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Effect of spacing and number of seedlings per hill on the yield performance of fine rice cv. kalizira

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Abstract: An experiment was conducted at the Agronomy Farm of Bangladesh Agricultural University, Mymensingh from July to December 2009 to investigate the effect of hill density and number of seedlings hill^{-1} on the yield performance of fine rice (cv. Kalizira). The experiment consisted of three hill densities, viz. 25cm×20cm, 25cm×15cm, 25cm×10cm and two levels of number of seedlings hill^{-1} viz. 2 and 4. The experiment was layout in randomized compete block design with three replications. The highest and the lowest number of total and effective tillers hill^{-1}, thousand grain weight and harvest index were found when hill densities were 25 cm×20 cm and 25 cm×10 cm, respectively. The highest number and the lowest of non-effective tillers hill^{-1} were found in case of 2-seedilings hill^{-1} and 4-seeedlings hill^{-1} respectively. The highest grain yield was observed where hill density was 25 cm×20 cm with 4- seedlings hill^{-1}. Results indicated that relatively wider hill density and higher number of seedlings hill^{-1} produced higher yield. So the variety Kalizira should preferably be transplanted in a hill density of 25 cm×20 cm with 4-seedilngs hill^{-1} to obtain the desired grain yield.
Key words: Spacing, Hill density, fine rice, Kalizira.

Introduction

Besides fineness, high palatability of grains of fine rice cultivars has some special appeal of their fragrance. Fine rice is used in many ways by the people but in "Polau" preparation it is the only rice that is mostly used. Fine rice has high market price. Because of the high price and likeability of this rice, its export can bring more considerable amount of foreign exchange for the nation. Planting density in transplant rice culture constitutes the spacing or hill density and number of seedlings hill^{-1}. The growth and development of rice plant is greatly affected both qualitatively and quantitatively by hill density. Optimum hill or planting density enables the rice plant to grow properly in its aerial and underground parts by utilizing maximum radiant energy, nutrients, space and water ultimately leading to bumper crop production. Improper spacing and hill density may adversely affect the normal physiological activities of the rice plant. In densely populated rice fields the interspecific completion between the plant height results in gradual shading and lodging and thus favor the increased production of straw instead of grain. On the contrary, sparsely populated fields with wide spacing lead to uneconomic utilization of space, profuse growth of weed pests and diseases and reduction of grain yield unit^{-1} area. Improper hill density and improper number of seedlings hill^{-1} may affect the physiological activity of rice plant and account for yield reduction. Like hill density number of seedlings hill^{-1} also influences the uptake of nutrients, availability of radiant energy, and other physiological phenomena and ultimately affect the growth and development of rice plant. Among various factors improper hill^{-1} density and number of seedlings hill^{-1} are now considered as the major reasons for low yield of rice in Bangladesh. Therefore, the present study was conducted with the following objectives. i) to find out the effect of hill density on the yield and yield components of fine rice cv. Kalizira, ii) to determine the optimum number of seedlings hill^{-1} and iii) to find out the interaction, if any, among hill density and number of seedlings hill^{-1}.

Materials and Methods

The experiment was conducted at the Agronomy Farm of Bangladesh Agricultural University, Mymensingh from July to December 2009 to investigate the effect of hill density and number of seedlings hill^{-1} on the yield performance of fine rice (cv. Kalizira). The experiment consisted of three hill densities, viz., 25 cm×20 cm, 25 cm×15 cm, 25 cm×10 cm and two levels of number of seedlings hill^{-1} viz., 2 and 4. The experiment was layout in randomized compete block design with three replications. There were 6 plots in each replication. The size of the unit plot was 4.0 m×2.5 m. Total plots in the experimental field were 18. The seeds were collected from the Bangladesh Agricultural University Farm, Mymensingh. Seedlings were raised in a medium high land. Care was taken so that there was no infestation of pests and diseases and no damage by birds or cattle. Manuring was done with cowdung at the rate of 5 t ha^{-1} during the land preparation. In addition the crop was fertilized with N, P_2O_5, K_2O, S and Zn at the rate of 60- 60-40-60-5 kg ha^{-1} at final land preparation in the form of urea, triple supper-phosphate, muriate of potash, gypsum and $ZnSO_4$, respectively. One-third of N was applied at final land preparation and the rest of N was top dressed in three equal splits on 10, 25 and 45 days after transplanting (DAT).Seedlings were uprooted carefully without causing any injury to the roots and were kept in soft mud under shade. Thirty five day old seedlings were transplanted in the puddled field on 23 August 2009.Intercultural operation were done as and when necessary. The crop was harvested plot wise on 9 December 2009 and full maturity and the yields of both grain and straw were recorded after thoroughly during in the sun. Data pertaining to plant characteristics were taken from randomly selected hills harvested and collected from each plot. The-1000 grains weight was taken from dried grain samples of each unit plot. In respect of yield and yield contributing characters of the fine rice under study, the following data were collected. i) Plant height (cm) ii) Total number of tillers hill^{-1} iii) Number of effective tillers hill^{-1}, iv) Number of non-effective tillers hill^{-1}, v) Length of panicle (cm), vi) Number of grains panicle^{-1}N, vii) Number of sterile spikelets panicle^{-1}, viii) Weight of 1000 grains (g), ix) Grain yield (t ha^{-1}), x) Straw yield (t ha^{-1}), xi) Biological yield (t ha^{-1}) and xii) Harvest index. The collected data were analyzed using "Analysis of Variance" technique with the help of a computer package (MSTAT) and the mean differences were adjudged with Duncan's Multiple Range Test (Gomez and Gomez, 1983).

