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Effect of Seedlings per Hill and Harvesting Time on the Yield Performance of Purple Rice

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Abstract:

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during April to September 2019 to observe the effect of number of seedlings hill^{-1} and harvesting time on the yield performance of purple rice in boro season. The experiment comprised five number of seedlings hill^{-1} viz. 1, 2, 3, 4 and 5 and three harvesting time viz. 20, 25, 30 days after flowering (DAF). The experiment was laid out in a randomized complete block design with three replications. Number of seedlings hill^{-1}, harvesting time and their interactions had significant effect on yield components and yield. Highest plant height (83.09 cm), number of total tillers hill^{-1} (10.11), number of effective tillers hill^{-1} (8.84) were recorded in 4 seedlings hill^{-1}, whereas panicle length (21.96 cm), number of grains panicle^{-1} (122.26), grain yield (6.92 t ha^{-1}), straw yield (8.78 t ha^{-1}), biological yield (15.71 t ha^{-1}) and harvest index (44.3%) were recorded highest in 3 seedlings hill^{-1}, the lowest grain yield (6.01 t ha^{-1}) was obtained in 1 seedlings hill^{-1}.

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Harvesting time showed the significant differences in all yield components except 1000-grain weight. The highest grain (6.86 t ha^{-1}) and straw yields (8.92 t ha^{-1}) were found when harvested at 25 DAF. In case of interaction, the highest plant height (89.47 cm), number of total tillers $hill^{-1}$ (11.93), number of effective tillers $hill^{-1}$ (11.47), number of grains $panicle^{-1}$ (128.16), grain yield (7.93 t ha^{-1}) and straw yield (9.60 t ha^{-1}) were recorded in 3 seedlings $hill^{-1}$ with harvesting time at 25 DAF and the lowest grain yield (5.53 t ha^{-1}) was obtained from the combination of 1 seedlings $hill^{-1}$ with harvested at 20 DAF. From the result, it can be said that cultivation of purple rice followings 3 seedlings $hill^{-1}$ with harvesting time at 25 DAF would be a promising technique to obtain the highest grain yield. Therefore, optimum date of harvesting for higher grain yield may be 25 days after flowering.

Keywords: Purple rice, seedlings per hill, harvesting time, flowering, rice yield

INTRODUCTION

Bangladesh is an agriculture based agronomical country. The agricultural system in Bangladesh is generally characterized by intensive crop production with the rice based cropping system. About 13.47% of the total GDP are contributed by agricultural sector (BBS, 2020). Almost 77% of the cropped area is adherent to rice production (Julfiquar, 2009) and 92% husbandman's grow rice (Rikabder, 2004). In year 2020-21 approximately 11.63 million hectares' land is used for rice cultivation and production is 36.27 million tons in Bangladesh having average yield of 3.15 t ha^{-1} (BBS 2020). Among the leading rice growing countries of the world, Bangladesh ranked 3rd in both acreage and production (FAO, 2020). Though Bangladesh ranks 3rd in the world but it ranks 32th in its yield (IRRI, 2020).

Rice is the most staple food for more than half of the world population. (Ebaid *et al.*, 2007; Mahadi *et al.*, 2006; Murthy *et al.*, 2011; Vivek *et al.*, 2004; Sreedhar and Ganesh, 2010). Rice demand would increase by 25% by 2025 to keep pace with population growth (Maclean *et al.,* 2009). It constitutes 95% cereal consumed and supplies more than 80% of the calories and about 50% of the protein in the diet of the general people of Bangladesh (Yusuf, 1997). Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh (BBS, 2020). Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 million. However, the country is now producing about 36.27 million tons to feed her 160 million people (BBS 2020). This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production. Selection of a suitable variety with high genetic potentiality which can be adopted to the wider range of environmental conditions that contribute to a much better performance to different yield attributes. Purple rice is the newly developed rice variety in Bangladesh. According to agriculture experts, China-origin purple paddy contains highest amount of vitamins and fiber (Daily Star, 2018). The purple rice is similar to the local variety Ufsi, which has steep and flat leaves and 20 to 24 spikes each. The plant is comparatively strong, storms and rain cannot damage it like other paddy plants. The yield is also high. This rice is very nutritious (Dhaka Tribune, 2020). Purple rice would help to increase the production of *boro* rice in Bangladesh. But before going for general cultivation in farmer's field, it needs to be thoroughly studied.

Therefore, considering above information, of the present study was designed to investigate the effect of seedling hill^{-1} and harvesting time on the growth and yield of purple rice.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh during the period from November 2019 to April 2020 to study the effect of number of seedlings hill^{-1} and harvesting time on the yield performance of purple rice in *boro* season. This chapter presents a brief description about experimental period, experimental site, agro-ecological region, climatic condition, treatments, experimental design and layout along with plant material and raising of seedlings, crop growing procedures, data recording and their statistical analysis are also stated precisely.

