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Effect of Sowing Dates on Some Morpho-physiological Traits of an Exotic (China) Hybrid Rice Variety in Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SB, MHR, SON and KUA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SB and MHR managed the analyses of the study. Author SON managed the literature searches and edited the manuscript. Author KUA supervised the experiment. All authors read and approved the final manuscript.

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ABSTRACT

This experiment was conducted at the Agricultural Botany experimental field of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka during the period from January to April 2014 to study the effect of sowing times on the morpho-physiological attributes of an exotic (China) hybrid rice variety in Bangladesh. Five treatments were considered regarding 5 sowing dates or transplanting dates viz. (i) S_1 = 1st sowing at 1st January 2014; transplanted at 21st January, (ii) S_2 = 2nd sowing at 21st January; transplanted at 11th February, (iii) S_3 = 3rd sowing at 11th February; transplanted at 3rd March, (iv) S_4 = 4th sowing at 3rd March; transplanted at 23rd March and (v) S_5 = 5th sowing at 23rd March; transplanted at 13th April. Data were recorded on different growth

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parameters to examine the effect of sowing times on the morpho-physiological attributes of the tested variety. The studied parameters were significantly affected by different sowing times or transplanting times. Results revealed that different parameters regarding morpho-physiological attributes, the seeds of the tested variety sown at 1st January 2014 and transplanted at 21st January (S_1) furnished the best results in respect of highest length of panicle at harvest (26.39 cm), and highest number of fertile tillers found from S_2= sowing at 21st January; transplanted at 11th February compared to the seedling transplanted on other dates. However, the shortest days of booting, ear emergence and anthesis were found from S_5 = 5th sowing 23rd March; transplanted at 13th April. It is revealed that early sowing facilitates tillering and late sowing helps in quick flowering. These findings can be used in further breeding program.

Keywords: Sowing dates; morpho-physiological traits; hybrid rice variety.

1. INTRODUCTION

Rice (*Oryza sativa*) belongs to the family Gramineae. In Asian countries, rice is a staple food for at least 62.8% of total planet inhabitants and it contributes on an average 20% of apparent calorie intake of the world population and 30% of the population. This calorie contribution varies from 29.5% for China to 72.0% for Bangladesh [1]. Around the world, it is the most important food crop and the foremost food for approximately more than two billion people in Asia [2]. All rice is grown 90% and consumed in Asia [3,4]. An alarming rate for Bangladesh is population increasing and reducing the cultivable land is due to urbanization and shortage of food due to industrialization. Every year about 2.3 million people to its total of 150 million people were added in the nation [5]. In Bangladesh, population growth demands continuously increase in rice production. So, the highest priority has been given to more rice production [6]. At least 60% increase production of rice has to be to meet up food requirement of the increasing population by the year 2020 [7]. So, scientists were concerned about various rice production technologies to augment the rice production. Hybrid rice technology is one of the most effective demand for mitigating tactics. Hybrid rice technology development in Bangladesh began in 1993. Hybrid rice yields about 15-20% more than the promising high yielding commercial varieties. The Government encouraged private sector companies to import hybrid rice seeds and try them with farmers. Some private seed companies imported rice hybrids and evaluated them through on-farm trials during 1997-98 in boro season (winter rice) [8]. The Chinese hybrid rice has demonstrated that the yield capability of hybrid rice must be accomplished, on the off chance that each ecological zone builds up its own particular variety or screens variety created in different areas to meet particular nearby conditions [9].

Planting time affects not only growth and productivity of rice but also generally affects on seed quality. Planting time affects seed quality through affecting seed growth and development as it obtained different environmental conditions in the processes of seed development and seed maturation [10]. In spite of the fact that variation in climatic parameters makes it hard to choose ideal planting times for hybrid rice, however, endeavor is needed to discover the most fitting time of cultivating hybrid rice keeping in mind the end goal to maintain a strategic distance from the hazard in hybrid rice production. In Bangladesh Boro rice has been gaining much importance. The average per hectare yield of boro rice is higher than that of aus and aman rice [11]. Among the three rice seasons of Bangladesh, it is the longest rice season, producing the highest grain yield [12]. More vital advantage of boro season is the lower winter temperature amid the prior crop growth. This encourages the assimilation of photosynthates, subsequently expanding carbon: nitrogen proportion. Amid the maturing time, the temperature rises encouraging the procedure. Variation in these parameters clarify variation in yields over the boro growing territories [13]. The variety used for this experiment is completely new in Bangladesh even if it has enough proficiency in china.

