on the number of non-effective tillers $hill^{-1}$ (Table 1). However, there was a small numerical variation (2.5-2.2) among varieties.

3.1.5. Panicle length

Highly significant variation on panicle length was observed due to variety and V_4 produced the longest panicle (25.6cm). On the contrary, the shortest panicle (22.1cm) was observed in V_3. The variety V_1 produced the intermediate length of panicle (25.2cm) followed by V_2 (24.5cm). The probable reason of variation in producing the

panicle length is the genetic make up of the varieties, which is primarily influenced by heredity. The result was in agreement with the findings of Eunus and Sadeque (1975) and Tsai (1987).

3.1.6. Total spikelet panicle^{-1}

It was observed that highly significant variation on total spikelets panicle^{-1} due to the effect of variety. The V_4 variety significantly produced the highest number of spikelets panicle^{-1} (175.0). The V_2 variety provided higher number of spikelets panicle^{-1} (100.5) compared to V_3 and V_1 but these two varieties differed significantly from each other (Table 1). The findings are in agreement with the results of Hossain et al. (1991) who found that rice varieties statistically influenced on the number of grain panicle^{-1}. The probable reason of variation in producing the total spikelets panicle^{-1} is longest panicle length which is primarily influenced by heredity. These results were in agreement with the findings of BINA (1993).

Table 1
Effects of variety on yield and yield attributes of four fine rice varieties.

Treat-ments Variey	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillershill^{-1}	Panicle length (cm)	Total spikelet panicle^{-1}	Filled grain panicle^{-1}	Non filled grain panicle^{-1}	1000 grain wt. (g)	Grain yield tha^{-1}
V_1	147.5a	10.5	8.3b	2.2	25.2ab	77.0d	62.2c	14.8c	16.49b	2.59c
V_2	140.8b	11.7	9.5a	2.5	24.5b	100.5b	81.1b	19.5b	14.81c	3.30b
V_3	137.3c	11.3	8.8b	2.5	22.1c	95.7bc	78.2b	17.5b	19.05a	3.62a
V_4	140.5b	9.7	7.4c	2.3	25.6a	175.0a	126.6a	48.6a	10.25d	2.27d
F-test	**	NS	**	NS	**	**	**	**	**	**
Sx	0.92	0.43	0.20	0.28	0.29	1.12	0.83	0.98	0.48	0.04

In a column figures having similar letter(s) do not differ significantly whereas figures having dissimilar letter(s) differ significantly as per DMRT. NS = Not Significant, and ** = Significant at 1% level. LEGEND: V_1= Bashmoti 370, V_2= BRRI dhan37, V_3= BRRI dhan38, V_4= Kalijira.

3.1.7. Number of grains panicle^{-1}

Number of grains panicle^{-1} was highly significant due to the effect of variety. V_4 produced significantly the highest number of grains panicle^{-1} (126.6). Oppositely V_1 produced the lowest number (62.2) of grains panicle^{-1}. V_2 exhibited slightly higher number of grains panicle^{-1} (81.1) than V_3 but statistically dissimilar with V_4. Hossain et al. (1991) observed also varietal variation in number of grains panicle^{-1}.

3.1.8. Number of sterile spikelets panicle^{-1}

The effect of variety was statistically significant in respect of the number of sterile spikelets panicle^{-1}. V_4 produced the highest number of sterile spikelets panicle^{-1} (48.6) but V_1 produced the lowest number of sterile spikelets panicle^{-1} (14.8), which was statistically different from V_2 and V_3 (Table 1). Sterile spikelets panicle^{-1} was higher in V_2 as compared to V_3. This result was in partial agreement with the findings of BINA (1993). This was perhaps due to varietal character, which is primarily influenced by genetic constitution, especially lodging character of V_4.

3.1.9. 1000-grain weight (g)

It was observed that 1000-grain weight was highly significant due to variety. The variety V_3 produced the highest 1000-grain weight (19.05 g) followed by V_1 (16.49g) and V_2 (14.81g) and the lowest was produced in V_4 (10.25g). It might be due to varietal variation, which is primarily influenced by heredity. Similar result was also found by Chowdhury and Ghosh (1978) who reported that 1000- grain weight was highly variable, ranging from 9.0~23.09 (g).