Experimental Site

The experiment was conducted in a sandy clay loam soil at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from November 2019 to April 2020. The experimental field is located at 24.75^0 N latitude and 90.50^0 E longitude at an average altitude of 18 m above the mean of sea level. The experimental site belongs to the Old Brahmaputra Floodplain Agro-ecological zone (AEZ-9). The region occupies a large area of Brahmaputra sediments which were laid down before the river shifted into its present Jamuna channel about 200 years ago.

Experimental treatments

Two factors were including in the experiment viz. number of seedling hill^{-1} and harvesting time and these were as follows: Factor A. Number of seedlings hill^{-1} (5): 1 seedlings hill^{-1} (S_1), 2 seedlings hill^{-1} (S_2), 3 seedlings hill^{-1} (S_3), 4 seedlings hill^{-1} (S_4), 5 seedlings hill^{-1} (S_5). Factor B: Harvesting time (3): 20 days after flowering (H_1), 25 days after flowering (H_2), 30 days after flowering (H_3)

Experimental Design

The experiment will be laid out in a randomized complete block design (RCBD) with three replications. The total number of plot was 45 (3 × 15). The size of each plot will be 5m^2 (2.5 m × 2.0 m). The space between blocks and plots were 1.0 m and 0.5 m, respectively. The bunds around individual plots were made firmly to control water movement among the plots. The treatments were randomly allocated in the plots.

Preparation of nursery bed experimental land

The soil of the experimental land was first opened on 10th January 2020 with the help of a tractor-drawn disc plough; later on 12th January 2020, the land was irrigated and prepared by three successive ploughing and cross ploughing. Each ploughing was followed by laddering to have a good puddled field. After ploughing and laddering, all kinds of uprooted weeds and previous crop residues were removed from the field. After the final land preparation, the field layout was made on 14th January 2020. The plots were fertilized with urea, triple superphosphate (TSP), muriate of potash (MoP), and gypsum at the rate of 200, 120, 60, and 60 kg ha^{-1}, respectively. The whole amount of TSP, MoP, and gypsum, and one-third of urea were applied at the time of final land preparation. The rest amount of urea was applied in equal installments at 15, 30, and 45 DAT.

Transplanting of seedlings

55 days old seedlings were uprooted carefully from the nursery beds on 15th January 2020 for transplantation maintaining two, three, four seedlings hill^{-1} as per treatment for this purpose, the nursery beds were made wet by the application of water on the previous day before uprooting the seedlings to minimize mechanical injury of roots.

Plant protection measures

No remarkable infestation of insect and disease organisms was noticed in the field. So, no plant protection measures were taken. The crop was protected from birds during the grain-filling period. Controlling the bird's watchman was deep-laid, especially during morning and afternoon.

General observation of the experimental field

The field was investigated from time to time to detect the visual difference between the treatment and any kind of infestation by weeds, insects, and diseases so that considerable losses by pests could be minimized. The field looked nice with normal purple color plants. Incidence of stem borer, green leafhopper, leaf roller, and rice hispa was observed during a tillering stage that was controlled properly. No bacterial and fungal disease was observed in the field.

Harvesting and Processing

The crop was harvested as per experimental specification. First harvesting was done on 20th April 2020 (20 days after flowering), second on 25th April 2020 (25 days after flowering) and third on 30th April 2020 (30 days after flowering). Five hills (excluding border hills and central 1 m^2 area) were selected randomly from each unit plot and uprooted before harvesting for recording data and 1m^2 areas from a middle portion of each plot were separately harvested and bundled, properly tagged, and then brought to the threshing floor for recording grain and straw yield. Threshing was done by using a pedal thresher. The grains were cleaned and sun-dried to a moisture content of 14 % approximately. Straw was also sun-dried properly. Final grain and straw yields plot^{-1}

Data collection on yield components and Yield

The following data on yield components and yield were recorded: Plant height, Number of total tillers hill^{-1}, Number of effective tillers hill^{-1}, Number of non-effective tillers hill^{-1}, Length of panicle, Number of filled grain panicle^{-1}, Number of sterile spikelet's panicle^{-1}, 1000-grains weight (g)**,** Grain yield (t ha^{-1}), Straw yield (t ha^{-1}), Harvest index (%).

Harvest Index (%)

It denotes the ratio of grain yield to biological yield and was calculated with the following formula.

$$\text{Harvest index (\%)} \quad \frac{\text{Grain yield}}{\text{Biological yield}} = \times 100$$

Statistical Analysis

The recorded data were compiled and tabulated for statistical analysis. The mean of all treatments were calculated and the analysis of variance for each of the characters under study was done with the help of computer package MSTAT. Collected data were analyzed using the "Analysis of variance" technique and the significance of the mean differences was adjudged by Duncan's Multiple Range Test (DMRT) at 5% and 1% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of Number of Seedlings Hill^{-1} on the Yield Contributing Characters and Yield of Purple rice