Based on the above importance, this research work is designed to evaluate the growth and yield performance of an exotic (China) hybrid rice varieties in different planting time with the following specific objectives.

- To find out the response of this hybrid rice to different dates of planting in boro season in Bangladesh.
- To study the morpho-physiological attributes of this hybrid rice variety.

2. METHODOLOGY

This experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from January to August 2014 to study the effect of sowing times on the morpho-physiological attributes of an exotic (China) hybrid rice variety in Bangladesh. Details of the materials and methods have been presented below:

2.1 Location

Experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is 23º74′N latitude and 88º35′ longitude with an elevation of 8.2 meter from sea level.

2.2 Climate

The geographical location of the experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October.

2.3 Weather

Details of meteorological data in respect of average temperature 19.10, 23.40, 31.60, 29.20 (ºC), rainfall 3.00, 2.00, 3.00, 1.00 (mm), relative humidity 66.50, 61.00, 72.70, 68.50 (%) and sunshine hours 194.10, 221.50, 227.00, 194.10 during January, February, March and April 2014 respectively.

2.4 Plant Material

An exotic (China) hybrid rice variety was used for the present study which was collected from Bangladesh Rice Research Institute (BRRI).

2.5 Experimental Details

2.5.1 Treatments

Randomized Complete Block Design (RCBD) with four replications.

Single factors: Sowing times

S_1 = 1st sowing at 1st January 2014; transplanted at 21st January

S_2 = 2nd sowing at 21st January; transplanted at 11th February

S_3 = 3rd sowing at 11th February; transplanted at 3rd March

S_4 = 4th sowing at 3rd March; transplanted at 23rd March

S_5 = 5th sowing at 23rd March; transplanted at 13th April

2.6 Unit Plot Size

The size of each unit plot was 12 m^2 (4 m x 3 m). There were 20 plots in total.

2.7 Growing of Crop

Seed sprouting and preparation of seedbed, preparation of main field, fertilizer and manure application were done as per recommendations of Bangladesh Rice Research Institute. (BRRI, 2013)

2.8 Intercultural Operation

Irrigation and drainage, weeding and gap filling, top dressing and other plant protection measures were taken as per necessity.

2.9 Data Recording

The morphological attributes of this experiment are plant height, number of tillers/hill, number of fertile tillers/hill, number of infertile tillers/hill, length of panicle, days to booting, days to anthesis and days to ear emergence. Data of plant height and number of tillers/hill were recorded 30, 50, 70, 90, 110 DAT (Days after transplanting) and at harvest. Data were counted from 10 selected samples in the field. Days to booting was recorded on 1st, 50%, 80% and 100% booting and was counted regarding DAT. Similar method was followed for data of ear emergence. On the other hand, Days to anthesis were recorded by counting the number of days required to begin from days to first anthesis to followed by 40%, 60%, 80% and 100% anthesis in each plot. Days to anthesis was estimated by ten (10) observations of plant. This data recording procedure is in conformity with Safdar, et al. [14].

2.10 Statistical Analysis

The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference

among the treatments means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability [15].