3.1.10. Grain yield

Grain yield mainly depends on the yield contributing characters like number of effective tiller per unit area, number of spikelets panicle^{-1}, grains panicle^{-1} and weight of individual grains. The results revealed that the grain yields were significantly varied among the varieties. Statistically the highest grain yield (3.62 t ha^{-1}) was recorded at the variety BRRI dhan38 the lowest (2.27 t ha^{-1}) was obtained from the variety Kalijira (Table 1). This result was in

agreement with the findings of Ahmed (1987) and Alam (1988), EL Sabagh et al. (2015) and Anis et al. (2016) who reported that a variety could give high yield even with finer grain size if there would be genetic potentiality. The probable reasons for variation in yield were due to the inheritance of the variety.

3.2. Effects of spacing on yield and yield attribute

3.2.1. Plant height

It was observed that wider spacing S_1 produced the tallest plant stature (147.50 cm) followed by S_2 and S_3. The closest spacing S_4 produced the shortest plant stature (135.3 cm). It might be due to the fact that widely spaced plants absorb more light, air and food materials which facilitated the plant to develop fully. Similar results were also reported by Kanda and Kalra (1986) and Shahi et al. (1976).

Table 2
Effects of spacing on yield and yield attributes of four fine rice varieties.

Treat-ments (Spacings)	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non effective tillershill^{-1}	Panicle length (cm)	Total spikelet panicle^{-1}	Filled grain panicle^{-1}	Non filled grain panicle^{-1}	1000 grain wt. (g)	Grain yield (tha^{-1})
S_1	147.5a	14.0a	11.0a	3.0a	25.8a	124.2a	102.0a	22.2c	15.71	2.66d
S_2	143.3b	11.5b	9.0b	2.5b	25.0b	116.6b	91.8b	24.8b	15.42	2.94b
S_3	140.0c	11.1c	8.9b	2.2c	24.1c	113.5b	87.8c	25.7b	14.96	3.60a
S_4	135.3d	6.5d	5.0c	1.8d	22.6d	94.0c	62.4d	31.6a	14.56	2.80c
F-test	**	**	**	*	**	**	**	**	NS	**
Sx	0.92	0.43	0.2	0.28	0.29	1.12	0.83	0.98	0.48	0.04
CV (%)	2.25	15.11	7.85	8.29	4.15	3.18	2.91	14.85	11.34	3.95

In a column figures having similar letter(s) do not differ significantly whereas figures having dissimilar letter(s) differ significantly as per DMRT; NS = Not Significant, ** = Significant at 1% level and * = 5% level.S1 = 25cm x 25cm, S2 = 20cm x 20cm, S3 = 20cm x 15cm, S4 = 15cm x l0cm.

3.2.2. Total number of tillers hill^{-1}

The different planting densities had significantly affected the formation of total tillers hill^{-1} (Table 2). The widest spacing S_1 produced the highest total number of tillers hill^{-1} (14.0). The medium and normally practiced spacing S_2 and S_3 produced intermediate number of total tillers hill^{-1} (11.5 and 11.1, respectively). The closest spacing of 15cm x 10cm (S_4) plants produced the lowest number of tillers hill^{-1} (6.5), while the widest spaced plants produced the highest number of tillers hill^{-1}, it is might be due to the fact that wider spaced plants absorbed more nutrient, moisture and intercept light which ultimately leads the plants to grow more tillers plant^{-1}. Haque and Nasiruddin (1988) also observed that wider spacing produced higher number of total tillers hill^{-1}. Although wider spacing produced higher tillers but failed to produce higher grain yield per unit area compared to closer spacing. This clearly indicates that more tillering is not always an index for higher yield.

3.2.3. Number of effective tillers hill^{-1}

Plant spacing significantly influenced the number of effective tillers hill^{-1} (Table 2). The S_1 spacing produced the highest number of effective tillers hill^{-1} (11.0) whereas that was minimum (5.0) in S_4. A gradual decrease in tiller number was observed as the spacing become closer between lines and hills. The wider spacing allowed much more area for growth of the plant and brought in less competition between them resulting in more number of total, effective and non-effective tillers hill^{-1}. This confirms the report of Dunand and Dilly (1982) who reported that number of productive tillers hill^{-1} decreased with closer planting densities.