Results and Discussion

Plant height: Plant height was not significantly affected by hill density. Apparently the tallest (143.85 cm) and the shortest (142.13 cm) plants were observed in 25 cm×20 cm and 25 cm×10 cm hill density, respectively (Table 1). Plant height was not significantly affected by number of seedlings hill^{-1} But 2 seedlings hill^{-1} produced taller plant than 4 seedlings hill^{-1} in appearance (Table 2). Interaction effect of hill density and number of seedlings hill^{-1}did not show any significant influence on plant height (Table 3).

Total tillers hill^{-1}: Hill density exerted significant effect on total tillers hill^{-1}. The highest number of total tillers hill^{-1} (10.72) was produced by the hill density of 25 cm×20 cm which was statistically similar to that produced by 25 cm×15 cm (Table 1). The hill density 25 cm×10 cm produced the lowest number (8.88) of total tillers hill^{-1}. The production of more tillers in widely spaced plants was probably due to absorption of more nutrients and mositure and also to availabitlity of more sunlight in comparison to densely transplanted plants. Similar results were reported by Shieh (1979), Ayub *et al*., (1987) and Miah *et al*., (1990). Number of total tillers hill^{-1} was significantly influenced on number of seedling hill^{-1}. Numerically higher number of total tillers hill^{-1} (9.93) was produced when 4 seedlings were transplanted hill^{-1}. (Table 2).Interaction effect of hill density and number of seedlings hill^{-1}did not show any significant influence on total tillers hill^{-1} (Table 3).

Table 1. Effect of hill density on yield and yield contributing characters of fine rice cv. Kalizira in aman season

Hill density	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Length of panicle (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	Wt. of 1000-grain (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
25 cm×20 cm	143.85	10.72a*	9.13a	1.53	20.75	97.64	21.20	10.52a	2.29	4.20	6.53	35.15a
25 cm×20 cm	142.78	10.09a	8.46a	1.61	20.35	95.48	20.79	1.26a	2.02	4.38	6.39	31.94b
25 cm×20 cm	142.13	8.88b	7.22b	1.71	20.78	98.94	20.25	10.38b	2.05	4.43	6.36	32.05
S $\bar{x}$	-	0.2908	0.2459	-	-	-	-	0.0738	-	-	-	0.9788
Level of sig.	NS	0.01	0.01	NS	NS	NS	NS	0.05	NS	NS	NS	0.05
CV (%)	4.04	14.40	14.57	38.95	5.51	15.53	14.60	3.48	21.35	16.57	14.90	14.51

*In a column figures having similar letter (s) do not differ significantly as per DMRT. NS = Not significant.

Table 2. Effect of no. of seedling hill^{-1} on yield and yield contributing characters of fine rice cv. Kalizira in aman season

Number of seedlings hill^{-1}	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Length of panicle (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	Weight of 1000-grain (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
2	143.35	9.86	7.98	1.87	20.87	100.91	20.99	10.42	2.17	4.33	6.53	33.26
4	142.49	9.93	8.56	1.36	20.38	93.79	20.50	10.36	2.06	4.27	6.33	32.48
Level of sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	4.04	14.40	14.57	37.95	5.51	15.53	14.60	3.48	21.35	16.57	14.90	14.51

NS = Not significant.

Effective tillers hill^{-1}: Number of effective tillers hill^{-1} was significantly influenced by hill density. The highest number of effective tillers hill^{-1} (9.13) produced by the hill density 25 cm×20 cm was statistically identical (Table 1). The hill density 25 cm×10 cm produced the lowest number of tillers hill^{-1} (7.22). Plant competition was more in hill density 25 cm×10 cm due to high plant population which caused a reduction in the production of effective tillers hill^{-1}. In hill density 25 cm×20 cm the maximum effective tillers were produced due to wider space, sufficient light, air, water and nutrients. Here the plants exploited more light for photosynthesis and produced more carbohydrate. Akita (1982) as well as Akita and Tanaka (1992) were also supported this view. Number of effective tillers hill^{-1} was not significantly affected by number of seedlings hill^{-1}. Numerically 2 seedlings hill^{-1} produced lower number of effective tillers hill^{-1} than that produced by 4 seedlings hill^{-1} (Table 2). Interaction effect of hill density and number of seedlings hill^{-1}did not show any significant influence on effective tillers hill^{-1} (Table 3).

