Journal BiNET
Scientific Publication

Published with Open Access at Journal BiNET
Vol. 19, Issue 02: 1613-1627
Journal of Bioscience and Agriculture Research

Journal Home: www.journalbinet.com/jbar-journal.html

Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates

Naznin Ahmed, Kamal Uddin Ahamed, Nasima Akhter, Md. Tofail Hosain, Rezowana Nizam and Md. Saidur Rahman

Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

✉ For any information: ask.author@journalbinet.com
Article received: 10.12.18; Revised: 20.02.19; First published online: 14 March 2019.

ABSTRACT

The actual planting date gives the best morpho-physiological characters and highest shoot reserve translocation which finally increased the rice yield. The experiment comprised of two factors- factor a: Planting time (2): T_1: 24 January planting; T_2: 23 February planting and factor b: Rice variety (5): V_1: BRRI dhan29; V_2: BRRI hybrid 2; V_3: Hera 2; V_4: Tia and V_5: Taj 1. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Among the different planting time and varieties, 24 January planting and Hera 2 were found superior in terms of morpho-physiological characters and shoot reserve remobilization of rice cultivars. Irrespective of planting times, the highest plant height (112.03 cm), tillers hill^{-1} (16.43), SPAD value of leaves (35.82), and leaf area index (5.74) were achieved. Hera 2 provided the highest shoot reserve translocation (17.83% and 15.84%) at 24 January planting and 23 February planting, respectively compared to other rice varieties. Finally, 24 January transplanting with Hera 2 exhibited the superior combinations than other parameters.

***Keywords**: Rice, Planting date and Shoot reserve remobilization*

Cite Article: Ahmed, N., Ahamed, K. U., Akhter, N., Hosain, M. T., Nizam, R. and Rahman, M. S. (2019). Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates. Journal of Bioscience and Agriculture Research, 19(02), 1613-1627.
Crossref: https://doi.org/10.18801/jbar.190219.196

I. Introduction

Rice (*Oryza sativa* L.) is the 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 and 30% of Asian populations (Hien et al. 2006). In Asia, more than 90% of this rice is consumed (IRRI 2013). The population of Bangladesh is increasing at an alarming rate and the cultivable land is decreasing due to urbanization and industrialization resulting in the shortage of food. The nation is still adding about 2.3 million every year to its total of 150 million people (Momin et al. 2009). Population growth required a continuous increase in rice production in Bangladesh. So, the highest priority has been given to produce more rice. Late or

Published with open access at journalbinet.com
EISSN: 2312-7945, © 2019 The Authors, Research paper

early planting, lake of proper management, suitable varieties and low diseases resistance gives the lowest rice yield (Prakash 2010). Planting time for successful rice production widely depends on varietal life duration, sensitivity to photoperiod, temperature, rainfall and other environmental factors. In Bangladesh, planting of boro rice starts in early November and continues up to last May. Such longer period of planting time is associated with inconsistent rainfall, late harvesting of preceding crops, early flood water and other socioeconomic factors (Zaman 1986). It is assumed that late planting reduces vegetative phase which results from reduced growth and yield of rice (Jhoun 1989). On the contrary, early planted rice sometimes lodges due to over growth or other natural hazards prevailing in the long growing season. Gangwar et al. (1997) also observed a higher number of panicles in early transplanting than in late transplanting. This was due to the fact that rice genotypes planted earlier had the longer period for their vegetative growth compared to those sown later. It is, therefore, essential to generate adequate information relating to planting time to exploit better growth and productivity. Planting time affects seed quality through affecting seed growth and development as it prevails through different environmental conditions in the processes of seed development and seed maturation (Castillo et al. 1994). Variety is the key component to produce the higher yield of rice depending upon their differences in genotypic characters, input requirements and of course the prevailing environmental conditions during the growing season (BRRI 2003) and suitable planting dates, input requirement for crop is studied by authors (Sultana et al. 2015; Siddique et al. 2007) . Now a day's different hybrid rice variety is available in Bangladesh, which has more yield potential than conventional high yielding varieties (Akbar 2004). Hybrid rice has high tillering capacity (Zhende 1988). Hossain et al. (2003) reported that although farmers got about 16% yield advantage in the cultivation of hybrids compared to the popularly grown inbred varieties, the yield gains were not stable. On the other hand, compared with conventional cultivars, the hybrids had larger panicles, heavier seeds, resulting in an average grain yield increase of 7.27% (Bhuiyan et al. 2014). This variety however needs further evaluation under the different adaptive condition to interact with different environmental conditions. Considering the above-mentioned facts and based on the prior observation, an investigation was undertaken to evaluate the morpho-physiological characteristics and shoot reserve remobilization of the some selected rice varieties at two different transplanting dates in Boro season.

II. Materials and Methods

Experimental site

The experiment was conducted at the Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the periods of November 2017 to July 2018. The climate of the experimental site is sub-tropical, wet and humid. Heavy rainfall occurs in the monsoon (mid-April to mid-August) and scanty during rest of the year. The soil of the experimental area was silt clay in texture. Soil pH was 6.7 and has organic carbon 0.45% (SRDI 2012).

Experimental treatment and design

Different rice varieties were used as the test crop in this experiment. The experiment comprise of two factors. Factor A: planting time (2): T_1: 24 January planting; T_2: 23 February planting and Factor B: Rice variety (5): V_1: BRRI dhan29; V_2: BRRI hybrid 2; V_3: Hera 2; V_4: Tia and V_5: Taj 1. The experiment was laid out in a randomized complete block design (RCBD) with three replications. There were 10 plots of $5m^2$ in size in each of 3 replications resulting 30 plots in total. The distance maintained between two blocks and two plots were 1.0m and 0.5m, respectively.

Crop husbandry

The seeds were sown in the seedbed @ $70gm^{-2}$ in order to have healthy seedlings. The fertilizers N, P, K, S, Zn and B in the form of urea, TSP, MoP, Gypsum, zinc sulphate and borax, respectively were applied @ 80kg, 60kg, 90kg, 12kg, 2.0kg and 10kg (BRRI 2013). The entire amount of TSP, MoP, gypsum, zinc sulphate and borax were applied during the final preparation of experimental plot. Urea was applied in two equal installments as top dressing at tillering and panicle initiation stages. Two seedlings (21 days) were transplanted in each hill with a plant to plant distance 15cm and row to row distance 20cm. Intercultural operations were done to ensure normal growth of the crop. Plant protection measures were followed as and when necessary.