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

The plant spacing also remarkably influenced the number of non-effective tillers hill^{-1} ranging from 1.8 to 3.0 (Table 2). The highest number (3.0) was produced in wider spacing (S_1), while the lowest number of 1.8 was produced in closer spacing (S_4). The intermediate and normally practiced spacing S_2 and S_3 were produced the second (2.5) and third (2.2) highest number of non-effective tillers hill^{-1} (Table 2). Tiller production of wider spaced plants till about heading stage due to allow much more area for the growth of the plant and brought in less

competition between them resulting in more number of non effective tillers hill^{-1}. Similar results were found by Ayub et al. (1987) who reported that wider spaced plants produced more number of non-effective tillers hill^{-1}.

3.2.5. Panicle length

The panicle length of rice plants was also significantly persuaded by the action of plant pacing and it increased with the increasing of spacing. So, the longest panicle length was 25.8cm with the spacing S_1 and it was statistically differed by S_2 (25.0cm). This was the poorest (22.6cm) in S_4. This confirmed the results of Rao et al. (1990), Thanamuthu and Subramanian (1983), Liou (1987) who stated that panicle length was significantly influenced by plant population. Wider spaced plants received more nutrient, moisture and light which ultimately leads to produce the longest length of panicle.

3.2.6. Total spikelet panicle^{-1}

Spacing had highly significant effect on total spikelet panicle^{-1} (Table 2). It was revealed that S_1 spacing produced the highest number of spikelets panicle^{-1} (124.2) compared to other spacings. The lowest spikelets panicle^{-1} (94.0) was produced in S_4. S_3 produced more spikelets panicle^{-1} than S_2 but significant variation was not found between them. Similar results were also reported by Quddus and Huda (1975) and Rao et al. (1990) who confirmed that wider spacing plants produced the highest number of grains panicle^{-1}. Due to more number of effective tillers hill^{-1} and longest panicle length enhanced more number of total spikelets panicle^{-1} by wider spacing.

3.2.7. Number of filled grains panicle^{-1}

Spacing had highly significant effect on number of filled grains panicle^{-1} (Table 2) and the S_1 spacing produced the highest number of grains panicle^{-1} (102.0) but it was the lowest (62.4) in the closest spacing of S_4. However, spacing S_2 produced significantly higher filled grains panicle^{-1} than spacing S_3. This result was in compliance with those of Quddus and Huda (1975) and Rao et al. (1990) who found that wider spacing produced higher number of grains panicle^{-1}. Evidently wider spacing induced greater number of fertile grains panicle^{-1} than did narrower spacing. It is evident that grains fertility and development depend on different factors such as nutrition, moisture and light; wider spacing is like those factors which possibly facilitated supply of more food materials, moisture and light for the plant and ultimately grains developed more compared to narrower spacing.

3.2.8. Number of sterile spikelets panicle^{-1}

A significant effect of spacing was observed in the sterile spikelets panicle^{-1}. A gradual increase in sterile spikelets was observed as the spacing become closer between the lines and hills. The closest spacing 15cm x 10cm (S_4) produced the highest sterile spikelets panicle^{-1} (31.6) and it was the lowest (22.4) in the widest spacing in S_1. The spacing S_2 and S_3 were produced the intermediate sterile spikelets panicle^{-1} (Table 2). This result was in partial agreement with the findings of BINA (1993). Closer spaced plants received less nutrients, moisture and light that ultimately affect to produce more number of sterile spikelets panicle^{-1}.

3.2.9. 1000-grain weight (g)

Plant spacings did not influence significantly on the on 1000-grain weight in this observation (Table 2). The plant spacing had no significant effect on 1000-grain weight as reported previously by Hwu and Thseng (1982).

