Comparing yield and yield attributes of three rice varieties considering different plant population

M. Shahaduzzaman, M.N. Bari, B.K. Biswas[1], R.C. Dey[1] and F. Ahmed[1]
Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur,
and [1]Department of Agricultural Extension, Khamarbari, Dhaka.

Abstract: A field experiment was conducted at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during *boro* season (2009-10) to compare yield and yield attributes of three rice varieties viz. BRRI dhan 29, hybrid IR68877H and IR69690H with five planting densities which constituted the experimental variables as T_1; IR68877H at 27 hills m^{-2} (25 cm x15 cm), T_2; IR69690H at 27 hills m^{-2} (25 cm x15 cm), T_3; BRRI dhan 29 at 27 hills m^{-2} (25 cm x15 cm), T_4; BRRI dhan 29 at 40 hills m^{-2} (25 cm x10 cm), T_5 ; BRRI dhan 29 at 50 hills m^{-2} (20 cm x10 cm), T_6 ; BRRI dhan 29 at 67 hills m^{-2} (15 cm x10 cm) and T_7; BRRI dhan 29 at 111 hills m^{-2} (15 cm x 6cm). The experiment was laid out in a complete block design (RCBD) with three replications where unit plots were 5m x 3m with a distance of plot to plot 1m and block to block 1.5 m. At maturity, 10 plants were uprooted to measure yield contributing characters and from center of each plot a 5 m^2 area was harvested to determine yield. Data revealed that among the three rice varieties, the hybrid IR69690H produced the highest yield of 5667 kg hac^{-1} at standard population density (27 hills m^{-2}) and it was followed closely by BRRI dhan 29 with 5417 kg ha^{-1} (27 hills m^{-2}). Results further revealed that BRRI dhan 29 at a population density of 40 hills m^{-2} produced grain yield of 5993 kg ha^{-1} which was the highest among all the treatments.
Key words: Yield attributes, rice varieties, planting density, yield.

Introduction

Population density has profound influence on grain yield of rice (Islam, 1986). Optimum planting density enables the rice plant to grow properly both in its aerial and underground parts by utilizing maximum radiant energy, space and water which ultimately leads to boost crop production (Miah *et al.* 1990). Several studies revealed that closer spacing increases grain yield (Islam *et al.* 1994). A number of reports (Miller *et al.,* 1991) also indicated a curvilinear relationship between plant population density and rice grain yield. Optimum number of tillers per unit area is a prerequisite for obtaining maximum yield and rice yield increases with increased number of panicles per unit area (BRRI, 1995). Higher yield potential of hybrid rice is primarily attributed to profuse tillering, large number panicles and higher spikelet density. It is assumed that BRRIdhan 29 may also yield higher if higher number of panicles per unit area with more or equal to 100 filled spikelets per panicles is ensured. After studying the relationship between yield and yield components of 17 rice cultivars Mesbah *et al.* (2004) concluded that grain yield has significantly positive correlation with the number of grains per panicle, the number of filled grains per panicle and 1000 grain weight. Besides, the number of grains per panicle and the number of filled grains per panicle were two major factors affecting grain yield. Under Bangladesh condition, it was felt necessary to examine the performance of BRRIdhan 29 which is the most popular and widely cultivated boro season rice variety at a range of population densities in comparison with hybrid rice to compare yield and yield attributes.