Non effective tillers hill^{-1}: Number of non effective tillers hill^{-1} was not influenced significantly by hill density. The closest hill density (25 cm×10 cm) produced the highest number of non effective tillers hill^{-1} and vice versa (Table 1). Number of non effective tillers hill^{-1} was not significantly affected by number of seedlings hill^{-1}. The higher number of non effective tillers hill^{-1} (1.87) was produced by 2 seedlings hill^{-1} while the lower number was produced by 4 seedlings hill^{-1} (Table 2). Interaction among hill density and number of seedlings hill^{-1} did not show significant effect on number of non-effective tillers hill^{-1} (Table 3).

Length of panicle: Panicle length was not significantly affected by hill density. Numerically the longest panicle (20.78 cm) was produced by the hill density 25 cm×10 cm while the lowest one (20-35 cm) was produced by 25 cm×15 cm (Table 1).

Number of seedlings hill^{-1} did not affect panicle length significantly. apparently, 2 seedlings hill^{-1} produced longer panicle than that produced by 4 seedlings hill^{-1} (Table 2). Interaction among hill density and no. of seedlings hill^{-1} did not show significance effect on no. of non effective tillers hill^{-1}.

Grains panicle^{-1}: Number of grains panicle^{1} was not significantly affected by hill density. Apparently, the highest number of grains panicle^{-1} (98.94) was produced by the hill density 25 cm×10 cm while the lowest number was produced by 25 cm×15 cm (Table 1).

Effect of number of seedlings hill^{-1} was found insignificant regarding total number of grains panicle^{-1}. Two seedlings

hill^{-1} produced numerically higher number of grains panicle^{-1} (100.91) than that produced by 4 seedlings hill^{-1} (93.79) (Table 2).

Grains panicle^{-1} showed insignificant response due to interaction of hill density × number of seedlings hill^{-1} (Table 3).

Table 3. Effect of interaction of hill density and number of seedlings hill^{-1} on yield and yield contributing characters of fine rice cv. Kalizirain aman season.

Interaction (Hill density x number of seedlings hill^{-1})	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Length of panicle (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	Weight of 1000-grain (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
D_1S_1	145.22	10.90	9.02	1.88	21.05	101.89	21.43	10.56	2.19ab*	4.15	6.42	34.53
D_1S_2	142.46	10.53	9.23	1.81	20.44	93.39	20.98	10.49	2.39a	4.25	6.64	35.77
D_2S_1	142.04	10.32	8.42	1.88	20.58	98.68	20.56	10.29	2.04ab	4.35	6.37	21.75
D_2S_2	143.51	9.85	8.50	1.33	20.12	92.29	21.02	10.22	2.00ab	4.41	6.41	32.14
D_3S_1	142.78	8.35	6.50	1.85	20.99	102.17	21.00	10.39	2.30a	4.51	6.80	33.50
D_3S_2	141.48	9.42	7.93	1.57	20.56	95.70	19.50	10.36	1.81b	4.14	5.93	30.61
S $\bar{x}$	-	0.2908	0.2459	-	-	-	-	-	0.1307	-	-	-
Level of sig.	NS	NS	NS	NS	NS	NS	NS	0.05	NS	NS	NS	NS
CV (%)	4.04	14.40	14.57	37.95	5.51	15.53	14.60	3.48	21.35	16.5	14.90	14.51

*In a column figures having similar letter (s) do not differ significantly as per DMRT. NS = Not significant.

Sterile spike lets panicle^{-1}: Number of sterile spike lets panicle^{-1} was not significantly affected by hill density. Numerically the highest and the lowest number of sterile spikelets panicle^{-1} were obtained from the hill densities 25 cm×20 cm and 25 cm×10 cm, respectively (Table 1).

Number of sterile spikelets panicle^{-1} was not significantly affected by number of seedlings hill^{-1}. Apparently, 2 seedlings hill^{-1} produced higher number of sterile spikelets panicle^{-1} (20.99) than that of produced by 4 seedlings hill^{-1} (Table 2). Interaction of hill density and number of seedlings hill^{-1} found insignificant for this character (Table 3).

Weight of 1000-grains: Weight of 1000-grains was significantly influenced by hill density. The hill density at 25 cm×20 cm produced the heaviest weight of 1000-grains (10.52g) which was statistically identical with that produced by 25 cm×10 cm (10.38 g) (Table 1). Production of the heaviest 1000-grains by the hill density of 25 cm×20 cm weight might be due to relatively less number of plant per unit area provide scope for increased photosynthetic activities and translocation of more metabolites to the seed sink.

