Bangladesh Agron. J. 2017, 20(2): 17-26

EFFECT OF SPACING AND SEEDLING PER HILL ON THE PERFORMANCE OF AUS RICE var. BRRI dhan48

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(**Received:** 20 April 2017, **Accepted:** 7 December 2017)

Key words: Spacing, No. of seedling, yield, var. BRRI dhan48, Aus rice

Abstract

An experiment was conducted at the research field and laboratory in the Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period of April to August, 2016 to study the effect of spacing and number of seedlings hill^{-1} on the yield of *Aus* rice var. BRRI dhan48. Four spacing's viz. 20 cm × 10 cm, 20 cm × 15cm, 20cm × 20 cm and 20 cm × 25cm and three number of seedlings hill^{-1} viz. 1, 2 and 4 were included in the study. Results indicated that the highest number of total tillers hill^{-1} (22.86), number of effective tillers hill^{-1} (21.24), number of grains panicle^{-1} (128.79) and 1000-grain weight (23.30g) were found with 20cm × 25cm spacing. The highest plant height (104.27 cm), number of leaves plant^{-1} (35.80), grain yield (3.06 tha^{-1}), straw yield (3.37 tha^{-1}) and harvest index were obtained from 20 cm × 10 cm spacing. The highest grain yield of 2.98 t ha^{-1} was obtained from 4 seedlings hill^{-1}, while the lowest 2.47 t ha^{-1} from 1 seedlings hill^{-1}. The highest grain yield of 3.40 tha^{-1} was obtained from 20 cm × 10 cm spacing with 4 seedlings hill^{-1} while the lowest grain yield of 2.21 tha^{-1} from the wider spacing. Results of the present study revealed that 20 cm x 10 cm spacing with 4 seedlings hill^{-1} combination was found to be the best for obtaining maximum grain yield of *Aus* rice var. BRRI dhan48.

Introduction

Rice is the most extensively cultivated staple food crop for the people of Bangladesh. It plays a vital role in Bangladesh agriculture as it covers 74 per cent of total cultivable area (AIS, 2001). The total production under rice cultivation in Bangladesh about 19.1 million tons from *Boro*, 13.02 million tons from *Aman* and 2.6 million tons from *Aus* rice in 2014-15 (BBS, 2015). Rice is grown in three distinct season's viz. *aus, aman* and *boro* among which *aus* rice covers only 12.27% of the rice growing area. The average yield of rice in *aus* is only 1.45 (BBS, 2001). So, among these three seasons, rice yield is the lowest in *Aus* season as compared to the other growing seasons and therefore, efforts should be made to increase the yield of *Aus* rice. Optimum plant density ensures proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, land as well as air spaces and water (Miah *et al.,* 1990). Regardless of plant spacing within and among rows, plant density must be such that the crop develops a canopy able to intercept more than 95% of the incoming solar radiation during reproductive growth. Baloch *et al.* (2002) reported that appropriate plant density of a cultivar is necessary for obtaining higher yield and quality of rice.

Number of seedlings hill^{-1} is an important factor for successful rice production which affects plant population unit^{-1} area, availability of sunlight and nutrients, photosynthesis and respiration, which ultimately influence the yield of crop (Chowdhury *et al.,* 1993). Excess number of seedlings hill^{-1} may produce higher number of tillers hill^{-1} resulting in mutual shading and lodging and thus favouring the production of higher grain and straw yield, while less number of seedlings hill^{-1} may cause reduction of total number of panicles in per unit area which may be associated with poor yield. Therefore, an experiment was conducted to find out the effect of spacing and number of seedlings hill^{-1} on the yield of *Aus* rice var. BRRI dhan48.