3. RESULTS

The results of the study were presented by evaluating the morpho-physiological performance of an exotic (China) hybrid rice variety by different dates of sowing of seeds maintaining the same interval of transplanting of seedlings. The experimental findings regarding morpho-physiological attributes have been presented under the following headings:

3.1 Plant Height at 30, 50, 70, 90 and 110 DAT and at Harvest

For different transplanting dates significant differences were found on plant height (Fig. 1). Results showed that the highest plant height (42.80, 71.68, 92.43, 102.5, 110.4 and 123.40 cm at 30, 50, 70, 90 and 110 DAT and at harvest respectively) was found from S_5 (13 April 2014), while the minimum plant height (22.60, 37.58, 61.56, 72.72, 96.46 and 100.00 cm at 30, 50, 70, 90 and 110 DAT and at harvest respectively) was recorded from S_1 (21 January 2014). Higher temperature in delay sowing may be attributable to the better plant height. Early time (April 20th) of sowing was topmost to other times of sowing for plant height reported by Abou-Khali [16]. These results are in line with Khakwani, et al. [17] and Paraye and Kandalkar [18] who measured that plant height are significantly influenced by sowing dates. These results are also in line with Saikia, et al. [19] and Gravois and Helms [20] who reported that early sowing of rice produced taller plants than delayed sowing. Similar result was found from Keith and Mehta [21]; Safdar, et al. [14].

3.2 Number of Tillers hill^{-1} at 30, 50, 70, 90 and 110 DAT and at Harvest

There were significant variations recorded incase of number of tillers hill^{-1} (Fig. 2) at different days after transplanting. Results provided that the highest number of tillers hill^{-1} (4.93, 9.34, 11.70, 13.52, 15.90 and 17.13 cm at 30, 50, 70, 90 and 110 DAT and at harvest respectively) were achieved from S_4 (23 March 2014), while the lowest number of tillers hill^{-1} (3.05, 4.89, 9.92, 11.73, 12.55 and 12.86 cm at 30, 50, 70, 90 and 110 DAT and at harvest respectively) were recorded from S_2 (11 February 2014). Similar result was found from the findings of Vergara and Chang [22]. Keith and Mehta [21] observed that in November planting of BR3 when the cool temperature, the vegetative phase was prolonged by 50 days and the relative tillering rate reached its peak at 40 to 50 days after transplanting.

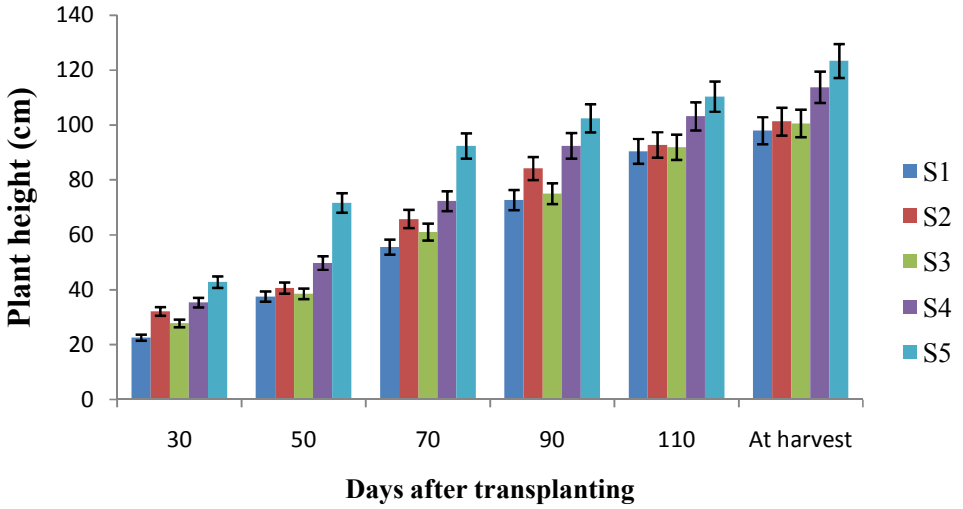

Fig. 1. Effect of sowing times on plant height of an exotic (China) hybrid rice variety

S_1 = 1st sowing at 1st January 2014; transplanted at 21st January
S_2 = 2nd sowing at 21st January ; transplanted at 11th February
S_3 = 3rd sowing at 11th February ; transplanted at 3rd March
S_4 = 4th sowing at 3rd March; transplanted at 23rd March
S_5 = 5th sowing at 23rd March; transplanted at 13th April

