Annual Research & Review in Biology

34(6): 1-8, 2019; Article no.ARRB.55141
ISSN: 2347-565X, NLM ID: 101632869

Evaluation of Conventional Cultivars and Hybrid Rice Varieties by Their Morpho-physiological Performance during *Aman* Season

Ariful Islam[1], Nasima Akhter[1], Md. Saidur Rahman[1*] and Md. Mofizur Rahman[2*]

[1]Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.
[2]Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. Authors AI and NA designed the study and wrote the protocol. Author AI performed statistical analysis and made some literature searches. Authors MSR and MMR wrote the first draft of manuscript and managed the analyses of the study. All authors read, contributed and approved the final version of the manuscript.

Article Information

DOI: 10.9734/ARRB/2019/v34i630172
Editor(s):
(1) Dr. Amit Kesarwani, G. B. Pant University of Agriculture and Technology, India.
Reviewers:
(1) Xin Yang, Shangrao Normal University, China.
(2) Agu Eensaar, Tallinn University of Applied Sciences, Estonia.
(3) Delian Elena, University of Agronomical Sciences and Veterinary Medicine of Bucharest, Romania.
Complete Peer review History: http://www.sdiarticle4.com/review-history/55141

Original Research Article

Received 22 December 2019
Accepted 28 February 2020
Published 13 March 2020

ABSTRACT

Aims: The objectives of the research work were to evaluate the morpho-physiological characteristics of selected local and high yielding varieties (HYV) of rice.
Study Design: The research used randomized complete block design (RCBD) with four replications.
Place and Duration of Study: Central research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during June to December 2017.
Methodology: In this research we used seven conventional rice cultivars (Kanchancni, Chinisagar, Sunashail, Ranjay, Lohadang, Haldijan, Kohabinni) and three high yielding rice varieties (BR11, BRRI dhan46 and BRRI dhan51) where different morpho-physiological data were taken for evaluation their performance. Obtaining data were analyzed by using analysis of variance technique

**Corresponding author: E-mail: saidur34@yahoo.com, saidur34@gmail.com, mofizurshawon509@gmail.com;*

and subsequently, least significance difference (LSD at 5%) for comparing the treatment means by MSTAT-C software.

Results: The morpho-physiological characters showed the considerable variation during the experimentation. Among the different growth parameter, the highest plant height and flag leaf area was found from Lohadang, number of leaves hill^{-1} and number of tillers hill^{-1} from Ranjay, crop growth rate and absolute grain growth rate from Sunashail, flag leaf dry weight from Kanchancni and SPAD value of flag leaf and specific leaf weight from BRRI dhan51. Meanwhile, the minimum days to anthesis, days from anthesis to maturity and life duration from germination to maturity were recorded from BRRI dhan46 and Kanchancni, respectively.

Conclusions: The results showed that among the conventional rice cultivars Kanchancni and the HYV varieties, BRRI dhan46 exhibit better morpho-physiological performance than others.

Keywords: Conventional rice cultivars; hybrid rice; crop growth rate; absolute grain growth rate; SPAD value; specific leaf weight.

1. INTRODUCTION

Rice (*Oryza sativa*) is the staple food for at least 62.8% of total planet populations contribute to an average of 20% of the calorie intake of the world and 30% of inhabitants in Asian countries [1]. In Asia more than 90% of this rice is consumed. In Bangladesh rice is the staple food of about 160 million people and its covers 75% of the total cropped area.

Bangladesh is famous for its wide-ranging rice biodiversity. Two types of rice cultivars are grown in Bangladesh viz. conventional (local) and modern (high yielding-HY) varieties. Local cultivars have some special qualities for which they are cultivated in Bangladesh. Though the soil and environment of our country is quite appropriate for production of rice, still it is facing many difficulties of which the poor yielding natural capability of our local varieties is the most vital one. Poor plant type, such as tall plants, long and droopy leaves, weak culms, susceptible to lodging etc. are the main reason of low yielding of local rice varieties. BRRI and BINA has developed many rice varieties with yield potential of 4 to 8 t/ha but varieties released by Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) have still could not restore the local cultivar completely. That means local varieties have some special qualities for which they are cultivated in Bangladesh. The farmers have long been growing the enormous number of traditional landraces with different quality of grains, resistance to the number of diseases and insects and with varying growing environment due to its diverse agro-ecological conditions [2]. Many of these land races such as Lati Shail and Niger Shail have been used by rice breeders as donors to develop privileged lines that have been used as parents for popular and improved rice varieties grown throughout Asia [3,4].