Data collection

Ten pre-selected hills per plot from which different data were collected. Data on the following parameters were recorded during the course of the experiment such as - plant height, number of tillers hill^{-1}, SPAD value of leaf, leaf area index, days to booting (DAT), days to panicle insertion (DAT), days to anthesis (DAT), days to maturity (DAT), shoot dry matter at pre-anthesis (gm^{-2}), shoot dry matter at maturity (gm^{-2}), changes in shoot dry matter (gm^{-2}) and shoot reserve translocation (%). Plants from 1m^2 were sampled from each plot at pre-anthesis and maturity. The harvested plants were separated into leaf blades (leaf), culm and sheath (stem) and panicles. Dry matter of each component was determined after drying at 72^{0}C for 72 hours. The shoot reserve translocation was calculated by a net loss in dry weight of vegetative organs between pre-anthesis and maturity (Bonnett et al. 1992) using the following formula:

$$\text{Shoot reserve translocation (\%)} = \frac{A - M}{A} \times 100$$

Where,

A = Total shoot dry matter at pre-anthesis (gm^{-2})
M = Total shoot dry matter at maturity (gm^{-2})

Statistical package

All the collected data were tabulated and analyzed statistically using analysis of variance technique and subsequently, Least Significance Difference (LSD at 5%) for comparing the treatment means, by MSTAT-C software (Gomez et al. 1984).

III. Results and Discussion

Plant height

Plant height at different DAT and harvest showed statistically significant differences due to different planting time (Figure 01). At 20, 40, 60, 80 DAT and harvest, the tallest plant (26.58, 56.63, 83.19, 92.29 and 111.16 cm, respectively) were recorded from 24 January planting and the shortest plant (24.64, 53.49, 78.90, 87.25 and 105.18 cm, respectively) were found from 23 February planting. Increased plant height in earlier transplanting dates was due to the availability of prolonged the period for vegetative growth of rice genotypes in these dates. This result is in agreement with that of (Kushwaha et al. 2016) and they reported that decrease of plant height in all years of delayed transplanting might be due to improper development of roots and short photoperiod duration. Khalifa (2009) showed that early date of sowing (20 April) is the best time of sowing for the highest plant height and sowing in 1 June has given the lowest value.

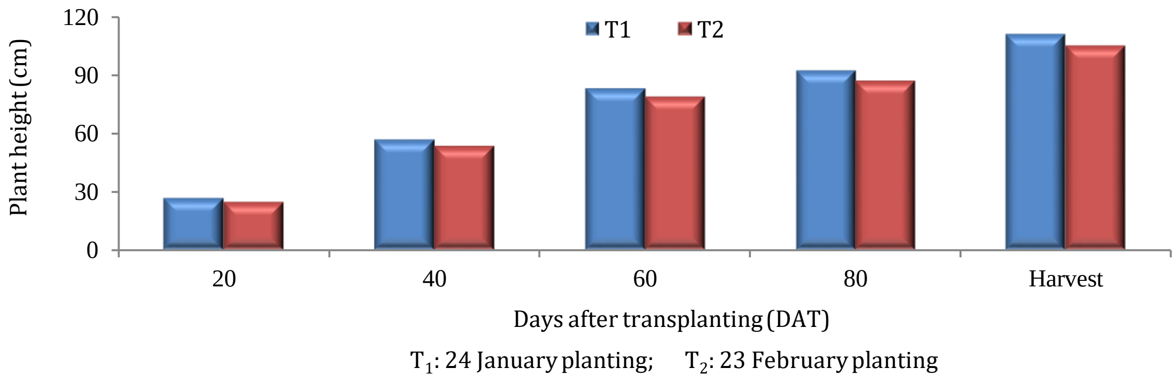
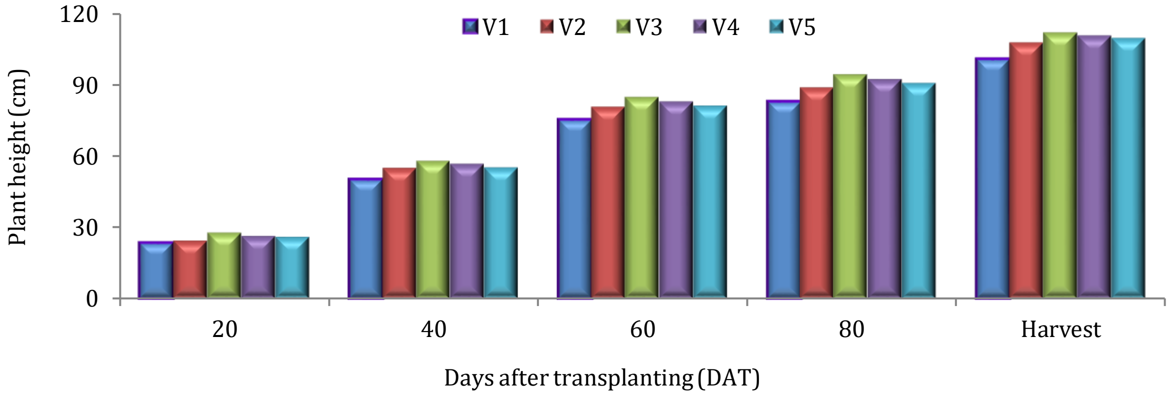


Figure 01. Effect of different planting time on plant height of rice.

Statistically significant variation was recorded in terms of plant height at different DAT and harvest due to different rice varieties (Figure 02). At 20, 40, 60, 80 DAT and harvest, the tallest plant (27.88, 58.08, 84.94, 94.41 and 112.03 cm, respectively) were observed from Hera 2, while the shortest plant (23.59, 50.38, 75.55, 82.92 and 100.93 cm, respectively) were recorded from V_1 (BRRI dhan29). Varieties showed different plant height on the basis of their varietal characters. Variety is the key component to produce plant height of rice depending upon their differences in genotypic characters, input requirements and response, growth process and of course the prevailing environmental conditions during the growing season. Khalifa (2009) reported that H1 hybrid rice variety surpassed other varieties in terms of plant height. Bhuiyan et al. (2014) reported that the different hybrid rice varieties had significant effects on plant height at maturity. This result also similar to the findings of Munoz et al. (1996).



V_1: BRRI dhan29; V_2: BRRI hybrid 2; V_3: Hera 2; V_4: Tia; V_5: Taj 1

Figure 02. Effect of different varieties on plant height of rice.

Interaction effect of different planting time and rice varieties showed statistically significant differences on plant height at different DAT and harvest (Table 01). At 20, 40, 60, 80 DAT and harvest, the tallest plant (29.94, 62.57, 89.58, 99.42 and 120.92 cm respectively) were recorded from treatment combination of 24 January planting with Hera 2, whereas the shortest plant (23.31, 49.56, 75.57, 82.25 and 100.92 cm respectively) were found from 23 February planting with BRRI dhan29.