Materials and Methods

The experiment was conducted at the research farm and laboratory of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during April to August, 2016 to study the effect of spacing and number of seedlings hill^{-1} on the yield of *Aus* rice var. BRRI dhan48. The experimental field was a medium high land belonging to the non-calcareous dark gray floodplain soil under the Agro-Ecological Zone (AEZ-1) of Old Himalayan Piedmont Plain (FAO, 2005). Treatments include four spacing's viz. 20 cm × 10 cm, 20 cm × 15 cm, 20 cm × 20 cm and 20 cm × 25 cm and three numbers of seedlings hill^{-1} viz. 1, 2 and 4 were. The experiment was carried out in a randomized complete block design with three replications. The unit plot size was 3.0 m × 2.0 m. BRRI dhan48 is a high yielding variety of aus rice developed by BRRI was used as planting material. The experimental land was prepared through ploughing and cross ploughing and fertilized with urea, triple super phosphate (TSP) muriate of potash (MOP), gypsum and zinc sulphate at the rate of 180, 100, 60, 60 and 10 kg ha^{-1}, respectively. Twenty five days old seedlings were transplanted on 5th May, 2016 with 20 cm spacing between lines and 10, 15, 20 and 25 cm spacing between hills in respective treatment Intercultural operations were done for maintaining the normal growth and development of the crop. The crop was harvested at full maturity and five hills were randomly selected from each unit plot for recording of necessary data. The collected data was analyzed by using the "Analysis of variance" (ANOVA) technique with the help of a computer package (MSTAT-C) program (Gomez and Gomez, 1984).

Results and Discussion

Plant height (cm): The effect of row spacing and number of seedling hill^{-1} on plant height at different days after transplanting (DAT) was statistically significant (Table. 1). Results showed that plant height increased with decreasing row spacing. The tallest plant was recorded at S_1 (20 cm × 10 cm) spacing while shortest plant was recorded at S_4 (20 cm × 25 cm) spacing. The taller plant in densely populated plants might have resulted due to competition for sunlight than those of wider spacing as reported by Abbas *et al.* (1994) and Akita *et al.* (1992). Result showed that at 35, 55, 75 DAT and at harvest N_3 (4 seedlings hill^{-1}) showed the longest plant while N_1 (1 seedling hill^{-1}) showed shortest plant. The result was similar with the findings of Shrirame *et al.* (2000) and Shah *et al.* (1991). Results indicated that the longest plant was found in 20 cm × 10 cm spacing with 4 seedlings hill^{-1} (S_1N_3).

Number of leaves hill^{-1}: Significant variations were observed in number of leaves hill^{-1} at 55 and 75 DAT as influenced due to row spacing (Table 1). Results showed that S_1 treatment was

evident for the highest number of leaves hill^{-1} and the lowest in S_4. In case of number of seedling hill^{-1} 4 seedling hill^{-1} showed highest number of leaves per hill while lowest number of leaves hill^{-1} from 1 seedling hill^{-1} which was supported by Shrirame *et al.* (2000). Interaction effect indicated that the highest number of leaves hill^{-1} was found S_1N_3 and the lowest number in S_4N_1 at 55 and 75 DAT.

Number of total tillers hill^{-1}: The highest number of total tillers hill^{-1} was recorded at S_4 (20 cm × 25 cm) and the lowest at S_1 (20 cm × 10 cm) spacing. Reduction in total tillers hill^{-1} in closer spacing might be due to increased number of plants per unit area. This increased number of plants per unit area exerted competition among plants for nutrients and light that caused a reduction in tiller number. Similar results were also reported by Baloch *et al.* (2002) in rice. Results showed that (4 seedling hill^{-1} showed the highest number of total tillers hill^{-1} (23.47). The results are in conformity with Karmakar *et al.* (2002), Shrirame *et al.* (2000) and BINA (1987). In case of interaction the highest number of total tillers hill^{-1} was found in S_4N_3 and the lowest one in S_1N_1.

Number of effective tillers hill^{-1}: The effect of row spacing, seedling number hill^{-1} and the interaction was statistically significant (Table 2). The highest number of effective tillers hill^{-1} was recorded at 20 cm x 25 cm spacing and the lowest 20 cm x 10 cm spacing Increase in effective tillers hill^{-1} in wider spacing might be due to increased number of plants per unit area. Similar results were also reported by Baloch *et al.* (2002) in rice. The highest number of effective tillers hill^{-1} was found from 4 seedlings hill^{-1} and the lowest number with 1 seedlings hill^{-1} which was supported by Islam (1980).

Number of non-effective tillers hill^{-1}: Row spacing, seedling number hill^{-1} and the interaction had significant influence on transplant aus rice (Table 2). The highest number of non-effective tillers hill^{-1} (6.69) was observed in S_1 and the lowest one (5.22) in closer spacing of S_4 Reduction in the number of non-effective tiller in widely populated area might be due to plant can able to produce effective tiller at later growth stages which was in agreement with those of Baloch *et al.* (2002). It was observed that the highest number of non-effective tillers hill^{-1} (7.17) was found in S_1N_1 and the lowest one (4.00) in S4N3.