Materials and Methods

The field experiment was conducted at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur under wet land condition during *boro* season (2009-10) to compare yield and yield attributes of three rice varieties considering different plant population. The rice varieties were BRRI dhan 29, hybrid IR68877H and IR69690H and five planting densities constituted the experimental variables as T_1; IR68877H at 27 hills m^{-2} (25 cm x15 cm), T_2; IR69690H at 27 hills m^{-2} (25 cm x15 cm), T_3; BRRI dhan 29 at 27 hills m^{-2} (25 cm x15 cm), T_4; BRRI dhan 29 at 40 hills m^{-2} (25 cm x10 cm), T_5 ; BRRI dhan 29 at 50 hills m^{-2} (20 cm x10 cm), T_6 ; BRRI dhan 29 at 67 hills m^{-2} (15 cm x10 cm) and T_7; BRRI dhan 29 at 111 hills m^{-2} (15 cm x 6 cm). The soil was silty clay of shallow red brown terrace type under Salna Series of Madhupur Tract containing a p^H of 6.5. The experiment was laid out in a complete block design (RCBD) with three replications where unit plots were 5m x 3m with a distance of plot to plot 1m and block to block 1.5 m. At the time of final land preparation cowdung was added @ 10 t hac^{-1} and K, S and Zn were applied @ 60, 12 and 3 kg ha^{-1} respectively. The rates of N were 124, 184, 230, 308 and 510 for the plant population of 27, 40, 50, 67 and 111 hills m^{-2} respectively and it was applied in four equal installments at basal, maximum tillering, panicle initiation and flowering stage. Thirty five days old one rice seedling was transplanted in each hill and gap filling was done after two weeks of transplanting with the same aged seedlings. Adequate intercultural practices were done to keep weed, insect-pest infestation at minimum level and a 2 to 4 cm standing water was maintained in the field until the varieties attained at hard dough stage. At maturity, 10 plant samples were uprooted to measure yield contributing characters and from center of each plot a 5 m^2 area was harvested to determine yield. Data recorded for different parameters were put to analysis of variance (ANOVA) and the means were compared using the Least Significant Different (LSD) test.

Results and Discussion

Yield and yield contributing characters

Plant height: Plant height varied from variety to variety as well as planting density. The tallest plants (94.32 cm) were found in IR69690H and the shortest (81.43 cm) were found in IR68877H at standard population density. Among different population densities of BRRIdhan 29, the tallest rice plant (101.79 cm) were found in T_7 (111 hills m^{-2}) treatment and the shortest (86.73 cm) were in the T_3 (27 hills m^{-2}) treatment (Table 1). The reason behind the tallest plants observed in the T_7 treatment might be due to that

over-crowding effect in the treatment caused stem elongation as because of lower penetration of solar radiation within the canopy.

Tillers m^{-2}: Rice varieties differed slightly interms of tiller production at standard plant density. Number of tillers increased with increasing population density. The highest tillers (710.4 m^{-2}) was found in the T_7 (111 hills m^{-2}) treatment of BRRIdhan 29 which was statistically identical with other densities and lowest (382.5 m^{-2}) was found in the standard spacing (27 hills m^{-2}) (Table 1). The result is similar with the findings of Zadesh and Mirlohi (1998) that number of tillers increase with increasing population density.

Table 1. Plant characters of selected rice varieties at harvest as affected by population density

Treatment	Plant height (cm)	Tillers m^{-2}	Effective tillers m^{-2}	Panicles length (cm)
T_1	81.43	356.4	316.8	22.75
T_2	94.32	346.5	336.8	24.47
T_3	86.73	382.5	347.4	24.67
T_4	94.39	466.7	384.0	25.15
T_5	94.50	526.7	408.3	25.09
T_6	94.09	578.4	443.2	25.76
T_7	101.79	710.4	352.8	24.76
CV (%)	3.61	7.67	7.33	2.61
LSD (0.05)	5.19	65.63	48.22	1.146

T_1 = IR68877H at 27 hills m^{-2}; T_2 = IR69690H at 27 hills m^{-2}; T_3, T_4, T_5, T_6 and T_7 = BRRI dhan 29 at 27, 40, 50, 67 and 111 hills m^{-2} respectively.

Panicles m^{-2}: Among the rice varieties at standard density the highest panicle density was observed in BRRIdhan 29 (347.7 m^{-2}), while the lowest was in IR68877H (316.8 m^{-2}). In case of BRRIdhan 29 panicle m^{-2} was increased up to T_6 (67 hills m^{-2}) treatment where the highest panicle density (443.2 m^{-2}) was found (Table 1). Going beyond this population density, number of panicles decreased. It might be due to that mortality percentage increased markedly after certain limit i.e. effective tiller decreased resulting lesser panicle production.

Panicle length: Panicles length was not much affected by plant population density in case of BRRIdhan 29. Higher population densities produced slightly longer panicles except T_7, which produced identical panicles as in T_3. Among the varieties the longer panicles (24.67 cm) were produced by BRRIdhan 29, while the shortest (22.75 cm) were by IR68877H (T_1) (Table 1).