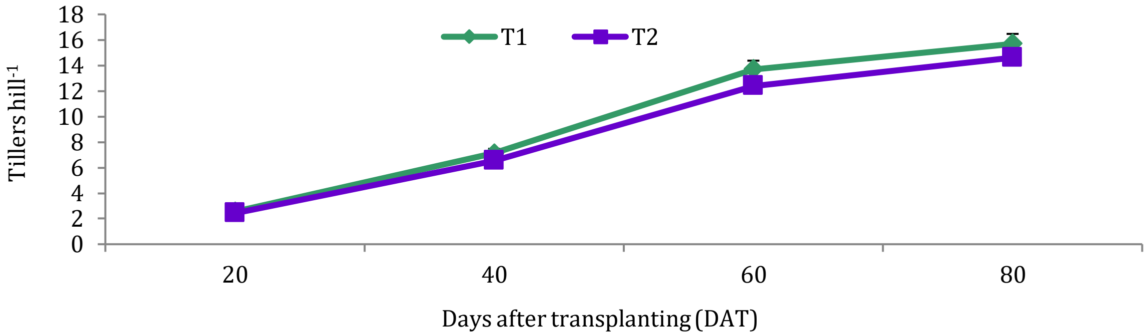
Table 01. Interaction effect of planting time and varieties on plant height at different days after transplanting (DAT) and at harvest of rice

Treatment	Plant height (cm) at				
	20 DAT	40 DAT	60 DAT	80 DAT	Harvest
24 January planting					
BRRI dhan29	23.87 b	51.21 c	75.57 c	83.58 de	100.93 d
BRRI hybrid 2	23.87 b	54.22 bc	77.70 bc	86.99 de	106.14 bcd
Hera 2	29.94 a	62.57 a	89.58 a	99.42 a	120.92 a
Tia	25.62 ab	55.13 bc	84.48 ab	96.41 ab	113.47 abc
Taj 1	29.62 a	60.05 ab	88.67 a	95.03 abc	114.35 ab
23 February planting					
BRRI dhan 29	23.31 b	49.56 c	75.53 c	82.25 e	100.92 d
BRRI hybrid 2	24.77 b	55.43 bc	83.75 ab	90.54 bcd	109.10 bcd
Hera 2	25.83 ab	53.60 bc	80.31 bc	89.41 cd	103.14 cd
Tia	26.86 ab	58.26 ab	81.07 bc	87.86 de	107.92 bcd
Taj 1	22.41 b	50.59 c	73.78 c	86.21 de	104.83 bcd
$LSD_{(0.05)}$	4.06	5.92	6.87	6.33	9.67
CV (%)	9.24	6.27	4.94	4.11	5.21

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

Number of tillers hill^{-1}

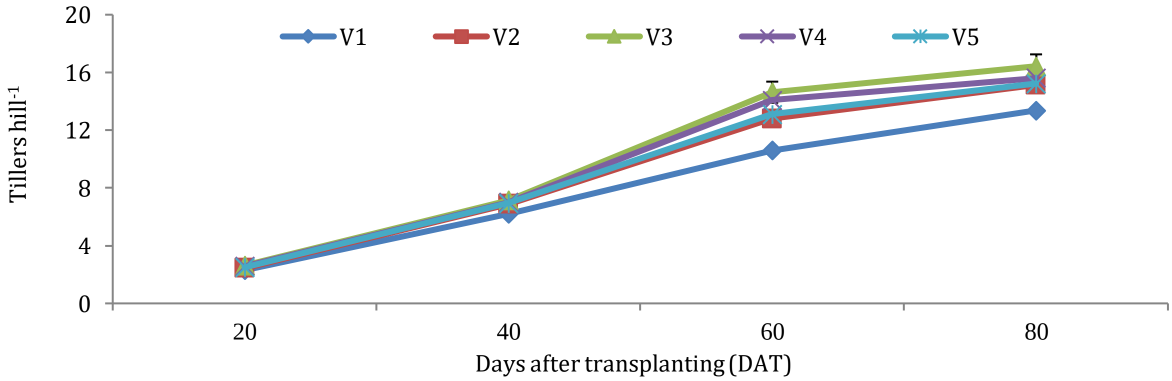
Planting time varied significantly for the number of tillers hill^{-1} at different DAT (Figure 03). At 20, 40, 60 and 80 DAT, the maximum number of tillers hill^{-1} (2.55, 7.12, 13.69 and 15.69 respectively) were found from 24 January planting, while the minimum number of tillers hill^{-1} (2.43, 6.53, 12.39 and 14.61 respectively) were recorded from 23 February planting. It might be due to the fact that late planting had a shorter growing period due to photoperiodic response and the timely transplanting provided favorable environmental condition which enabled the plant to increased number of tillers as compared to the late transplanting. Masum et al. (2008) reported maximum (25.63) tiller at 45 DAT, then with advancement to age it declined up to maturity, whereas, in the case of BRRI dhan44, maximum (18.92) tiller production was observed around panicle initiation stage at 60 DAT. This result also supported by the Khalifa (2009).



T_1: 24 January planting; T_2: 23 February planting

Figure 03. Effect of different planting time on tillers plant^{-1} of rice.

The number of tillers hill^{-1} showed statistically significant variation at 20, 40, 60 and 80 DAT for different rice varieties (Figure 04). At 20, 40, 60 and 80 DAT, the maximum number of tillers hill^{-1} (2.63, 7.13, 14.63 and 16.43 respectively) were found from Hera 2, whereas the minimum number of tillers hill^{-1} (2.30, 6.20, 10.60 and 13.37 respectively) were observed from BRRI dhan29. Kainth et al. (1985) reported that in November planting of BR 3 when the temperature was cool, the vegetative phase was extended by 50 days and the relative tillering rate reached its peak at 40 to 50 days after transplanting but planting in July when the temperature was high, the relative tillering rate reached the highest value within 15 to 25 days after transplanting. This result also similar to the findings of (Sarkar et al. 2006; Farrell et al. 2006).



V_1: BRRI dhan 29; V_2: BRRI hybrid 2; V_3: Hera 2; V_4: Tia; V_5: Taj 1

Figure 04. Effect of different varieties on tillers plant^{-1} of rice.

Statistically significant variation was recorded due to the interaction effect of different planting time and rice varieties on number of tillers hill^{-1} at different DAT (Table 02). At 20, 40, 60 and 80 DAT, the maximum number of tillers hill^{-1} (2.67, 7.40, 16.07 and 17.20 respectively) were recorded from treatment combination of 24 January planting with Hera 2, while the minimum number of tillers hill^{-1} (2.27, 5.80, 10.27 and 13.33 respectively) were recorded from 23 February planting with BRRI dhan29 treatment combination.

Published with open access at journalbinet.com

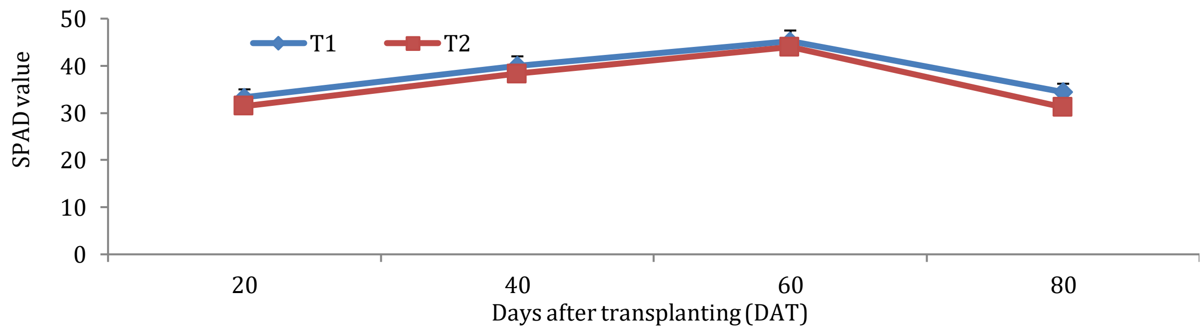
Table 02. Interaction effect of planting time and varieties on tillers hill^{-1} at different days after transplanting (DAT) of rice