Length of panicle (cm): The longest panicle length (23.35 cm) was produced by 20 cm × 25 cm spacing and the shortest one (20.97 cm) by 20cm × 10 cm. similar results was observed by Lious (1987) who stated that closer spacing decreased panicle length. The longest panicle length (24.40 cm) was produced by 4 seedlings hill^{-1} and the shortest one (20.02 cm) by 1 seedlings hill^{-1}.

Number of grains panicle^{-1}: The highest number of grains panicle^{-1} (128.79) was observed in 20 cm × 25 cm spacing while lowest number of grains panicle^{-1} (104.17) in 20 cm × 10 cm spacing. Reduction in the number of grains panicle^{-1} under closer spacing might be due to increased number of plants per unit area. This increased number of plants per unit area exerted competition among plants for nutrients and light that might have caused lower crop growth rate with consequently a reduction in the number of filled grains panicle^{-1} which was supported by Sarker *et al.* (2002) and Ghosh *et al.* (1988). It was found that more seedling with higher no. of grains while less no. of seedling produced lowest (111.30) number of grains panicle^{-1}.

Number of sterile spikelet's panicle^{-1}: Result revealed that the number of sterile spikelets panicle^{-1} decreased with increasing row spacing. The highest number of sterile spikelets panicle^{-1} (27.06) was found in 1 seedling hill^{-1}. The highest number of sterile spikelets panicle^{-1} (30.50) was obtained from 20 cm × 10 cm with 1 seedlings hill^{-1} and the lowest one (20.00) from 20 cm × 25 cm with 4 seedlings hill^{-1}.

Thousand-grain weight (g): The highest 1000-grain weight (23.30g) was recorded from 20 cm × 25 cm spacing and the lowest one (22.51g) from 20 cm × 10 cm spacing. 1000-grain weight decreased with increasing plant density in rice which was obtained by Baloach *et al.* (2002) and Yan *et al.* (2007). Result revealed that 4 seedling hill^{-1}) showed highest 1000 grains weight (24.20g) while 1 seedling hill^{-1} showed the lowest 1000 grains weight (21.87g). Similar findings were observed by Wen and Yang (1991). In interaction, the highest 1000- grain weight (24.60g) was found in S_4N_3 and lowest one (21.57g) in S_1N_1.

Grain yield (tha^{-1}): Grain yield was significantly influenced by spacing, number of seedlings hill^{-1} and the interaction (Fig. 1, 2 & 3). The highest (3.06 tha^{-1}) grain yield was recorded in 20 cm × 10 cm spacing and the lowest grain yield (2.47 tha^{-1}) in wider row spacing of 20 cm × 25 cm. The highest grain yield was recorded in closer spacing might be due to highest number of plants per unit area which was supported by Neelam and Nisha (2000) Kang *et al.* (2001) and Baloach *et al.*(2002). Result revealed that more seedling showed the highest grain yield (2.98 tha^{-1}) where the lowest grain yield (2.47 tha^{-1}) with 1 seedling hill^{-1}. Similar results were also found by Islam *et al.* (2002) and Obulamma *et al.* (2002). The interaction between 20 cm × 10 cm with 4 seedlings hill^{-1} produced the highest grain yield (3.40 tha^{-1}) and 20 cm × 25 cm with 1 seedlings hill^{-1} produced the lowest grain yield (2.21 tha^{-1}).

Straw yield (tha^{-1}): Straw yield was significantly influenced by spacing, number of seedlings hill^{-1} and their interaction (Fig. 1, 2 & 3). The highest straw yield was recorded in 20 cm × 10 cm spacing (3.37 tha^{-1}) and the lowest in 20 25 cm spacing (3.07 tha^{-1}). The result is consistent with the findings of Baloach *et al.* (2002). Result revealed that 4 seedling hill^{-1} showed the highest straw yield (3.61 tha^{-1}), while the lowest straw yield (2.92 tha^{-1}) with 1 seedling hill^{-1}. The results found by Karmakar *et al.* (2002) and Shrirame *et al.* (2000) were similar with the findings. The interaction between 20 cm × 10 cm with 4 seedlings hill^{-1} produced the highest straw yield (3.75 tha^{-1}) and 20 cm × 25 cm with 1 seedling hill^{-1} produced the lowest straw yield (2.78 tha^{-1}).