Plant height was significantly affected by number of seedlings hill^{-1}. The result disclosed that the tallest plant height (83.09 cm) was observed in 4 seedlings hill^{-1} and shortest plant height (73.84 cm) was recorded in 1 seedlings hill^{-1} (Figure 1). It was clear that the plant height decreased with decrease in the number of seedling hill^{-1}. Promsomboon *et al.* (2019) reported that 1 seeding hill^{-1} produced minimum plant height. Banik *et al.,* (1997) also reported that among the different number of seedlings hill^{-1}, 4 seedlings hill^{-1} recorded maximum plant height than 2, 6 and 8 seedlings hill^{-1}. Zhang and Hung (1990) reported from China, that there was significant increase in the plant height due to increase in number of seedlings hill^{-1}. Number of total tillers hill^{-1} was significantly influenced by seedling hill^{-1}. The higher number of tillers hill^{-1} (10.11) was produced by 4 seedlings hill^{-1} and the lower number of total tillers hill^{-1} (8.27) was produced by 1 seedlings hill^{-1} (Figure 1). Paul *et al.* (2017) reported that number of tillers hill^{-1} increased with the increase in the number of seedlings used hill^{-1}. Banik *et al.* (1997) reported that among the different number of seedlings hill^{-1}, 4 seedlings hill^{-1} recorded maximum tillers hill^{-1} than 2, 6 and 8 seedlings hill^{-1}. Shah *et al.* (1991), Cai *et al.* (1991) found that the tiller number increased with increased in seedlings number hill^{-1}. Effective tillers hill^{-1} was significantly affected by number of seedling hill^{-1} at 5% level of probability. The highest number of effective tillers hill^{-1} (8.84) was recorded from 4 seedlings hill^{-1} and the lowest number (6.94) was recorded from 1 seedlings hill^{-1} (Figure 1). Biswas *et al.* (2015) reported highest number of effective tillers hill^{-1} from 4 seedlings hill^{-1}. Mahato *et al.* (2018) observed the highest number of effective tiller m^{-2} in 4 number of seedlings hill^{-1}. Number of non-effective tillers hill^{-1} was significantly affected by number of seedling hill^{-1}. The maximum number of non-effective tillers hill^{-1} (1.56) was found when 5 seedlings hill^{-1} were transplanted and the minimum number of non-effective tillers hill^{-1} (1.24) was obtained when 3 seedlings hill^{-1} were transplanted (Figure 1). Panicle length was significantly influenced by seedlings hill^{-1}. Results showed that 3 seedlings hill^{-1} produced the longest panicle length (21.96 cm) on the other hand 5 seedlings hill^{-1} produced the shortest panicle length (21.16 cm) (Figure 1). Mahato *et al.* (2018) also proved that 5 seedlings hill^{-1} recorded the shortest panicle length. Chauhan (2005) found that crop planted with 3 seedlings hill^{-1} produced higher panicle length (23.02 cm). Number of grain panicle^{-1} was significantly affected by number of seedling hill^{-1}. Number of grain panicle^{-1} increased with the increasing seedlings up to 3 seedlings hill^{-1} (122.26) and there after declined. Statistically poorest value (119.88) was recorded at 1 seedling hill^{-1} (Figure 1). The number of grains panicle^{-1} decreased with increasing seedling density was reported by Inaba and Kitano (2005). Filled grains panicle^{-1} and weight of 1000-grain was not significantly influenced by number of seedlings hill^{-1} as it may be controlled by genetic makeup reported by Islam *et al.* (2008). Number of sterile spikelets panicle^{-1} was significantly affected by number of seedling hill^{-1}. The lowest number of sterile grain panicle^{-1} (12.99) was recorded in 3 number of seedlings hill^{-1} which was statistically par with 4 number of seedlings hill^{-1} whereas 5 and 1 number of seedlings hill^{-1} recorded the highest number of sterile grain panicle^{-1} (13.48) (Figure 1). Similar, result was also recorded by the Frauk *et al.* (2009) also recorded highest number of sterile grain panicle^{-1} in 5 number of seedlings hill^{-1}. Weight of 1000-grain was significantly affected by number of seedling hill^{-1}. Numerically maximum weight of 1000-grain (22.56 g) was obtained in 3 seedlings hill^{-1} and the minimum weight of 1000-grain (22.29 g) was found in 3 seedlings hill^{-1} (Figure 1). Sarker *et al.* (2017), Mahamud *et al.* (2013), and Islam *et al.* (2012), stated that the weight of 1000-grains was not significantly influenced by the number of seedlings hill^{-1}. Grain yield was significantly affected by number of seedlings hill^{-1}. The highest grain yield (6.92 t ha^{-1}) was obtained from 3 seedlings hill^{-1} and the lowest grain yield (6.01 t ha^{-1}) was obtained from 1 seedlings hill^{-1} (Figure 1). Because mainly of lowest number of effective tillers hill^{-1} and lowest number of grains panicle^{-1}. Increasing seedling number hill^{-1} increased grain yield (Figure 1) Grain yield exhibited a regular trend of increase with the increase in number of seedling hill^{-1}. The result was conformity with Promsomboon *et al.* (2019) and Verma *et al.,* (2002) also found maximum grain yield from 3 seedling hill^{-1} and minimum yield from 1 seedling hill^{-1}. Mahamud *et al*., (2013), stated that grain yield was not significantly influenced by the number of seedlings hill^{-1}. Mahamud *et al*., (2013), stated that grain yield was not significantly influenced by the number of seedlings hill^{-1}. Straw yield was not significantly affected by number of seedling hill^{-1}. Maximum straw yield (8.78 t ha^{-1}) was obtained from hills having 3 seedlings hill^{-1} while the lowest straw yield (8.29 t ha^{-1}) was recorded from 2 seedlings hill^{-1} (Figure 1) In agreement with this result, Rasool *et al*. (2012) found that 3 seedlings gave maximum straw yield (9,280 t ha^{-1}) than 5 seedling hill^{-1} (8.57 t ha^{-1}). Bhowmik *et al.* (2012) also obtained lowest yield from 2 seedling hill^{-1}. Islam *et al.* (2008) who also found non-significant relations in straw yield with number of seedlings hill^{-1}. Biological yield was significantly affected by number of seedling hill^{-1}. The highest biological yield (15.71 t ha^{-1}) was found from 3 seedlings hill^{-1} and the lowest biological yield (14.48 t ha^{-1}) was obtained from 1 seedlings hill^{-1} (Figure 1). Harvest index was significantly influenced by number of seedling hill^{-1} at 1% level of probability. The harvest index was statistically influenced with the number of seedlings per hill. The highest harvest index (44.26%) was found from 4 seedlings hill^{-1} and the lowest harvest index (41.49%) was obtained from 1 seedlings hill^{-1} (Figure 1). Bhowmik *et al.* (2012) reported an experiment which is partially supported by the finding.