Treatment	Tillers hill^{-1} (No.) at			
	20 DAT	40 DAT	60 DAT	80 DAT
24 January planting				
BRRI dhan29	2.33 cd	6.60 cd	10.93 d	13.40 d
BRRI hybrid 2	2.53 abc	6.93 bc	13.40 c	15.20 bc
Hera 2	2.67 a	7.40 a	16.07 a	17.20 a
Tia	2.60 ab	7.20 ab	14.73 b	16.20 ab
Taj 1	2.60 ab	7.47 a	13.33 c	16.47 ab
23 February planting				
BRRI dhan29	2.27 d	5.80 e	10.27 d	13.33 d
BRRI hybrid 2	2.33 cd	6.80 bcd	12.20 c	15.07 bc
Hera 2	2.60 ab	6.87 bc	13.20 c	15.67 b
Tia	2.53 abc	6.80 bcd	13.40 c	15.00 bc
Taj 1	2.40 bcd	6.40 d	12.87 c	14.00 cd
$LSD_{(0.05)}$	0.22	0.41	1.26	1.38
CV (%)	5.27	3.50	5.61	5.31

In a column means having similar the letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

SPAD value of leaf

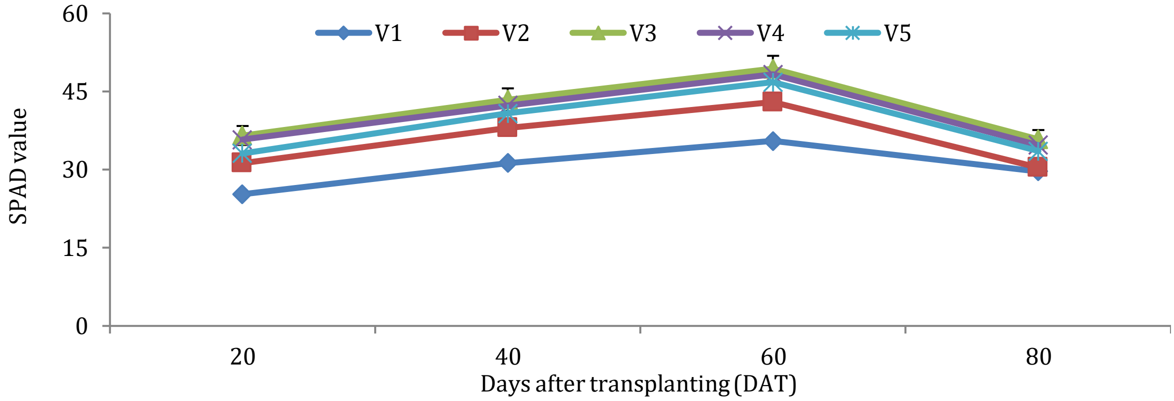
SPAD value at 20, 40, 60 and 80 DAT showed statistically significant differences due to different planting time (Figure 05). At 20, 40, 60 and 80 DAT, the maximum SPAD value (33.33, 40.00, 45.22 and 34.47 respectively) were recorded from 24 January planting and the minimum SPAD values (31.46, 38.35, 43.99 and 31.20 respectively) were observed from 23 February planting. It might be due to the fact that late planting had a shorter growing period due to photoperiodic response and the timely transplanting provided favorable environmental condition which enabled the plant to maximum chlorophyll on leaf as compared to the late transplanting. Khalifa (2009) found that early date of sowing (20 April) is the best time of sowing for highest chlorophyll content and sowing in 1st June has given the lowest value. This result also similar to the findings of Haque et al. (2015).



T_1: 24 January planting; T_2: 23 February planting

Figure 05. Effect of different planting time on SPAD value of rice.

Statistically significant variation was recorded in terms of SPAD value at 20, 40, 60 and 80 DAT due to different rice varieties (Figure 06). At 20, 40, 60 and 80 DAT, the maximum SPAD value (36.56, 43.44, 49.39 and 35.82 respectively) were observed from Hera 2. On the other hand, the minimum SPAD values (25.29, 31.27, 35.53 and 29.71 respectively) were found from BRRI dhan29. Tang et al. (2010) reported that hybrid rice contains higher amounts of chlorophyll in their leaves. Islam et al. (2010) found that in aman season (July to December) recorded higher leaf chlorophyll content in hybrids over inbred rice varieties.



V_1: BRRI dhan29; V_2: BRRI hybrid 2; V_3: Hera 2; V_4: Tia; V_5: Taj 1

Figure 06. Effect of different varieties on SPAD value of rice.

Interaction effect of different planting time and rice varieties showed statistically significant differences on SPAD value at different DAT (Table 03). At 20, 40, 60 and 80 DAT, the maximum SPAD value (38.54, 44.33, 50.01 and 37.60 respectively) were observed from treatment combination of 24 January planting with Hera 2, while the minimum SPAD value (24.83, 30.43, 34.60 and 28.31 respectively) were found from 23 February planting with BRRI dhan29 treatment combination.

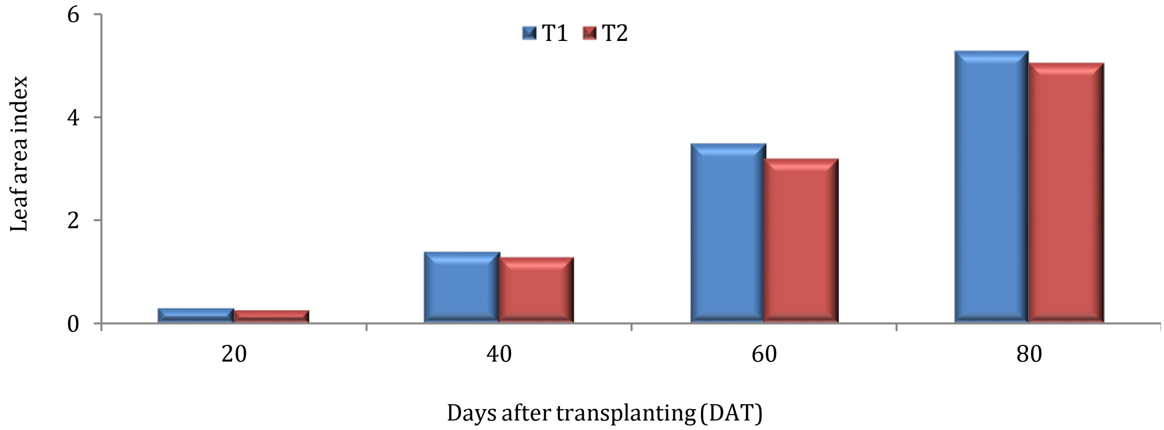
Table 03. Interaction effect of planting time and varieties on SPAD value at different days after transplanting (DAT) of rice