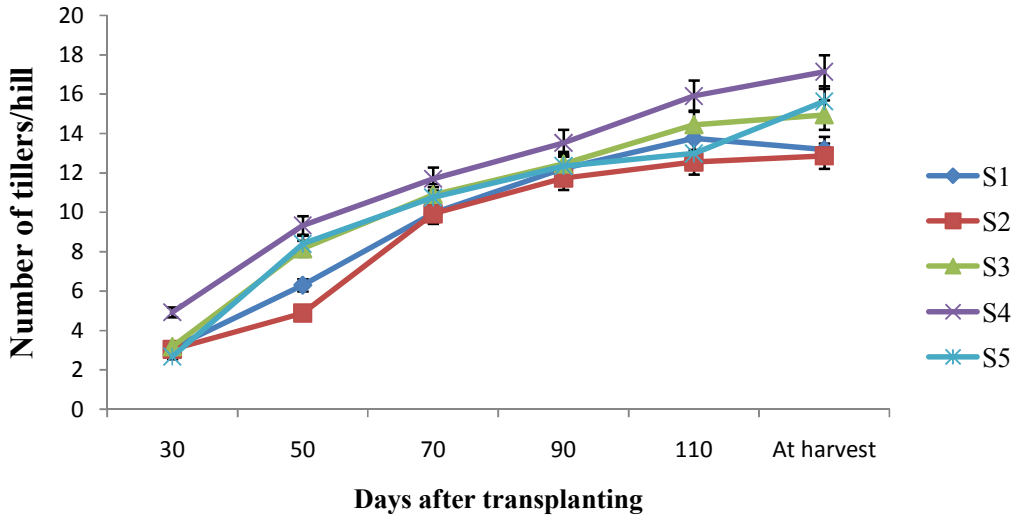

Fig. 2. Effect of sowing times on number of tillers hill^{-1} of an exotic (China) hybrid rice variety

S_1 = 1st sowing at 1st January 2014; transplanted at 21st January
S_2 = 2nd sowing at 21st January; transplanted at 11th February
S_3 = 3rd sowing at 11th February; transplanted at 3rd March
S_4 = 4th sowing at 3rd March; transplanted at 23rd March
S_5 = 5th sowing at 23rd March; transplanted at 13th April

3.3 Number of Fertile and Infertile Tillers hill^{-1}

It is revealed (Table 1) that the maximum number of fertile tillers hill^{-1} (13.77) were achieved from S_2 (11 February 2014) where the minimum number of fertile tillers hill^{-1} (8.92) were recorded from S_5 (13 April 2014). These results are similar to that of Akbar, et al. [23], they indicated that different sowing dates had a significant effect on the number of fertile tillers/m^2. The findings showed that the highest number of infertile tillers (6.70) were obtained from S_5 (23 April 2014) where the lowest number of infertile tillers (0.68) were recorded from S_2 (11 February 2014). These results are also in line with Rakesh and Sharma [24] who reported that delaying in planting in rice resulted in significant decrease in a number of productive tillers per meter square and ultimately the paddy yield. Similarity was found the research from Islam, et al. [25]. Our results are in match with the observation of Pandey, et al. [26], Lu and Cai [27] and Paraye and Kandalkar [18].

3.4 Length of Panicle at Harvest

The findings (Table 1) showed that the highest length of panicle at harvest (26.39 cm) was achieved from S_1 (21 January 2014) whereas, the lowest length of panicle at harvest (23.97 cm) was recorded from S_5 (13 April 2014). These findings are in conformity with those of IRRI [28]; Afghani [29]). Maximum grain yield was found due to accumulation effect of longer panicle (Salam, et al. [30]. Same findings were also reported by Rahman [31].

3.5 Days to first, 50%, 80% and 100% Booting

Date of transplanting exerted significant differences exist among the results of days to first booting of all the treatments (Fig. 3). The longest days to first booting (82.0) was obtained from sowing date S1 (21 January 2014) where the shortest days to first booting (47.0) was achieved from sowing date S5 (13 April 2014). Early sowing has the beneficial that the accumulation of dry matter is appropriate in the early stage by Zhong-yang, et al. [32]. Similar result was obtained by Osman, et al. [33] and Khalifa, et al. [34]. Results showed that the highest days to 50% booting (87.00) was recorded from sowing date S1 (21 January 2014) where the lowest days to 50% booting (61.00) was observed from S5 (13 April 2014). The observations showed that the maximum days to 80% booting (92.00) was obtained from sowing date S1 (21 January 2014) where the minimum

days to 80% booting (66.00) was obtained from S5 (13 April 2014). In case of 100% booting, S1 (21 January 2014) showed the longest days (96.00). On the other hand, the shortest days to 100% booting (71.00) was obtained from S5 (13 April 2014).