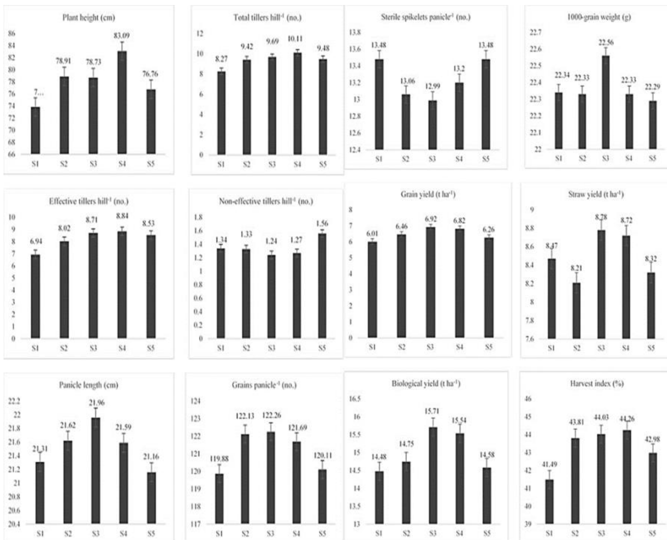

Figure 1. Effect of number of seedlings hill-1 on the yield contributing characters and yield of purple rice.

Effect of Harvesting Time on the Yield Contributing Characters and Yield of Purple Rice

Plant height was significantly affected by harvesting time. The result disclosed that the highest plant height (82.29 cm) was recorded when the crop was harvested at 25 DAF. The lowest plant height (75.63 cm) was recorded at 20 DAF (Figure 2). Time of harvesting significantly influenced the number of total tillers. Maximum number of total tillers (10.19) was recorded at 25 DAF and minimum tillers (8.82) was obtained at 20 DAF (Figure 2). Number of effective tiller was significantly influenced by harvesting time. The highest number of effective tillers (9.39) was obtained for harvesting at 25 DAF followed by 30 and 20 DAF. The lowest number of effective tillers was found (7.45) when harvested at 20 DAF (Figure 2). Effect of harvesting time had significant effect on non-effective tillers hill^{-1}. However, numerically the non-effective tillers were the highest (1.55) for 30 DAF and the lowest (1.04) for 25 DAF (Figure 2). Panicle length was significantly influenced by harvesting time. Results showed that the longest panicle length (22.00cm) was obtained for harvesting at 25 DAF. On the other hand, the shortest panicle length was found (21.22cm) when harvested at 20 DAF (Figure 2). Number of grains panicle^{-1} was significantly affected by harvesting time at 1% level of probability. The highest number of grains panicle^{-1} (123.59) was found for harvesting at 25 DAF, which was statistically identical to harvesting at 25 DAF (120.21). The lowest number of grains panicle (119.85) was found from harvesting at 20 DAF (Figure 2). Harvesting time had significant effect on number of sterile spikelets panicle^{-1}. The highest number of sterile spikelets panicle^{-1} (13.46) was produced at 30 DAF. The lowest number of sterile spikelets panicle^{-1} (13.39) was produced at harvesting 20 DAF (Figure 2). Effect of harvesting time was found insignificant for 1000-grains weight. However, apparently the highest 1000-grain weight (22.43 g) was obtained for 25 DAF and the lowest (22.31 g) for 20 DAF (Figure 2). Harvesting time showed significant influence on grain yield having the maximum grain yield (6.86 t ha^{-1}) when harvested at 25 DAF and the lowest grain yield was obtained (6.21 t ha^{-1}) when harvested at 20 DAF (Figure 2). Similar result was also observed by Jewel *et al.* (2016) who found that the lowest yield was obtained for harvesting at 20 DAF due to immaturity of spikelet. Harvesting at 30 DAF was intermediate in respect of grain yield (6.41 t ha^{-1}). Optimum harvest timings play an important role for higher grain yield. Harvesting at immature stage and increase up to full heading causes shattering loss and low moisture content of seeds. The effect of harvesting time had significant effect for straw yield. The highest straw yield (8.93 t ha^{-1}) was obtained from 25 DAF and the lowest one (8.09 t ha^{-1}) was found in 30 DAF. 20 DAF was intermediate in respect of straw yield (8.53 t ha^{-1}) (Figure 2). The effect of harvesting time had significant effect for biological yield. However, the height biological yield (15.79 t ha^{-1}) was found for 25 DAF and the lowest one (14.74 t ha^{-1}) was found in 30 DAF (Figure 2). Effect of harvesting time had significant effect for harvest index. The highest harvest index (44.46%) were found for 30 DAF and the lowest harvest index (42.08%) was found for 20 DAF. Harvesting at 25 DAF was intermediate in respect of harvest index (Figure 2).