Harvest index (%) : The highest harvest index was observed in wider row spacing of 20 cm × 10 cm (47.63%) and the lowest one (44.52%) from the spacing of 20 cm × 25 cm. Result revealed that 4 seedlings hill^{-1}) showed the highest harvest index (47.12%) where the lowest (45.69 %) with 1 seedling hill^{-1} which was also achieved by Karmakar *et al.* (2002), Shrirame *et al.* (2000) and BINA (1993). The interaction between 20 cm × 10 cm with 4 seedlings hill^{-1} produced the highest harvest index (47.55%) and 20 cm 25 cm with 1 seedlings hill^{-1} produced the lowest harvest index (44.34%).

Effect of Spacing and Seedling Per Hill on the Performance

Table 1. Effect of spacing and number of seedling hill^{-1} on plant height, number of leaves hill^{-1} and number of total tillers hill^{-1} of *Aus* rice at different days after transplanting (DAT)

Treatment	Plant height (cm)				Leaves hill^{-1} (no.)			Total tillers hill^{-1}(no.)			
Spacing	35 DAT	55 DAT	75 DAT	At harvest	35 DAT	55 DAT	75 DAT	35 DAT	55 DAT	75 DAT	At harvest
S_1	60.00a	79.22a	99.99a	104.27a	21.03	29.11a	35.80a	7.28d	10.28d	15.81d	22.86a
S_2	59.11ab	78.67ab	99.66a	103.72a	20.23	28.33a	34.94ab	8.44c	11.28c	17.39c	21.96b
S_3	58.00bc	78.67ab	96.56b	100.90b	19.11	28.72a	33.93bc	8.89b	12.17b	18.11b	21.14c
S_4	57.67c	77.67b	96.36b	100.75b	20.01	26.42b	32.82c	10.17a	13.00a	19.44a	20.34d
Level of significance	**	*	**	**	NS	**	**	**	**	**	**
Seedling hill^{-1}											
N_1	57.17b	76.25c	94.58c	99.22b	14.35c	29.11c	30.91c	6.12c	9.83c	15.23c	19.85c
N_2	57.42b	78.67b	98.68b	103.67a	19.63b	28.33b	32.42b	8.96b	11.79b	18.13b	21.41b
N_3	61.50a	80.75a	101.16a	104.35a	26.32a	28.72a	39.80a	11.00a	13.42a	19.71a	23.47a
Level of significance	**	**	**	**	**	**	**	**	**	**	**
Interaction											
S_1N_1	56.33	77.00	95.67eg	101.60cd	15.60	21.83g	32.17ce	5.33h	8.50	14.10i	21.20ef
S_1N_2	57.67	79.33	97.33df	107.19b	19.83	30.00de	34.00c	8.00e	10.50	16.33fg	22.73c
S_1N_3	63.00	82.00	107.00a	111.56a	27.67	36.00a	41.67a	8.50de	11.83	17.00ef	24.65a
S_2N_1	58.00	76.00	95.00fg	98.92df	14.77	20.00h	32.17ce	6.00gh	9.00	14.83hi	20.47g
S_2N_2	59.00	77.33	98.67d	100.00cf	19.33	29.00ef	31.00de	8.83d	11.33	17.83de	21.50e
S_2N_3	62.00	80.33	104.30b	106.67b	26.60	35.50a	41.23a	10.50c	13.50	19.50bc	23.90b
S_3N_1	57.00	76.67	94.00g	99.04df	13.67	20.17h	29.80de	6.17g	10.33	15.50gh	19.30h

Treatment	Plant height (cm)				Leaves hill^{-1} (no.)			Total tillers hill^{-1}(no.)			
Spacing	35 DAT	55 DAT	75 DAT	At harvest	35 DAT	55 DAT	75 DAT	35 DAT	55 DAT	75 DAT	At harvest
S_3N_2	58.33	80.00	96.00dg	98.00ef	20.00	32.00c	32.33cd	9.00d	12.33	18.67cd	21.13f
S_3N_3	61.00	81.00	101.67c	105.67b	23.67	34.00b	39.67a	11.50b	13.83	20.17b	23.00c
S_4N_1	56.00	75.33	93.67g	97.30f	13.37	19.97h	29.50e	7.00f	11.50	16.50fg	18.42i
S_4N_2	56.00	78.00	96.32dg	100.64ce	19.33	28.00f	32.33cd	10.00c	13.00	19.67bc	20.27g
S_4N_3	60.00	79.67	98.09de	102.33c	27.33	31.30cd	36.63b	13.50a	14.50	22.17a	22.34d
Level of significance	NS	NS	**	**	NS	**	**	**	NS	**	**
CV (%)	3.21	2.40	3.50	3.64	7.45	3.10	4.17	5.00	4.31	3.33	3.89