3.6 Days to First, 50%, 80% and 100% Emergence of Ear

Results showed (Fig. 4) that the maximum days to first emergence (93.00) was obtained from sowing date S_1 (21 January 2014) where the

Table 1. Effect of sowing times on yield contributing parameters regarding number of fertile tillers hill^{-1}, number of infertile tillers hill^{-1} and length of panicle of an exotic (China) hybrid rice variety

Treatments	Number of fertile tillers hill^{-1}	Number infertile tillers hill^{-1}	Length of panicle at harvest (cm)
S_1	13.32 a	1.85 c	26.39 a
S_2	13.77 a	0.68 d	25.37 b
S_3	12.19 b	1.18 d	24.65 c
S_4	11.97 b	5.15 b	25.21 b
S_5	8.92 c	6.70 a	23.97 d
$LSD_{0.05}$	0.69	0.55	0.55
CV (%)	6.11	8.33	7.44

In a column, same lettering indicates significantly same result and different indicate significantly different results among the treatments

S_1 = *1st sowing at 1st January 2014; transplanted at 21st January*
S_2 = *2nd sowing at 21st January; transplanted at 11th February*
S_3 = *3rd sowing at11th February; transplanted at 3rd March*
S_4 = *4th sowing at 3rd March; transplanted at 23rd March*
S_5 = *5th sowing at 23rd March; transplanted at 13th April*

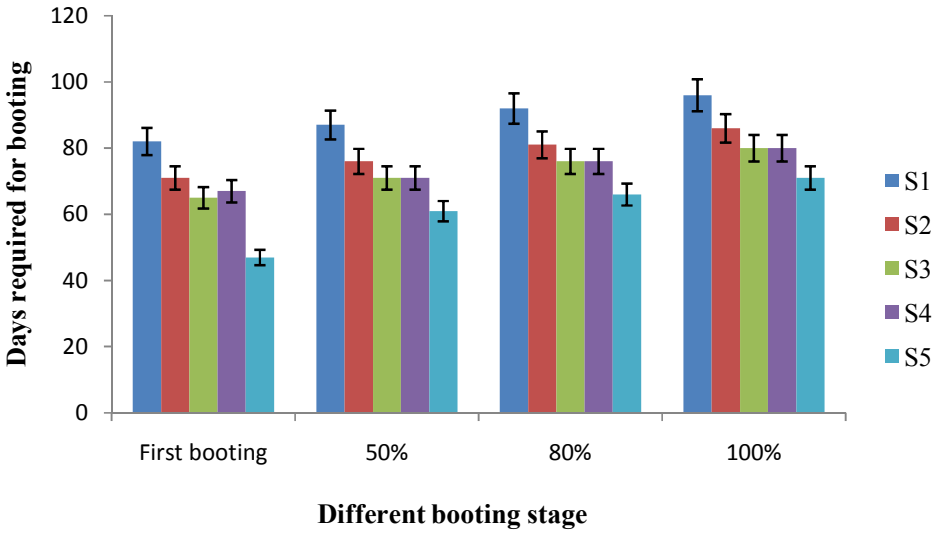

Fig. 3. Effect of sowing times on days to booting at different days after transplanting of an exotic (China) hybrid rice variety

S_1 = *1st sowing at 1st January 2014; transplanted at 21st January*
S_2 = *2nd sowing at 21st January; transplanted at 11th February*
S_3 = *3rd sowing at 11th February; transplanted at 3rd March*
S_4 = *4th sowing at 3rd March; transplanted at 23rd March*
S_5 = *5th sowing at 23rd March; transplanted at 13th April*

minimum days to first emergence (66.00) was obtained from S_5 (13 April 2014). Longest days to 50% emergence (97.00) was obtained from S_1 (21 January 2014) while the lowest days to 50% emergence (71.00) was recorded from S_5 (13 April 2014). Table showed that the highest days to 80% emergence (99.00) was achieved from S_1 (21 January 2014) and the lowest days to 80% emergence (78.00) was recorded from S_5 (13 April 2014). Similar result was found for 100% emergence of ear.