Treatment	SPAD value at			
	20 DAT	40 DAT	60 DAT	80 DAT
24 January planting				
BRRI dhan29	25.75 f	32.11 c	36.46 d	31.12 cd
BRRI hybrid 2	32.00 de	37.95 b	42.63 c	31.35 cd
Hera 2	38.54 a	44.33 a	50.01 a	37.60 a
Tia	36.71 b	43.02 a	48.73 a	35.10 ab
Taj 1	33.63 cd	42.59 a	48.28 a	37.21 ab
23 February planting				
BRRI dhan29	24.83 f	30.43 c	34.60 d	28.31 d
BRRI hybrid 2	30.49 e	38.08 b	43.33 c	29.48 d
Hera 2	34.59 c	42.56 a	48.78 a	34.03 bc
Tia	34.78 c	41.64 a	47.89 a	34.30 bc
Taj 1	32.60 d	39.04 b	45.33 b	29.91 d
$LSD_{(0.05)}$	1.64	2.49	1.98	3.04
CV (%)	4.95	3.70	5.59	6.39

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

Leaf area index (LAI)

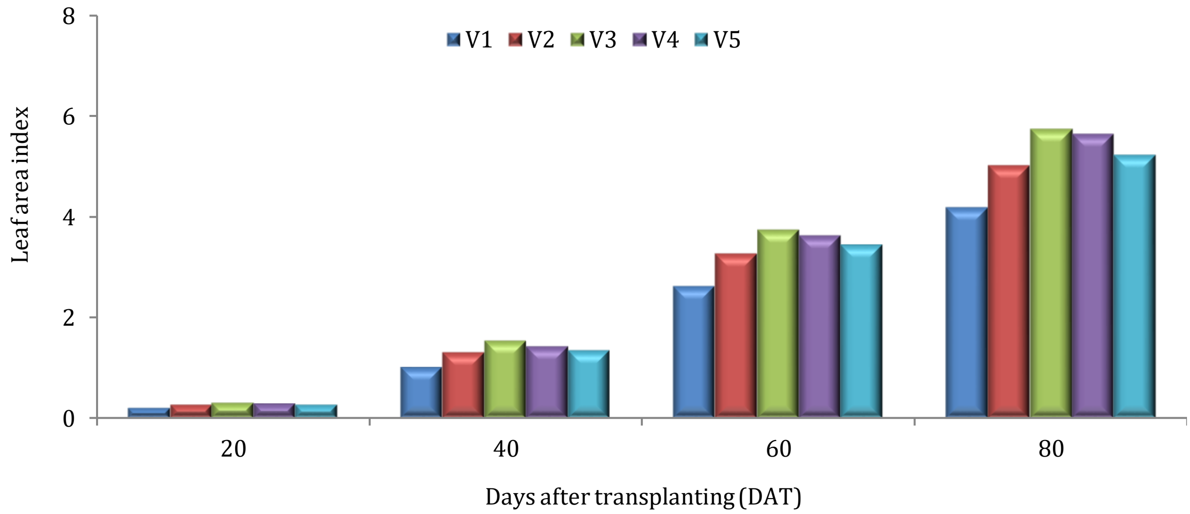
Leaf area index showed statistically significant differences due to different planting time at different DAT (Figure 07). At 20, 40, 60 and 80 DAT, the higher leaf area index (0.285, 1.38, 3.48 and 5.28 respectively) were found from 24 January planting and the lower leaf area index (0.259, 1.28, 3.20 and 5.04 respectively) were recorded from 23 February planting. Haque et al. (2015) observed that in the case of early planting, higher biomass accumulation and rapid expansion of the leaf area of the tested hybrids produced higher leaf area index (LAI). Khalifa (2009) observed that early date of sowing (April 20) is the best time of sowing for highest leaf area index and sowing in 1 June has given the lowest value.



T_1: 24 January planting; T_2: 23 February planting

Figure 07. Effect of different planting time on leaf area index of rice.

Statistically significant variation was recorded in terms of leaf area index at different DAT due to different rice varieties (Figure 08). At 20, 40, 60 and 80 DAT, the highest leaf area index (0.305, 1.54, 3.74 and 5.74 respectively) were found from Hera 2, while the lowest leaf area index (0.212, 1.02, 2.62, 4.17respectively) were observed from BRRI dhan29. This result is similar to the findings of Haque et al. (2015) who observed that the maximum value of LAI gradually decreased in hybrid and inbred varieties with delayed transplanting due to the reduction of vegetative phase.



V_1: BRRI dhan29; V_2: BRRI hybrid 2; V_3: Hera 2; V_4: Tia; V_5: Taj 1

Figure 08. Effect of different varieties on leaf area index of rice.

Interaction effect of different planting time and rice varieties showed statistically significant differences on leaf area index at different DAT (Table 04). At 20, 40, 60 and 80 DAT, the highest leaf area index (0.320, 1.65, 3.89 and 5.96 respectively) were found from treatment combination of 24 January planting with Hera 2 and the lowest leaf area index (0.205, 1.01, 2.52 and 4.08 respectively) were found from 23 February planting with BRRI dhan29 treatment combination.

Table 04. Effect of planting time and varieties on leaf area index at different days after transplanting (DAT) of rice

Treatment	Leaf area index (LAI) at			
	20 DAT	40 DAT	60 DAT	80 DAT
24 January planting				
BRRI dhan29	0.218 e	1.04 c	2.72 d	4.25 d
BRRI hybrid 2	0.269 c	1.30 b	3.42 bc	4.87 c
Hera 2	0.320 a	1.65 a	3.89 a	5.96 a
Tia	0.307 a	1.61 a	3.81 a	5.66 a
Taj 1	0.313 a	1.30 b	3.57 ab	5.67 a
23 February planting				
BRRI dhan29	0.205 e	1.01 c	2.52 d	4.08 d
BRRI hybrid 2	0.281 bc	1.31 b	3.12 c	5.17 bc
Hera 2	0.290 b	1.42 b	3.59 ab	5.52 ab
Tia	0.280 bc	1.26 b	3.46 bc	5.64 a
Taj 1	0.242 d	1.40 b	3.32 bc	4.79 c
$LSD_{(0.05)}$	0.02	0.15	0.31	0.41
CV (%)	7.36	6.73	5.41	4.58

In a column, means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability

Days to booting, panicle insertion and anthesis

Days to booting, panicle insertion and anthesis showed statistically significant differences due to different planting time (Table 05). The maximum days to booting, panicle insertion and anthesis (68.13, 78.33 and 98.33 respectively) were observed from 24 January planting and the minimum days (65.33, 75.53 and 95.93 respectively) were recorded from 23 February planting. This was due to the fact that rice genotypes planted earlier had a longer period for their vegetative growth compared to those sown later. Too early planting seedling take more times for their developmental process like as booting, panicle initiation and anthesis comparison too late or delayed planting seedling because too early or too late transplanting could not fulfill the required temperature and photoperiod for rice crop. Khalifa (2009) found that early date of sowing (20 April) is the best time of sowing for number of days to heading (HD) and panicle initiation, while sowing in 1 June has given the lowest value. This result also is similar to the findings of (Nahar et al. 2009; Shah 2001).