In a column, values followed by similar letter (s) did not differ significantly by DMRT at 5% level of significant

Note: NS = Not Significance

S_1 = 20 cm x 10 cm, S_2 = 20 cm x 15 cm, S_3 = 20 cm x 20 cm, S_4 = 20 cm x 25 cm
N_1 = 1 seedling, N_2 = 2 seedlings, N_3 = 3 seedling

Effect of Spacing and Seedling Per Hill on the Performance

Table 2. Effect of spacing and number of seedling hill^{-1} on the yield attributes of *Aus* rice

Treatment	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1}(no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000 - grains weight (g)	Harvest index (%)
Spacing							
S_1	18.24d	6.69a	20.97d	104.17d	28.94a	22.51d	47.63a
S_2	19.74c	6.12b	21.88c	110.72c	26.55b	22.80c	45.62b
S_3	20.41b	5.70bc	22.63b	112.83b	23.62c	23.08b	45.05bc
S_4	21.24a	5.22c	23.35a	128.79a	21.69d	23.30a	44.52c
Level of significance	**	**	**	**	**	**	**
Seedling hill^{-1}							
N_1	17.75c	6.54a	20.02c	111.30c	27.06a	21.87c	45.69c
N_2	20.10b	6.42a	22.21b	113.71b	25.14b	22.69b	46.31b
N_3	21.87a	4.84b	24.40a	117.38a	23.40c	24.20a	47.12a
Level of significance	**	**	**	**	**	**	**
Interaction							
S_1N_1	16.25h	7.17a	18.73	101.67h	30.50a	21.57j	47.15ab
S_1N_2	18.25f	7.17a	20.75	104.00g	29.50b	22.15h	47.20ab
S_1N_3	20.22d	5.75bc	23.42	106.83f	26.83c	23.80d	47.55a
S_2N_1	17.25g	6.67ab	19.82	106.50f	29.08b	21.80i	45.31df
S_2N_2	20.68d	6.68ab	21.83	111.33e	26.20c	22.50g	46.40bc
S_2N_3	21.28c	5.00cd	24.00	114.33cd	24.37d	24.10c	46.17df
S_3N_1	18.50f	6.50ab	20.40	110.50e	25.23d	22.03h	44.97ef
S_3N_2	20.22d	6.00bc	22.83	113.00d	23.20ef	22.90f	45.54ce
S_3N_3	22.50b	4.60de	24.67	115.00c	22.42fg	24.30b	46.63ef
S_4N_1	19.00e	5.83bc	21.13	126.53b	23.42e	22.09h	44.34f
S_4N_2	21.25c	5.83bc	23.42	126.50b	21.67g	23.20e	46.09cd
S_4N_3	23.47a	4.00e	25.50	133.33a	20.00h	24.60a	45.80cd
Level of significance	**	**	NS	**	**	**	**
CV (%)	7.45	12.26	5.54	6.73	11.29	3.43	4.03

Note: NS= Not Significance
In a column, values followed by similar letter(s) did not differ significantly by DMRT at $P \leq 5$

S_1 = 20 cm x 10 cm, S_2 = 20 cm x 15 cm, S_3 = 20 cm x 20 cm, S_4 = 20 cm x 25 cm
N_1 = 1 seedling, N_2 = 2 seedlings, and N_3 = 3 seedling