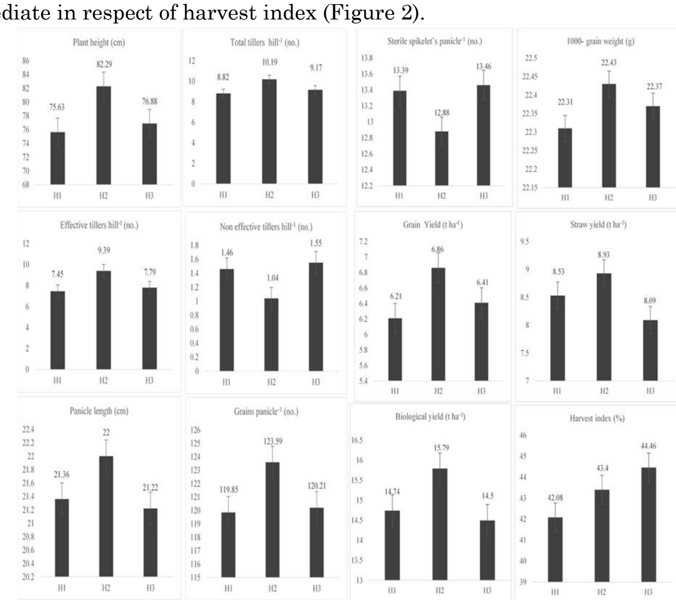

Figure 2. Effect of harvesting time on the yield contributing characters and yield of purple rice

Interaction Effect of Harvesting Time and Seedlings Hill^{-1} on the Yield Contributing Characters and Yield of Purple Rice