Spikelets $panicle^{-1}$: Total number of Spikelets $panicle^{-1}$ i.e. filled and unfilled spikelets $panicle^{-1}$ were found to be influenced by population density. Spikelets $panicle^{-1}$ varied between 140 in T_7 (111 hills m^{-2}) to 163.3 in T_6 (67 hills m^{-2}) (Table 2). It might be mentioned that incremental application of N and P with increasing number of hills per unit area could not contribute much to spikelet formation beyond 67 hills m^{-2} (T_6). Among the varieties BRRIdhan 29 produced highest spikelets $panicle^{-1}$ with the least in IR69690H.

Table 2. Variety and planting density effects on yield and attributes of three rice varieties

Treatment	Spikelets $panicle^{-1}$	Filled spikelets $panicle^{-1}$	% Ripening	1000 grain weight (gm)	Grain yield (kg/hac)	Straw yield (kg/hac)	Harvest Index
T_1	111.6	78.02	70.83	25.59	4813	4167	0.54
T_2	127.9	65.75	51.68	26.38	5667	5298	0.52
T_3	141.4	89.47	63.10	20.49	5417	5861	0.48
T_4	155.9	83.81	55.17	20.49	5993	5766	0.51
T_5	153.6	73.33	47.33	20.23	5267	6483	0.45
T_6	163.3	73.49	45.01	19.62	5000	8252	0.38
T_7	140.0	61.39	43.85	19.33	4240	9092	0.32
CV (%)	7.46	16.16	13.27	1.28	11.77	13.27	
LSD (0.05)	18.84	21.57	12.71	0.497	1089	1515	

T_1 = IR68877H at 27 hills m^{-2}; T_2 = IR69690H at 27 hills m^{-2}; T_3, T_4, T_5, T_6 and T_7 = BRRI dhan 29 at 27, 40, 50, 67 and 111 hills m^{-2} respectively.

Filled spikelets $panicle^{-1}$: The number of filled spikelets $panicle^{-1}$ was influenced variety and plant population density. BRRIdhan 29 produced the highest number of filled spikelets $panicle^{-1}$ and the lowest was produced by IR69690H. Among the population densities of BRRIdhan 29, number of filled spikelet $panicle^{-1}$ decreased with increasing planting density. At standard plant density (27 hills m^{-2}) BRRIdhan 29 produced the highest filled spikelet while 111 hills m^{-2} (T_7) produced the lowest (Table 2).

Ripening percentage: The ripening percentage was the highest in IR68877H and the lowest in IR69690H. However, the ripening percentage of BRRIdhan 29 at standard density was intermediate. In case of BRRIdhan 29 increasing planting density progressively decreased ripening percentage. The lowest ripening percentage was found in the treatment T_7 (111 hills m^{-2}) treatment (Table 2).

1000 grain weight: Among the rice varieties IR69690H produced the heaviest grains, while BRRIdhan 29 the highest ones and IR68877H was in the intermediate range.

Among the treatments containing different population densities of BRRIdhan 29, grain weight did not vary significantly with increasing population density, although T_6 and T_7 treatments produced lighter grains than the other treatments (Table 2).

Grain yield: Among the rice varieties at standard density IR69690H produced the highest grain yield of 5667 kg ha^{-1} and BRRIdhan 29 and IR68877H were next to it with 5417 kg ha^{-1} and 4813 kg ha^{-1} respectively (Table 2). However, no statistically significant difference in grain yield was observed between the three rice varieties. In case of population density treatments of BRRIdhan 29 grain yield decreased progressively with increasing population density. The highest yield (5993 kg ha^{-1}) was recorded in T_4 (40 hills m^{-2}) treatment and the lowest (4240 kg ha^{-1}) was observed in the T_7 (111 hills m^{-2}) treatment.

Harvest index: The highest harvest index (0.54) was found in IR68687H which was followed by IR69690H (0.52). However, BRRIdhan 29 also showed comparable harvest index (0.48) with hybrid varieties. Moreover, increasing the population density to 40 hills m^{-2} might be the better option to achieve higher harvest index (0.51) as compared to hybrid varieties (Table 2).

From the above study, it could be concluded that among three varieties IR69690H performed best at standard spacing. But adjusting plant population density to 25cm x 10cm (40 hills m-2) produced the highest yield compared to all treatments including the hybrid varieties at standard spacing with a more favourable harvest index.

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