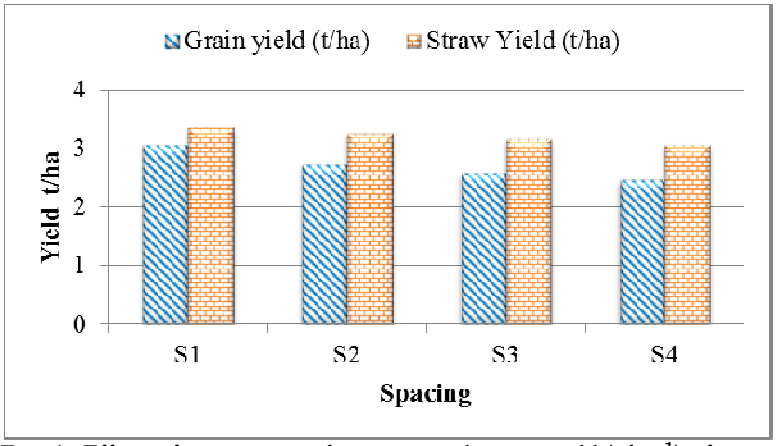

Fig. 1. Effect of spacing on the grain and straw yield (t ha^{-1}) of *Aus* rice

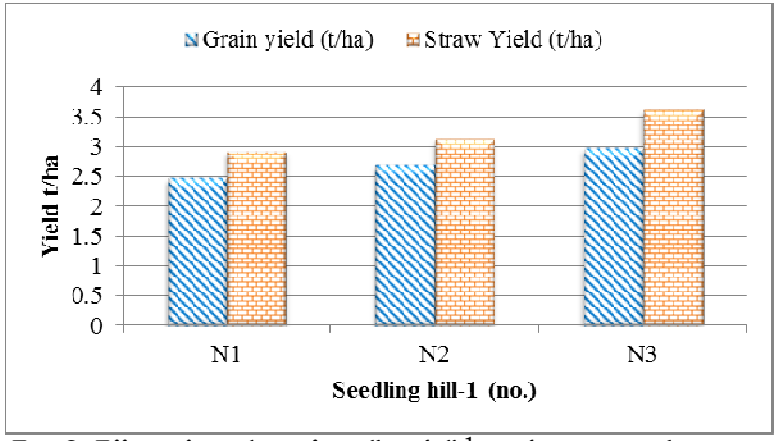

Fig. 2. Effect of number of seedling hill^{-1} on the grain and straw yield (t ha^{-1}) of *Aus* rice

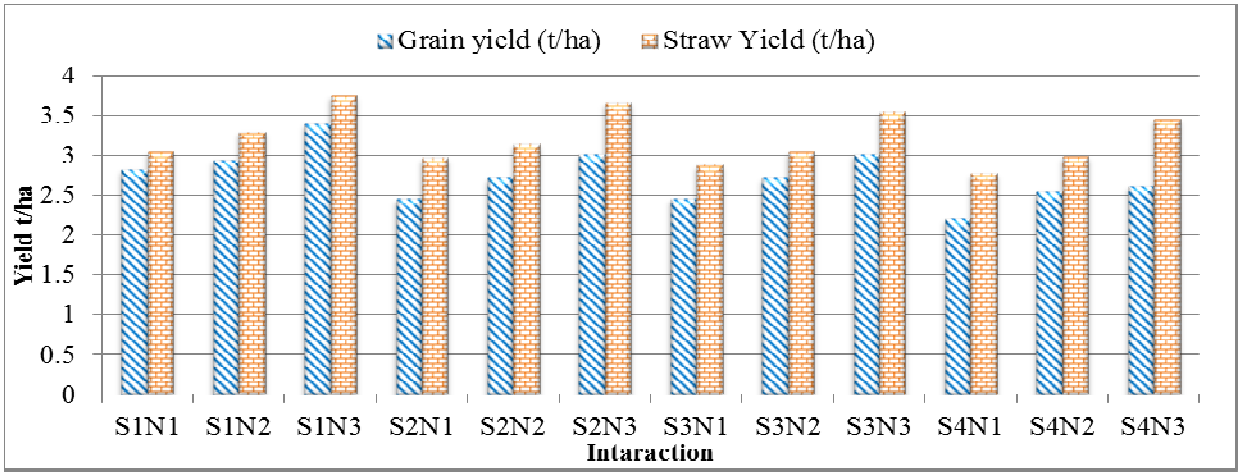

Fig. 3. Effect of interaction between spacing and number of seedling hill^{-1} on the grain and straw yield (t ha^{-1}) of *Aus* rice

Conclusion

Based on the present study it may be concluded that the *Aus* rice var. BRRI dhan48 grown under 20 cm × 10 cm spacing with 4 seedlings hill^{-1} could obtained optimum grain yield. However, these findings need to be further investigated and evaluated on different agro-ecological zone before final recommendation to the farmers.

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