Interaction of harvesting time and seedlings hill^{-1} had significant effect on plant height. The tallest plant (89.47 cm) was obtained from H_2S_3 (25 days after flowering + 3 seedling hill^{-1}) and the shortest plant (72.13 cm) was obtained H_3S_3 (30 days after flowering + 3 seedling hill^{-1}) (Table 1). Number of total tillers hill was significantly influenced by the interaction between harvesting time and seedlings hill^{-1}. Number of total tillers hill^{-1} was gradually increased up to certain period thereafter it becomes decreased. The highest number of tillers hill^{-1} (11.93) was obtained from H_2S_3 (25 days after flowering + 3 seedling hill^{-1}) and the lowest one (7.80) was obtained from H_1S_1 (20 DAF + 1 seedling hill^{-1}) and H_2S_1 (25 DAF + 1 seedling hill^{-1}) (Table 1). The interaction effect of harvesting time and seedlings hill^{-1} was statistically significant in terms of number of effective tillers hill^{-1}. All the interaction produced higher number of effective tillers hill^{-1}. Among these the highest number of effective tillers hill-^{1} was found (11.47) in H_2S_3 (25 DAF + 3 seedling hill^{-1}) and lowest number of effective tiller was found (6.37) in H_1S_1 (20 DAF + 1 seedling hill^{-1}) (Table 1). The interaction effect of harvesting time and seedlings hill^{-1} was significant in terms of number of non-effective tillers hill^{-1}. The lowest number of non-effective tillers hill^{-1} (0.47) was obtained from H_2S_3 (25 DAF + 3 seedling hill^{-1}). The highest number of non-effective tiller hill^{-1} (1.73) was found in H_1S_3 (20 DAF + 3 seedling hill^{-1}), H_3S_4 (30 DAF + 4 seedling hill^{-1}), and H_3H_5 (30 DAF + 5 seedling hill^{-1}) (Table 1). The interaction effect of harvesting time and seedlings hill^{-1} was significant in terms of panicle length. The highest number of panicle length was found (23.05 cm) in H_2S_3 (25 DAF + 3 seedling hill^{-1}) and lowest number of panicle length was found (20.72 cm) in H_1S_2 (20 DAF + 2 seedling hill^{-1}) (Table 1). Interaction of harvesting time and seedlings hill^{-1} was significant effect on grains panicle^{-1}. However, apparently the highest number of (128.16) grains per panicle was recorded in H_2S_3 (25 DAF + 3 seedling hill^{-1}) and the lowest number of grains per panicle was recorded (177.99) in H_1S_3 (20 DAF + 3 seedling hill^{-1}) (Table 1). Interaction between harvesting time and seedlings hill^{-1} on number of sterile spikelets panicle^{-1} was highly significant. The highest number of sterile spikelets panicle^{-1} (13.79) was obtained from H_1S_2 (20 DAF + 2 seedling hill^{-1}) and the lowest number of sterile spikelets panicle^{-1} (12.25) was recorded in H_2S_3 (25 DAF + 3 seedling hill^{-1}) (Table 1). The interaction between harvesting time and seedlings hill^{-1} was significant effect on 1000-grain weight. Apparently the highest weight of 1000-grain (22.73 g) was recorded from H_2S_3 (25 DAF + 3 seedling hill^{-1}) and the lowest one (22.20g) is recorded in H_1S_5 (20 DAF + 5 seedling hill^{-1}) (Table 1). Grain yield was significantly affected by the interaction between harvesting time and seedlings hill^{-1}. The highest grain yield (7.93 t ha^{-1}) was achieved from H_2S_3 (25 DAF + 3 seedling hill^{-1}) and the lowest grain yield (5.53 t ha^{-1}) was found in H_1S_1 (20 DAF + 1 seedling hill^{-1}) (Table 1). The interaction effect of harvesting time and seedlings hill^{-1} on straw yield was significant. The highest straw yield (9.60 t ha^{-1}) was recorded at H_2S_3 (25 DAF + 3 seedling hill^{-1}). The lowest straw yield (7.73 t ha^{-1}) was found in H_3S_2 (30 DAF + 2 seedling hill^{-1}) (Table 1). Biological yield was significantly affected by interaction of harvesting time and seedlings hill^{-1} at 1% level of probability. The highest biological yield (17.53 t ha^{-1}) was found in H_2S_3 (25 DAF + 3 seedlings per hill) and lowest one (13.70 t ha^{-1}) was H_1S_1 (20 DAF + 1 seedling hill^{-1}) (Table 1). The effect of interaction of harvesting time and seedlings hill^{-1} on biological yield was significant at 5% level of probability. The highest (45.93%) harvest index was found in H_3S_2 (30 DAF + 2 seedling hill^{-1}) and the lowest (40.38%) one in H_1S_1 (20 DAF + 1 seedling hill^{-1}). Numerically H_3S_2 is the best but statistically H_2S_3 (25 DAF + 3 seedling hill^{-1}) is suitable (Table 1).

Table 1. Interaction effect of harvesting time and seedlings hill^{-1} on the yield contributing characters and yield of purple rice.

Harvesting time: Seedlings hill^{-1}	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	Sterile spikelet's panicle^{-1}	1000 grain weight	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
H_1:S_1	72.47e	7.80f	6.37g	1.43a-c	21.67c-f	120.05cd	13.79a	22.33ab	5.53c	8.17bc	13.70d	40.38c
H_1:S_2	72.53e	8.50d-f	6.90fg	1.40a-c	20.72g	121.03b-d	12.81c-e	22.33ab	6.12bc	8.37bc	14.49b-d	42.22a -c
H_1:S_3	74.60e	8.13ef	7.07e-g	1.73a	21.89b-d	117.99d	13.28a-d	22.40ab	6.23bc	8.67a-c	14.90b-d	41.87a-c
H_1:S_4	83.87bc	10.20a-d	9.00b-d	1.20b-d	21.05d-g	121.05b-d	13.37a-d	22.30ab	6.72b	8.73a-c	15.45b	43.42a-c
H_1:S_5	74.67e	9.47c-f	7.93c-g	1.53ab	21.47c-g	119.11cd	13.69ab	22.20b	6.43b	8.73a-c	15.17bc	42.50a-c
H_2:S_1	72.40e	7.80f	6.53g	1.33bc	21.03d-g	120.43b-d	13.00b-d	22.30ab	6.17bc	8.83ab	15.00b-d	41.11bc
H_2:S_2	86.67ab	10.70a-c	9.57bc	1.13cd	22.30a-c	123.67bc	13.00b-d	22.37ab	6.70b	8.77a-c	15.47b	43.28a-c
H_2:S_3	89.47a	11.93a	11.47a	0.47e	23.05a	128.16a	12.25e	22.73a	7.93a	9.60a	17.53a	45.25ab
H_2:S_4	87.87ab	11.40ab	10.53ab	0.87d	22.56ab	124.93ab	12.71de	22.40ab	7.37a	9.50a	16.87a	43.69a-c
H_2:S_5	75.07e	9.10c-f	8.87b-e	1.40a-c	21.08d-g	120.76b-d	13.43a-d	22.33ab	6.13bc	7.93bc	14.07cd	43.67a-c
H_3:S_1	76.67de	9.20c-f	7.93c-g	1.27bc	21.24d-g	119.17cd	13.67b-d	22.40ab	6.33b	8.40bc	14.73b-d	42.98a-c
H_3:S_2	77.53de	9.07c-f	7.60d-g	1.47a-c	21.85b-e	121.71b-d	13.36a-d	22.30ab	6.57b	7.73c	14.30b-d	45.93a
H_3:S_3	72.13e	9.00c-f	7.60d-g	1.53ab	20.92fg	120.64b-d	13.44a-c	22.53ab	6.60b	8.09bc	14.69b-d	44.96ab
H_3:S_4	77.53de	8.73c-f	7.00e-g	1.73a	21.16d-g	119.09cd	13.52a-c	22.30ab	6.37b	7.93bc	14.30b-d	45.68a
H_3:S_5	80.53cd	9.87b-e	8.80b-f	1.73a	20.93e-g	120.45b-d	13.31a-d	22.33ab	6.20bc	8.30bc	14.50b-d	42.77a=c
$S\bar{x}$	**1.55**	**0.32**	**0.38**	**0.09**	**0.18**	**0.67**	**0.11**	**0.03**	**0.15**	**0.14**	**0.26**	**0.42**
Level of significance	*	**	**	**	**	*	*	*	**	*	**	*
CV (%)	**3.65**	**10.87**	**12.09**	**10.08**	**2.22**	**2.01**	**2.80**	**1.07**	**5.92**	**6.39**	**4.52**	**4.88**