3.7 Days to first, 40%, 60%, 80% and 100% Anthesis

Results revealed (Fig. 5) that the highest days to first anthesis (96.00) was achieved from S_1 (21 January 2014) where the lowest days to first anthesis (71.00) was recorded from S_5 (13 April 2014. The highest days to 40% anthesis (100.00) was achieved from S_1 (21 January 2014) and the lowest (74.00) was recorded from S_5 (13 April 2014). The highest days to 60% anthesis (103.00) was achieved from S_1 (21 January 2014) and the lowest (76.00) from S_5 (13 April 2014). Results showed that the highest days to 80% and 100% anthesis (106.00 and 115.00 respectively) were achieved from S_1 (21 January 2014) while the lowest days to 80% and 100% anthesis (80.00 and 90.00 respectively) were recorded from S_5 (13 April 2014). Due to increasing temperature during late sowing it causes hampered for anthesis period observed by Jagadish, et al. [35].

4. DISCUSSION

Results from the present study on different parameters as plant height, number of tillers hill^{-1}, length of panicle, days to booting, days to emergence of ear, days to anthesis were significantly affected by different sowing times or transplanting times. Results revealed that plant height showed an increasing trend with delayed transplanting. The highest plant height (42.80, 71.68, 92.43, 102.5, 110.4 and 123.40 cm at 30, 50, 70, 90 and 110 DAT and at harvest respectively) was found from S_5 (13 April 2014) and the minimum plant height (22.60, 37.58, 61.56, 72.72, 96.46 and 100.00 cm at 30, 50, 70, 90 and 110 DAT DAS and at harvest respectively) was recorded from S_1 (21 January). It was obtained from Table 1 that number of tillers were increased progressively with the increase of time and growth stages up to at harvest. Sowing was attributed due to the favorable environmental conditions which enabled the plant to improve its growth and

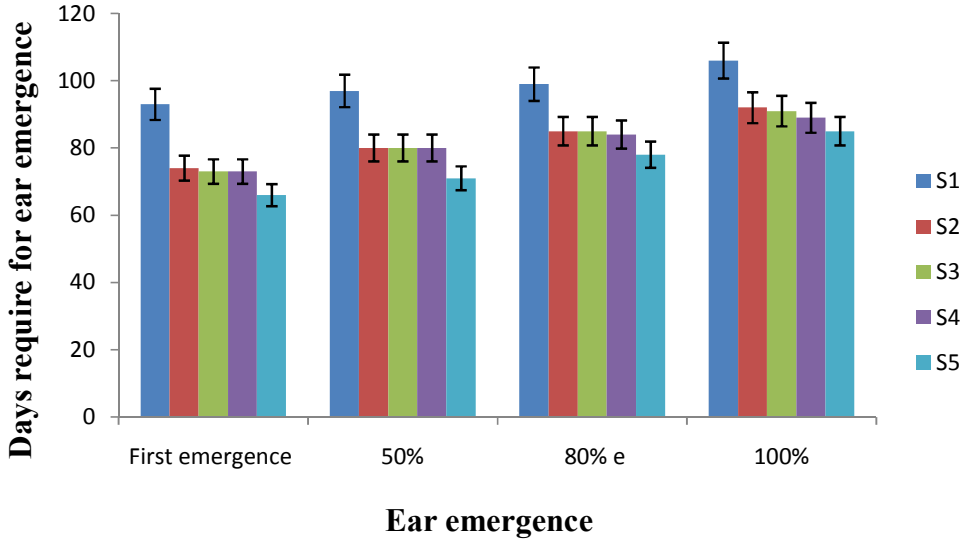

Fig. 4. Effect of sowing times on days to emergence of ear at different days after transplanting of an exotic (China) hybrid rice variety