3.2.10. Grain yield

Different plant spacings had significant effect on the grain yield of the aromatic rice varieties. A gradual increase of grain yield was observed with the increase of spacing up to the spacing of S_3 (20cm x 15cm) and thereafter declined. Spacing S_3 produced the highest grain yield (3.60 t ha^{-1}) due to optimum and more number of effective tillers m^{-2} area, S_1 produced the lowest grain yield (2.66 t ha^{-1}) due to less hill m^{-2} area and more number of non-effective tillers m^{-2} area. This result was in partial agreement with the findings of Rao et al. (1990) who reported that normally practiced and intermediate spacing gave higher yield and decreased with closer spacing.

3.3. Interaction effect

In combination of variety and spacing did not influence significantly on the plant height, and the highest and the lowest plant heights (155.7 cm and 130.3cm) were recorded in the combination of V_1S_1 and V_3S_4, respectively

(Table 3). The interaction of variety and plant spacing did not produce any significant variation on total number of tillers hill^{-1}. The number of effective tillers hill^{-1} differed significantly due to interaction of variety and spacing. Both V_2S_1 and V_3S_1 produced the highest number of effective tillers hill^{-1} (12.0) followed by V_1S_1, V_2S_2, V_2S_3 and V_4S_2. The lowest number of effective tillers hill^{-1} (4.0) was observed in V_4S_4 followed by V_lS_4 and V_3S_4. This is might be due to genotypic variation among the varieties. No significant interaction was found between the variety and spacing on the non-effective tillers hill^{-1} and on panicle length. However, there was gradual decreased in panicle length with closer spacing of each variety. Variety x spacing interaction had highly significant effect on total spikelet panicle^{-1}. The variety V_4 produced the highest number of grains panicle^{-1} (190.6) with the S_1 spacing followed by V_2 (120.7), V_3 (100.4) with the same spacing, while V_1 produced the lowest number of grains panicle^{-1} (70.0) with S_4 spacing. A significant interaction effect of variety and spacing was observed on the formation of the grain panicle^{-1}. The variety V_4 produced the highest number of grains panicle^{-1} (148.6) with wider spacing of S_1 compared to other spacings followed by V_2 (103.7), V_3 (81.4) at the same spacing. The combination of V_1S_1 produced the lowest number of grains panicle^{-1} (49.2) in this study. The interaction effect of variety and spacing was highly significant on the number of sterile spikelets panicle^{-1}. The variety V_4 produced the highest number of sterile spikelets panicle^{-1}(60.4) at S_4 spacing. On the other hand, V_4S_1 combination produced significantly least number of sterile spikelets panicle^{-1} (11.5) (Table 3). No significant interaction effect was found on 1000-grain weight. But it was observed that V_3 produced the highest 1000-grain weight compared to other varieties, irrespective of different spacing but V_4 produced the lowest 1000-grain weight almost at all spacing.

Table 3
Interaction effects of planting density and variety on the yield and yield attributes of four fine rice varieties.

Treatments	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Total spikelet panicle^{-1}	Filled grain panicle^{-1}	Non filled grain panicle^{-1}	1000 grain wt. (g)	Grain yield (tha^{-1})
V_1S_1	155.7	13.0	10.0b	3.0	27.3	85.0h	74.5h	11.5k	17.43	2.08h
V_1S_2	150.7	11.3	9.0c	2.3	26.5	78.0i	64.0j	14.0j	17.13	2.48g
V_1S_3	143.0	11.0	9.0c	2.0	25.3	7s.0j	61.0k	14.0j	16.22	2.95e
V_1S_4	140.7	6.5	5.0f	1.5	21.7	70.0k	49.2m	19.9f	15.17	2.50g
V_2S_1	145.3	15.0	12.0a	3.0	25.8	120.8d	103.7d	17.0i	15.55	3.02e
V_2S_2	141.3	12.5	10.0b	2.5	25.1	105.8e	84.9f	21.0f	14.99	3.18d
V_2S_3	141.0	12.3	10.0b	2.3	24.4	100.5f	83.5f	17.0i	14.51	4.00b
V_2S_4	135.3	7.0	6.0e	2.0	22.7	75.5j	52.51	23.0e	14.19	3.00e
V_3S_1	144.0	15.0	12.0a	3.0	23.4	100.4f	81.4g	19.0h	19.33	3.02e
V_3S_2	140.0.	11.7	9.0c	2.7	22.4	99.2f	79.2h	20.0g	19.08	3.40c
V_3S_3	135.0	11.5	9.0c	2.5	21.7	96.0g	75.9i	20.1g	18.95	4.27a
V_3S4	130.3	7.0	S.0f	2.0	20.9	70.5k	57.5n	23.0e	18.85	3.00e
V_4S_2	145.0	13.0	10.0b	3.0	26.6	190.6a	148.6a	42.0d	10.51	2.50g
V_4S_2	141.3	10.7	8.0d	2.7	25.9	175.0b	131.0b	44.0c	10.30	2.70f
V_4S_3	140.7	9.5	7.5de	2.0	24.9	174.Sb	126.5c	48.0b	10.16	3.18d
V_4S_4	135.0	5.5	4.0g	1.5	25.0	160.0c	100.4e	60.4a	10.03	2.70e
CV(%)	2.25	15.11	7.85	8.29	4.15	3.18	2.91	14.85	11.34	3.95
Sx	1.84	0.86	0.40	0.57	0.58	2.23	1.66	1.96	0.96	0.08
F-test	NS	NS	*	NS	NS	**	*	**	NS	*