Means with the same letters within the same column do not differ significantly.
** = Significant at 1% level of probability, *= Significant at 5% level of probability.

SUMMARY AND CONCLUSION

The crop was harvested at maturity when 90% of the grain become golden yellow in color. The crop was harvested at different days after flowering (DAF) viz. 20, 25 and 30. The harvested crop was threshed and dried, and of grain and straw were recorded plot wise and converted into t ha^{-1}. Data were analyzed using the "Analysis of Variance" technique and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT). The mean differences among the treatments were compared by least significant difference test at 5 % and 1% level of significance.

Based on the result it can be concluded that: 3 seedlings hill^{-1} could be followed in transplanting to get higher yield of purple rice, in case of harvesting time 25 days after flowering (DAF) could be followed for harvesting of purple rice. The combination of 3 seedlings hill^{-1} and 25 days after flowering could be the best possible combination for obtaining higher yield of purple rice.

REFERENCES

1. Banik P, Sarker B, Samuel T, Ghosol PK, Bafohi DK 1997: Effect of different numbers and age of seedlings on rice cultivars in low land Plateau region of Bihar. *Indian Journal of Agronomy* **42(2)** 265-268.
2. BBS (Bangladesh Bureau of Statistics), 2020: Statistical yearbook of Bangladesh for 2020: Bureau of Statistics, Statistics and Information Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.
3. Bhowmik SK, Sarkar MA, Zaman F 2012: Effect of spacing and number of seedlings per hill on the performance of aus rice cv. NERICA 1 under dry direct seeded rice (DDSR) system of cultivation. *Journal of Bangladesh Agriculture University* **10(2)** 191–196.
4. Biswas KK, Hussain AI, Abuyusuf M, Hassan MZ, Jannat N 2015: Hill spacing and number of seedlings per hill on the yield of t. *Aman* rice (var. BRRI dhan52) in the tidal ecosystem. *American Research Thoughts* **1(11)** 2392-2876.
5. Cai YZ, Cheng GF, Wu HM, Xue YS 1991: Investigation of target for yield components and the establishment of relative population for the high yielding Japonica rice hybrid, Han You 102. *Acta Agriculturae Scandinavica* **7(3)** 41-45.
6. Chauhan SS 2005: Effect of Number of Seedlings per Hill and Varying Zinc Sulphate Doses on Paddy Varieties Under Delayed Planting Condition, Ph.D. Thesis, C.S.A.U.A. & T., Kanpur.