S_1 = 1st sowing at 1st January 2014; transplanted at 21st January
S_2 = 2nd sowing at 21st January; transplanted at 11th February
S_3 = 3rd sowing at 11th February; transplanted at 3rd March
S_4 = 4th sowing at 3rd March; transplanted at 23rd March
S_5 = 5th sowing at 23rd March; transplanted at 13th April

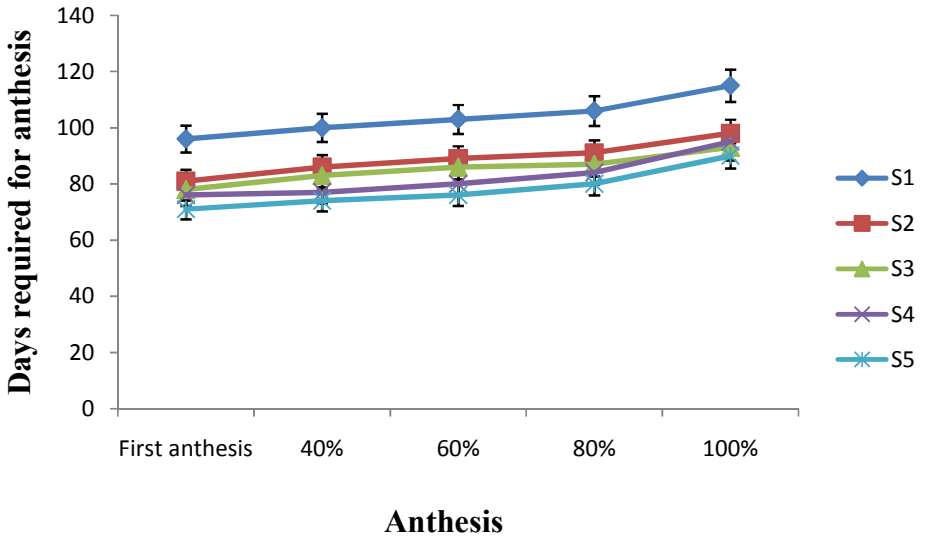

Fig. 5. Effect of sowing times on days to anthesis at different days after transplanting of an exotic (China) hybrid rice variety

S_1 = *1st sowing at 1st January 2014; transplanted at 21st January*
S_2 = *2nd sowing at 21st January; transplanted at 11th February*
S_3 = *3rd sowing at 11th February; transplanted at 3rd March*
S_4 = *4th sowing at 3rd March; transplanted at 23rd March*
S_5 = *5th sowing at 23rd March; transplanted at 13th April*

development as compared to late sowing dates. Findings showed that the highest length of panicle at harvest (26.39 cm) was achieved from S_1 (21 January 2014) and then decreased gradually. The reduction in panicle length for late sowing dates could be attributed to the effect photoperiod and temperature according to the fact that rice is considered as a summer and short-day crop. Required days to first, 50%, 80% and 100% booting was reported at S_1 (21 January). Along with the delayed sowing date booting, showed an apparent downward trend and the difference was increasing with the growing process. Results from the present study regarding days to emergence of ear, S_1 (21 January 2014) treatment showed the highest days required from days to first emergence of ear to 100% emergence of ear where S_5 (13 April 2014) required lowest days to first emergence of ear to 100% emergence of ear during the cropping period. Similarly, S_1 (21 January) showed the highest attribute to anthesis. Early favorable environmental condition facilitates such incidence.

5. CONCLUSION

Results revealed that different sowing dates have significant effects on the described exotic hybrid rice. Our data showed that early sowing lengthened the plant height and also responsible for reduced tiller numbers. However, early sowing showed higher number of fertile tillers than late sowing. On the other hand, shortest days to booting occurred in late sowing and vice-versa. Inversely shortest days to emergence of ear happened in early sowing. That means sowing dates have varied effect on the physio-morphological traits of rice variety. The variable associations between sowing dates and morphological traits can be exploited in rice breeding programs aimed at developing rice varieties in Bangladesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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