Statistically significant variations were recorded in terms of days to booting, panicle insertion and anthesis due to different rice varieties (Table 05). The maximum days to booting, panicle insertion and anthesis (70.33, 81.50 and 101.83 respectively) were found from Hera 2, while the minimum days (61.33, 71.33 and 92.17 respectively) were recorded from BRRI dhan29. This result is similar to the findings of Kushwaha et al. (2016) who found that longest days to heading were obtained from NR 11050-B-B-B-B-17 (122 days) in 2013 and shortest from Khumal 4 (78 days) in 2011 in transplanting.

Interaction effect of different planting time and rice varieties showed statistically significant differences on days to booting, panicle insertion and anthesis (Table 06). The maximum days to booting, panicle insertion and anthesis (72.67, 84.00 and 104.00 respectively) were observed from treatment combination of 24 January planting with Hera 2 and the minimum days (60.33, 70.67 and 91.00 respectively) were recorded from 23 February planting with BRRI dhan29 treatment combination.

Days to maturity

Days to maturity showed statistically significant differences due to different planting time (Table 05). The maximum day to maturity (131.87) was found from 24 January planting and the minimum days to maturity (128.47) were recorded from 23 February planting. Early maturity of late sown crop might be due to short vegetative and reproductive period of late sown crop. Khan et al. (2002) shown the decreasing trend was observed in number of days to maturity with delay in sowing dates. Crop sown on 2 May took maximum days to maturity and a minimum day to maturity was observed in 13 June crop sown. Statistically significant variation was recorded in terms of days to maturity due to different rice varieties (Table 05). The maximum days to maturity (135.17) was found from Hera 2, while the minimum days to maturity (124.67) was observed from BRRI dhan29. This result is similar to the findings of Kushwaha et al. (2016) who showed that longest days to maturity were obtained from NR 11011-B-B-B-B-29 (178 days) in 2014 and shortest from Khumal-4 (144 days) in 2011 in transplanting. Interaction effect of different planting time and rice varieties showed statistically significant differences on days to maturity (Table 06). The maximum days to maturity (138.33) was observed from treatment combination of 24 January planting with Hera 2 and the minimum days to maturity (123.33) was found from 23 February planting with BRRI dhan29 treatment combinations.

Table 05. Effect of planting time and variety on days to booting, days to panicle initiation, days to anthesis and days to maturity of rice

Treatment	Days to booting	Days to panicle insertion	Days to anthesis	Days to maturity
Planting time				
24th January planting	68.13 a	78.33 a	98.33 a	131.87 a
23rd February planting	65.33 b	75.53 b	95.93 b	128.47 b
$LSD_{(0.05)}$	1.72	1.40	1.18	1.95
CV (%)	3.69	5.60	1.73	4.14
Variety				
BRRI dhan29	61.33 b	71.33 d	92.17 c	124.67 b
BRRI hybrid 2	63.33 b	74.00 c	93.67 c	126.50 b
Hera 2	70.33 a	81.50 a	101.83 a	135.17 a
Tia	68.50 a	78.17 b	98.33 b	132.83 a
Taj 1	70.17 a	79.67 ab	99.67 b	131.67 a
$LSD_{(0.05)}$	2.99	2.43	2.04	3.38
CV (%)	3.69	5.60	1.73	4.14

In a column, means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

Table 06. Interaction effect of planting time and varieties on days to booting, days to panicle initiation, days to anthesis and days to maturity of rice

Treatment	Days to booting	Days to panicle insertion	Days to anthesis	Days to maturity
24 January planting				
BRRI dhan29	62.33 de	72.00 de	93.33 de	126.00 de
BRRI hybrid 2	65.67 cd	76.33 c	95.33 cd	129.33 cd
Heera 2	72.67 a	84.00 a	104.00 a	138.33 a
Tia	71.33 ab	81.00 ab	100.67 b	135.33 ab
Taj 1	68.67 abc	78.33 bc	98.33 bc	130.33 bcd
23 February planting				
BRRI dhan29	60.33 e	70.67 e	91.00 e	123.33 e
BRRI hybrid 2	61.00 e	71.67 e	92.00 e	123.67 e
Hera 2	68.00 bc	79.00 bc	99.67 b	132.00 bc
Tia	65.67 cd	75.33 cd	96.00 bc	130.33 bcd
Taj 1	71.67 ab	81.00 ab	101.00 b	133.00 bc
$LSD_{(0.05)}$	4.22	3.43	2.88	4.77
CV (%)	3.69	5.60	1.73	4.14

In a column, means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

Shoot dry matter at pre-anthesis and maturity stage

Shoot dry matter at pre-anthesis and maturity period showed statistically significant differences due to different planting time (Table 07). The maximum shoot dry matter at pre-anthesis and maturity (27.73

and 23.43 gm^{-2} respectively) were recorded from 24 January planting and the minimum shoot dry matters (26.12 and 22.70 gm^{-2} respectively) were recorded from 23 February planting. This was due to the fact that rice genotypes planted earlier had a longer period for their vegetative growth compared to those sown later. Early flowering and maturity gives the low yield at late planting than their actual planting time. Haque et al. (2015) observed that dry matter accumulation decreased 28% and 17.5% in the hybrids and inbred at 5 February planting compared to 20 December planting. Vandana et al. (1994) who reported that dry matter accumulation in leaves decreased with test cultivar with later transplanting dates. Statistically significant variations were recorded in terms of shoot dry matter at pre-anthesis and maturity due to different rice varieties (Table 07). The highest shoot dry matter at pre-anthesis and maturity (29.49 and 24.52 gm^{-2} respectively) were found from Hera 2, whereas the lowest shoot dry matter (23.79 and 21.18 gm^{-2} respectively) were recorded from BRRI dhan29. This result is similar to the findings of Haque et al. (2015) who observed that dry matter accumulation of hybrid Hera 2 and BRRI hybrid dhan2 was higher than that of elite inbred BRRI dhan45. Interaction effect of different planting time and rice varieties showed statistically significant differences on shoot dry matter at pre-anthesis and maturity (Table 08). The highest shoot dry matter at pre-anthesis and maturity (30.19 and 24.81 gm^{-2} respectively) were recorded from treatment combination of 24 January planting with Hera 2, while the lowest shoot dry matter (22.98 and 20.58 gm^{-2} respectively) were found from 23 February planting with BRRI dhan29 treatment combination.

Change in shoot dry matter

Change in shoot dry matter showed statistically significant differences due to different planting time (Table 07). The maximum change in shoot dry matter (4.30 gm^{-2}) was found from 24 January planting and the minimum shoot dry matter at maturity (3.42 gm^{-2}) was recorded from 23 February planting. Statistically significant variation was recorded in terms of change in shoot dry matter due to different rice varieties (Table 07). The highest change in shoot dry matter (4.97 gm^{-2}) was observed from Hera 2, while the lowest change in shoot dry matter (2.61 gm^{-2}) was recorded from BRRI dhan29. Interaction effect of different planting time and rice varieties showed statistically significant differences on change in shoot dry matter (Table 08). The highest change in shoot dry matter (4.95 gm^{-2}) was recorded from treatment combination of 24 January planting with Tia and the lowest change in shoot dry matter (2.40 gm^{-2}) was observed from 23 February planting with BRRI dhan29 treatment combination.