7. DhakaaTribune,,2020:Https://archive.dhakatribune.com/bangladesh/nation/2020/05/16/purple-paddy-attracts-farmers-in-tangail. Published at 09:25 pm May 16th, 2020.
8. Ebaid RA, El-Refaee IS 2007: Utilization of rice husk as an organic fertilizer to improve productivity and water use efficiency in rice fields. *African Crop Science Conference Proceedings* **8** 1923-1928.
9. FAO (Food and Agriculture Organization) 2020: *Production Year Book*. Food and Agricultural Organization of the United Nations, Rome, Italy 75-76.
10. Faruk M, Rahman M, Hasan M 2009: Effect of seedling age and number of seedling per hill on the yield and yield contributing characters of BRRI Dhan33. *International Journal of Sustainable Crop Production* **4(1)** 58-61.
11. Gomez AK, Gomez AA 1984: Statistical Procedures Agricultural Research (2nd edition), John Wiley and Sons, New York 207-215.
12. Inaba K, Kitano M, 2005: Effect of number of seedlings per hill on rice tillering. *Japanese Journal of Crop Science* **74(2)** 141-148.
13. IRRI (International Rice Research Institute) 2020: *Rice production Manual*. Annual Report for 2020. UPLB, Los Banos, Languna, Philippines 170-178.
14. Inaba K, Kitano M 2005: Effect of number of seedlings per hill on rice tillering. *Japanese Journal of Crop Science* **74(2)** 141-148.
15. Islam MR, Sikder S, Bahadur MM, Hafiz MHR 2012: Effect of different fertilizer management on soil properties and yield of fine rice cultivar. *Journal of Environmental Science and Natural Resources* **5(1)** 239-242.
16. Islam MS, Akhter MM, Rahman MSQ, Banu MB, Khalequzzaman KM 2008: Effect of nitrogen and number of seedlings per hill on the yield and yield components of transplanted *aman* rice (BRRI Dhan33). *International Journal of Sustainable Crop Production* **3(3)** 61-65.
17. Julfiquar AW, Jamil M, Kulsum U, Ali MH 2009: Development of Hybrids in *Public Sector Research*, Paper presented at the National Seed Fair, Bangladesh-China friendship Conference center, Dhaka.
18. Maclean JL, Dawe DC, Hardy B, Hettel GP 2009: Rice Almanace, Los Banos (Phillipines): International Rice Research Institute. Boukae (Coted. Lovire): Wast Africa Rice Diversification Association Cali (Colombia): International Center for Tropology Agriculture, Rome (Italy): *Food and Agricultural Organization* 253.
19. Mahamud JA, Haque MM, Hasanuzzaman M 2013: Growth, dry matter production and yield performance of transplanted aman rice varieties influenced by seedling densities per hill. *International Journal of Sustainable Agriculture* ***5*(1)** 16-24.
20. Mahato M, Pokhrel K, Singh S, Poudel PR 2018: Effect of age and number of seedling per hill on production of rice in sub-tropical region of Nepal. *American Journal of Agricultural Science* **5(4)** 55-58.
21. Mahadi MA, Dadari SA, Mahmud M, Babaji BA 2006: Effect of pre-emergence herbicides on yield and yield components of rice. *Journal of Food, Agriculture and Environment* **4(2)** 164-167.
22. Murthy K, Kumar A, Hittalmani S 2011: Response of rice (*Oryza sativa* L.) genotypes under aerobic conditions. *Electronic Journal of Plant Breeding* **2(2)** 194-199.
23. Paul SK, Sarkar MAR, Hossain MA 2017: Impact of row arrangements, age of tiller seedlings and number of tiller seedlings hill on the growth performance of transplanted *aman* rice (cv. BR23). *Journal of Archives of Agriculture and Environmental Science* **2(3)** 152-161.
24. Promsomboon P, Sennoi R, Puthmee T, Marubodee R, Ruanpan W, Promsomboon S 2019: Effect of seedlings numbers per hill on the growth and yield of Kum Bangpra Rice Variety (*Oryza sativa* L.). *International Journal of Agricultural Technology* **15(1)** 103-112.
25. Rasool F, Habib R, Bhat MI 2012: Evaluation of plant spacing and seedlings per hill on rice (*Oryza sativa* L.) productivity under temperate conditions. *Pakistan Journal of Agricultural Science* **49(2)** 169-172.
26. Rikabder MF 2004: *Dhan Chaser nana katha* (In Bengaki). Krishikatha. **64(2)** 39-40.
27. Sarker BC, Nahar N 2017: Effect of number of seedlings per hill and spacing on growth and yield of transplanted aman rice (*Var.* Ranisalute). *Khulna University Studies Volume* **14(1-2)** 27-38.
28. Shah MH, Khushu MK, Khanday BA, Bali AS 1991: Effect of spacing and seedlings hill^{-1} on transplanted rice under late sown condition. *Indian Journal of Agronomy* **36(2)** 274-275.
29. Sreedhar M, Ganesh M 2010: Studies on influence of age of seedlings and spacing on seed yield and quality under system of rice (*Oryza sativa* L.) intensification. *Journal Research ANGRAU* **38(1/2)** 103-107.
30. The Daily Star, 2018: https://www.thedailystar.net/country/high-yielding-purple-paddy-1610995. Published at 12:00 am, Thusday, Jul 26, 2018
31. Varma AK, Pandey N, Tripathi S 2002: Effect of transplanting spacing and number of seedlings on productive tillers, Spikelet sterility, grain yield and harvest index of hybrid rice. *International Rice Research Notes (Philippines)* **27(1)** 51.
32. Vivek KT, Gomez SM, Suresh R, Kumar SS, Yogameenakshi P, Chezhian P, Boopathi NM, Shanmugasundaram P, Babu RC 2004: Genetic diversity analysis among rice accessions differing in drought tolerance using molecular markers. *Journal of Food, Agriculture and Environment* **2(3-4)** 217-222.
33. Yusuf HKM 1997: In Report of the sustainable Food Security Mission in Bangladesh (FAO, Rome), Dhaka.
34. Zhang XG, Huang YK 1990: Effect of seedlings hill^{-1} on individual rice plant yield and yield components. *International Rice Research Newsletter* **15(4)** 21-22.