Weight of 1000-grains was not significantly affected by number of seedlings hill^{-1}. 2 seedlings hill^{-1} produced heavier weight of 1000-granis (10.42 g) than that 4 seedlings hill^{-1} (Table 2). Interaction of hill density and number of seedlings hill^{-1} failed to show any significant effect on 1000 grains weight.

Grain yield: Grain yield was not significantly affected by hill density. The hill density of 25 cm×20 cm produced the highest grain yield (2.29 t ha^{-1}) while 25 cm×15 cm produced the lowest grain yield (2.02 t ha^{-1}) (Table 1).

Grain yield did not vary significantly due to number of seedlings hill^{-1} Numerically the highest grain yield (2.17 t ha^{-1}) was obtained from 2 seedlings hill^{-1} while 4 seedlings hill^{-1} produced the lowest yield (2.06 t ha^{-1}) (Table 2).

The interaction was found insignificant regarding grain yield (Table 3).

Straw yield: Straw yield was not affected significantly by hill density. But numerically the highest straw yield (4.38 t ha^{-1}) was produced by 25 cm×15 cm while the lowest yield (4.20 t ha^{-1}) by 25 cm×20 cm (Table 1).

Although the straw yield was not significantly affected by number of seedlings hill^{-1}. The higher straw yield (4.33 t ha^{-1}) was produced by 2 seedlings hill^{-1} and the lowest yield (4.27 t ha^{-1}) by 4 seedlings hill^{-1} (Table 2).

Interaction was found insignificant regarding straw yield.

Biological yield: Biological yield was not significantly affected by hill density. Numerically the highest biological yield (6.53 t ha^{-1}) was obtained from 25 cm×20 cm and the lowest yield (6.36 t ha^{-1}) from 25 cm×10 cm (Table 1).

Number of seedlings hill^{-1} did not show any significant effect on biological yield. Apparently, 2 seedlings hill^{-1} produced higher biological yield (6.53 t ha^{-1}) than that of 4 seedlings hill^{-1} (Table 2).

Interaction effect did not show significant effect for the studied above character.

Harvest index: Harvest index was significantly affected by hill density. The hill density of 25 cm×20 cm produced the highest harvest index (35.15%) (Table 1). The hill density of 25 cm×15 cm produced the lowest one (31.94%) which statistically identical followed by 25 cm×10 cm (32.05%).

Number of seedlings hill^{-1} did not show any significant effect on harvest index. Numerically higher (32.48) harvest index was produced by 4 seedlings hill^{-1} (Table 2).

It was further observed that interaction of hill density x number of seedlings hill^{-1}did not significantly affect the harvest index. The highest grain yield was obtained in hill density of 25 cm x 20 cm with 4-seedling hill^{1} (Table 3).

The effect of hill density, the tallest plant was found to be produced in 25 cm×20 cm and the shortest in 25 cm×10 cm. Again 2-seedlings hill^{-1} produced the tallest plant over 4-seedlings hill^{-1}. Total effective and non-effective tillers did not differ significantly due to number of seedlings hill^{-1}. 25 cm×20 cm spacing produced the highest effective tillers and the lowest number was found in 25 cm×10 cm. In case of number of seedlings hill^{-1}, 4-seedlings hill^{-1} produced the maximum total and effective tillers but minimum non-effective tillers. Number of grains panicle^{-1} and number of sterile spikelet panicle^{-1} also did not differ significantly due to hill density, number of seedlings hill^{-1}. Weight of 1000-grains differed significantly due to hill density but not due to number of seedlings hil^{-1}. 25 cm×10 cm produced the highest 1000-grains weight which was identical . Grain yield did not differ significantly due to

hill density, number of seedlings hill^{-1}. But interaction between hill density and number of seedling hill^{-1} differed significantly. The highest grain yield was obtained from 25 cm×20 cm and the lowest from 25 cm×15 cm spacing. 2 seedlings hill^{-1} produced the higher grain yield than 4 seedlings hill^{-1}. Straw yield and biological yield did not differ significantly due to hill density and number of seedlings hill^{-1}.Harvest index differed significantly due to hill density but it did not differ due to number of seedlings hill^{-1}. The highest harvest index was obtained from 25 cm×20 cm hill density and the lowest from 25 cm×10 cm which was statistically similar with 25 cm×15 cm hill density.

The Kalizira variety of fine rice can be cultivated in 25 cm×20 cm hill density with 4-seedlings hill^{-1} as the promising practice to produce better grain yield. This conclusion has been made based on the results of the study, conducted only in one season. Detailed studies are necessary to arrive at a definite conclusion.

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