Table 07. Effect of planting time and variety on dry matter accumulation in shoot and its translocation to the grain

Treatment	Shoot dry matter at pre-anthesis (gm^{-2})	Shoot dry matter at maturity (gm^{-2})	Changes in shoot dry matter (gm^{-2})	Shoot reserve translocation (%)
Planting time				
24 January planting	27.73 a	23.43 a	4.30 a	15.26 a
23 February planting	26.12 b	22.70 b	3.42 b	12.97 b
$LSD_{(0.05)}$	0.84	0.61	0.35	1.06
CV (%)	4.43	3.78	13.09	10.74
Variety				
BRRI dhan29	23.79 d	21.18 d	2.61 d	10.94 b
BRRI hybrid 2	25.78 c	22.54 c	3.24 c	12.52 b
Hera 2	29.49 a	24.52 a	4.97 a	16.84 a
Tia	28.19 ab	23.91 ab	4.28 b	15.11 a
Taj 1	27.38 b	23.19 bc	4.19 b	15.16 a
$LSD_{(0.05)}$	1.45	1.06	0.61	1.84
CV (%)	4.43	3.78	13.09	10.74

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

Shoot reserve translocation

Shoot reserve translocation showed statistically significant differences due to different planting time (Table 07). The maximum shoot reserve translocation (15.26%) was recorded from 24 January planting and the minimum shoot reserve translocation (12.97%) was found from 23 February planting. Accumulation of more dry matter before heading and its higher translocation into the developing grain during filling stage resulting in higher yield of rice varieties. Haque et al. (2015) observed that the shoot reserve translocation (%) to grain varied among the different planting dates and gradually decreased with delayed planting. This result also similar to the findings of Khalifa (2009). Statistically significant variation was recorded in terms of shoot reserve translocation due to different rice varieties (Table 07). The highest shoot reserve translocation (16.84%) was observed from Hera 2, while the lowest shoot reserve translocation (10.94%) was recorded from BRRI dhan29. This result is similar to the findings of Haque et al. (2015) who observed that Hybrid rice varieties exhibited higher degree of sensitivity in regard to shoot reserve remobilization to grain compared to the inbred. Interaction effect of different planting time and rice varieties showed statistically significant differences on shoot reserve translocation (Table 08). The highest shoot reserve translocation (17.83%) was recorded from treatment combination of 24 January planting with Hera 2 and the lowest shoot reserve translocation (10.43%) was found from 23 February planting with BRRI dhan29 treatment combination.

Table 08. Interaction effect of planting time and varieties on dry matter accumulation in shoot and its translocation to the grain

Treatment	Shoot dry matter at pre-anthesis (gm^{-2})	Shoot dry matter at maturity (gm^{-2})	Changes in shoot dry matter (gm^{-2})	Shoot reserve translocation (%)
24 January planting				
BRRI dhan29	24.60 de	21.77 cd	2.83 bc	11.45 cd
BRRI hybrid 2	25.42 cd	22.02 cd	3.40 b	13.29 bcd
Hera 2	30.19 a	24.81 a	5.38 a	17.83 a
Tia	29.01 ab	24.06 ab	4.95 a	17.02 a
Taj 1	29.42 ab	24.50 ab	4.92 a	16.70 a
23 February planting				
BRRI dhan29	22.98 e	20.58 d	2.40 c	10.43 d
BRRI hybrid 2	26.14 cd	23.06 bc	3.08 bc	11.75 cd
Hera 2	28.78 ab	24.22 ab	4.56 a	15.84 ab
Tia	27.37 bc	23.75 ab	3.62 b	13.20 bcd
Taj 1	25.34 cd	21.88 cd	3.46 b	13.62 bc
$LSD_{(0.05)}$	2.05	1.50	0.87	2.60
CV (%)	4.43	3.78	13.09	10.74

In a column, means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ significantly at 0.05 level of probability.

IV. Conclusion

It can be concluded that among the five rice varieties, Hera 2 demonstrated the best performance on morpho-physiological characters and shoot reserve remobilization at different transplanting dates. The 24 January planting of seedling increased the plant height, tillers hill^{-1}, SPAD value of leaves, leaf area index and shoot reserve translocation were 5.78%, 7.39%, 10.48%, 4.76% and 17.66% respectively over the 23 February planting because delayed transplanted rice seedlings had always lower morpho-physiological characters than right time transplanted rice and took shorter days to flower and mature than early transplanted rice which might be due to improper root growth and development causing less absorption of nutrients from soil and shorter duration of temperature and photoperiod during grain filling period. So this might be the possible reason to have high shoot reserve remobilization in right time transplanting of seedling. Finally, 24 January transplanting with Hera 2 exhibited the superior combinations than most the parameters studied. However, further study is required regarding the other rice varieties with different management practices in different Agro-Ecological Zones (AEZ) of Bangladesh for testing the regional compliance and other quality attributes.

References

[1]. Akbar, M. K. (2004). Response of hybrid and inbred rice varieties to different seedlings ages under system of rice intensification in transplant aman season. M.S. (Ag.) Thesis, Dept. Agron. BAU, Mymensingh.

[2]. Bhuiyan, M. S. H., Zahan, A., Khatun, H., Iqbal, M., Alam, F. and Manir, M. R. (2014). Yield performance of newly developed test crossed hybrid rice variety. International Journal of Agronomy and Agricultural Research, 5(4), 48-54.

[3]. Bonnett, G. D. and Incoll, L. D. (1992). The potential pre-anthesis and post-anthesis contribution of stem internodes to grain yield in crop of winter barley. Annals of Botany, 69(3), 219-225. https://doi.org/10.1093/oxfordjournals.aob.a088333

[4]. BRRI. (2003). Annual internal review for 2003. Grain Quality and Nutrition Division. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh.

[5]. BRRI. (2013). Adhunik dhaner chash (in Bengali). Bangladesh Rice Research Institute, Joydebpur, Gazipur.

[6]. Castillo, A. G., Hampton, J. G. and Coolbear, P. (1994). Effect of sowing dates and harvest timing on seed vigor in garden pea (*Pisum sativum* L.). New Zealand Journal of Crop and Horticultural Science, 22, 91-95. https://doi.org/10.1080/01140671.1994.9513810

[7]. Farrell, T. C., Fukai, S. and Williams, R. L. (2006). Minimizing cold damage during reproductive development among temperate rice genotypes. I. Avoiding low temperature with the use of appropriate sowing time and photoperiod-sensitive varieties. Australian Journal of Agricultural Research, 57(1), 75-88.