In a column figures having similar letter(s) do not differ significantly whereas figures having dissimilar letter(s) differ significantly as per DMRT. NS = Not Significant, ** = Significant at 1% level and * = 5% level. LEGEND: V_1= Bashmoti 370, V_2= BRRI dhan37, V_3= BRRI dhan38, V_4= Kalijira. S_1= 25cm x 25cm, S_2 = 20cm x 20cm, S_3= 20cm x 15cm, S_4= 15cm x l 0cm.

The correlation between 1000-grain weight and grain yield showed that there existed a positive relationship. The correlation co-efficient was statistically significant (r^2 =0.0633) and it revealed that the higher 1000-grain weight gave the higher grain yield (Fig. 1). The interaction of variety and spacing also had significant effect on the grain yield. The highest grain yield (4.27 t ha^{-1}) was observed at V_3S_3 interaction followed by V_2S_3 (4.0 t ha^{-1}), V_4S_3 (3.18 t ha^{-1}), and V_1S_3 (2.95 t ha^{-1}) interactions and the lowest grain yield (2.08 t ha^{-}) was observed in the combination of V_1S_1. Grain yields of V_1S_3, V_2S_l, V_2S_4, V_3S_1, and V_3S_4 were statistically identical to each other.

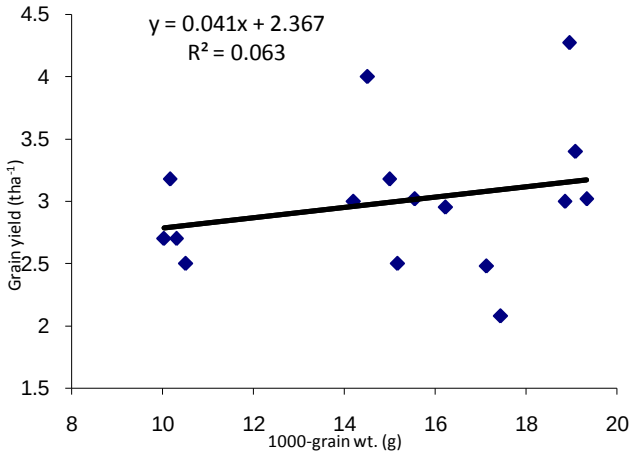

Fig. 1. Relationship between 1000-grain weight and grain yield.

4. Conclusion

It could be concluded that the used spacing treatments in the newly developed and locally improved fine rice varieties showed almost similar results previously reported by different researchers. It was confirmed that the spacing 20cm x l5cm was the best compared to other spacing treatments studied here. The results further pointed out that among the genotypes, BRRI dhan37 and BRRI dhan38 varieties performed better that Bashmoti 370 and Kalijira (local varieties), and BRRI dhan38 is the highest grain yielder (3.62 t ha^{-1}) than BRRI dhan37 (3.30 t ha^{-1}). BRRI dhan38 with the spacing of 20cm x l5cm can be grown for getting maximum yield of aromatic rice.

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