[8]. Gangwar, K. S. and Sharma, S. K. (1997). Influence of planting dates on productivity of traditional scented rice varieties. IRRN, 22(1), 42.

[9]. Gomez, K. A. and Gomez, A. A. (1984). Statistical procedure for agricultural research. International Rice Research Institute. John Wiley and Sons, New York, USA.

[10]. Haque, M. M., Pramanik, H. R., Biswasm, J. K., Iftekharuddaula, K. M. and Hasanuzzaman, M. (2015). Comparative performance of hybrid and elite inbred rice varieties with respect to their source-sink relationship. Scientific World Journal, pp. 1-11.

[11]. Hien, N. L., Yoshihashi, T. and Sarhadi, W. A. (2006). Evaluation of aroma in rice using KOH method, molecular markers and measurement of 2-acetyl-1-pyrroline concentration. Japanese Journal of Tropical Agriculture, 50, 190-198.

[12]. Hossain, M. and Deb, U. K. (2003). Liberalization of rice sector: can Bangladesh withstand regional competition? Poster paper presented at PETRRA communication fair 2003 held at Hotel Sheraton, Dhaka, Bangladesh. https://doi.org/10.1016/S1672-6308(09)60033-0

[13]. IRRI (International Rice Research Institute) (2013). Trend in global rice consumption. Rice Today, 12(1), 44-45.

[14]. Islam, M. S., Bhuiya, M. S. U., Rahman, S. and Hussain, M. M. (2010). Evaluation of SPAD and LCc based nitrogen management in rice (*Oryza sativa* L.). Bangladesh Journal of Agricultural Research, 34(4), 661–672. https://doi.org/10.3329/bjar.v34i4.5841

[15]. Jhoun, H. R. K. (1989). Effect of time of planting and age of seedling on growth and yield of dwarf rice. Indian Journal of Agronomy, 34, 325-327.

[16]. Kainth, G. S. and Mehra, P. L. (1985). Rice production-potential and constraints. Inter-India Publications, New Delhi, India.

[17]. Khalifa, A. A. B. A. (2009). Physiological evaluation of some hybrid rice varieties under different sowing dates. Australian Journal of Crop Science, 3(3), 178-183. http://www.cropj.com/khalifa_3_3_178.

[18]. Khan, N., Oasim, M., Ahmed, F., Naz, F. and Khan, R. (2002). Effect of sowing dates on yield of maize under Agroclimatic condition of kaghan valley. Asian Journal of Plant Science, 1(2), 146-147. https://doi.org/10.3923/ajps.2002.146.147

[19]. Kushwaha, U. K. S., Khatiwada, S. P. and Upreti, H. K. (2016). Delayed transplanting of aged rice seedlings causes the yield reduction in farmer's field. Genomic Applied Biology, 7(1),1-9.

[20]. Masum, S. M., Ali, M. H. and Ullah, J. (2008). Growth and yield of two T. aman rice varieties as affected by seedling number per hill and urea supper granules. Journal of Agricultural Education and Technology, 11(1 and 2), 51-58. https://doi.org/10.5376/gab.2016.07.0001

Published with open access at journalbinet.com

[21]. Momin, S. I. and Husain, M. (2009). Technology development and dissemination to augment rice production in Bangladesh. In: The Guardian.

[22]. Munoz, D., Gutierrez, P. and Carredor, E. (1996). Current status of research and development of hybrid rice technology in Colombia. In. Abst., Proc. 3r Intl. Symp. On Hybrid Rice. Directorate Rice Research, Hyderabad, India.

[23]. Nahar, K., Mirza, H. and Ratna, R. M. (2009). Effect of low temperature stress in transplanted aman rice varieties mediated by different transplanting dates. Academic Journal of Plant Science, 2(3), 132-138.

[24]. Prakash, N. B. (2010). Different sources of silicon for rice farming in Karnataka. Paper presented in Indo-US workshop on silicon in agriculture, held at University of Agricultural Sciences, Bangalore, India.

[25]. Sarkar, R. K. and Reddy, J. N. (2006). Response of lowland rice (*Oryza sativa*) cultivars to different sowing dates during rainy season. Indian Council of Agricultural Research. New Delhi, India.

[26]. Shah, M. L. and Yadav, R. (2001). Response of rice varieties to age of seedlings and transplanting dates. Nepal Agriculture Research Journal, 4 & 5, 14-17.

[27]. Soil Resource Development Institute (SRDI) (2012). Characteristics of experimental soil. Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka, Bangladesh.

[28]. Siddique, M. N. A., Sultana, J., Sultana, N. and Hossain, M. (2007). Effect of planting dates on growth and flowering of Hippeastrum (Hippeastrum hybridum). Int. J. Sustain. Crop. Prod. 2(5), 12-14.

[29]. Sultana, J., Siddique, M. N. A. and Abdullah, M. R. (2015). Fertilizer recommendation for agriculture: practice, practicalities and adaptation in Bangladesh and Netherlands. International Journal of Business, Management and Social Research, 1(1), 21-40. https://doi.org/10.18801/ijbmsr.010115.03

[30]. Tang, W. B., Zhang, G. L., Xiao, Y. H., Deng, H. B., Fan, K., Liu, G. H. and Chen, L. Y. (2010). Physiological and biochemical characteristics in flag leave of the C Liangyou series of rice hybrid combinations at late growth stages. Rice Science, 17(4), 319–325.

[31]. Vandana, J., Anis, G. S. B. and Mavi, H. S. (1994). Effect of different dates of transplanting on biomass of production and its partitioning in various parts of rice crop. Indian Journal of Ecology, 21(1), 13-18.

[32]. Zaman, S. M. H. (1986). Current status and prospects for rainfed food grain production in Bangladesh. BRRI, Gazipur.

[33]. Zhende, Y. (1988). Agronomic management of rice hybrids compared with conventional varieties. International Rice research Institute, Manila, Philippines.

HOW TO CITE THIS ARTICLE?

Crossref: https://doi.org/10.18801/jbar.190219.196

MLA
Ahmed et al. "Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates." Journal of Bioscience and Agriculture Research 19(02) (2019): 1613-1627.

APA
Ahmed, N., Ahamed, K. U., Akhter, N., Hosain, M. T., Nizam, R. and Rahman, M. S. (2019). Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates. Journal of Bioscience and Agriculture Research, 19(02), 1613-1627.

Chicago
Ahmed, N., Ahamed, K. U., Akhter, N., Hosain, M. T., Nizam, R. and Rahman, M. S. "Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates." Journal of Bioscience and Agriculture Research 19(02) (2019): 1613-1627.

Harvard
Ahmed, N., Ahamed, K. U., Akhter, N., Hosain, M. T., Nizam, R. and Rahman, M. S. 2019. Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates. Journal of Bioscience and Agriculture Research, 19(02), pp. 1613-1627.

Vancouver
Ahmed, N, Ahamed, KU, Akhter, N, Hosain, MT, Nizam, R and Rahman, MS. Morpho-physiological characters and shoot reserve remobilization of rice under different planting dates. Journal of Bioscience and Agriculture Research. 2019 March 19(02): 1613-1627.