Aman season, however available information regarding the yield and yield contribution characteristics of HYV rice varieties are not enough in Bangladesh. That is why it is a prime need to carry out more research work to find out and develop sustainable technologies regarding HYV rice cultivation under the prevailing local conditions in the *aman* season. Therefore, if HYV rice is introduced, crop duration can be reduced by 20-40 days. It is the farmers who have increasingly replaced the local indigenous low yielding rice varieties by high yielding ones and modern varieties of rice developed by Bangladesh Rice Research Institute (BRRI) only because of getting 20 to 30% more yield [5]. IRRI parent materials were not found suitable for the aman season which is subjected to water and extended waterlogging. For this season, BRRI scientists have crossed international elite lines with Bangladeshi landraces to develop suitable varieties. The most popular of them is BR11 which was released in 1981. However, several traditional varieties are still popular among farmers due to their extraordinary traits. Hossain and Jaim [6] reported that farmers in Bangladesh still cultivate more than 1,000 traditional varieties/landraces. It is important to find out the special characteristics of our huge local rice cultivars in order to improve our HYV of rice through gene transfer.

Production of rice has to be augmented by at least 60% to meet up food demand of the increasing population by the year 2020 [7]. Population growth requires a constant enhancement of rice production in Bangladesh. So, the main concern has been given to produce more rice [8]. Keeping the above point of view,

the present study was undertaken to evaluate the morpho-physiological characteristics of selected local and HYV of rice.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted in the experimental field at Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from July to December 2017.

2.2 Climate and Soil

The experimental area was sub-tropical, high temperature, high humidity and heavy rainfall in kharif season (April-September) and less rainfall in Rabi season (October-March). The soil was Silty Clay in texture. Soil pH was 6.2 and had organic carbon 0.43%.

2.3 Experimental Treatment and Design

Rice was used as the test crop in this experiment. The experiment comprised a single factor where seven conventional rice cultivars i.e. Kanchancni, Chinisagar, Sunashail, Ranjay, Lohadang, Haldijan and Kohabinni and three high yielding rice varieties i.e. BRRI dhan46, BR11 and BRRI dhan51 were used. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications (block). There were 10 plots of $6m^2$ (3 m × 2 m) in size in each of 4 replications resulting in 40 plots in total. The distance maintained between the two-unit plots was 0.5 m and between the blocks was 1 m.

2.4 Crop Husbandry

The 22 days aged seedlings were transplanted in the main field on August 5, 2017 with the plant to plant distance of 15 cm and row to row distance of 20 cm. The fertilizers cowdung, urea, Triple super phosphate (TSP), Murate of potash (MoP), gypsum, zinc sulphate and borax were applied @10 tha^{-1}, 150 kg, 100 kg, 100 kg, 10 kg, 60 kg and 10 kg, respectively [9]. The entire fertilizers without urea were applied during the final land preparation. Urea was applied in three equal installments at the seedling establishment, tillering and before panicle initiation. Intercultural operations and plant protection measures were followed when necessary.

2.5 Data Collection

Ten hills per plot were used and data were collected from them. Data on the following parameters were recorded during the course of the experiment such as: Plant height (cm), Number of leaves $hill^{-1}$, Number of total tillers $plant^{-1}$, Crop growth rate (g $cm^{-2}day^{-1}$), Absolute grain growth rate (mg $plant^{-1}day^{-1}$), SPAD value of flag leaf during anthesis and grain filling stage, Flag leaf area (cm^2), Flag leaf dry weight (g), Specific leaf weight (mg cm^{-2}), Days to first anthesis, Duration from anthesis to maturity and Duration from germination to maturity.

2.6 Statistical Analysis

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 [10].

3. RESULTS AND DISCUSSION

3.1 Morphological Performance

3.1.1 Plant height

Plant height of different rice varieties differed remarkably among them. Among the different rice varieties, Kanchancni (25 DAT and 50 DAT) and Lohadang (75 DAT and at harvest) gave a better plant height than that of other varieties (Table 1). The conventional cultivars showed a higher plant height than HYV varieties because of having longer internodes. Plant height also depends on the genetic character of a plant and environmental conditions. Varieties produced different plant height on the basis of their varietal characters and also genetically influences but environmental and different management practices also influence plant height [11]. Munshi [12] and Sarker, et al. [13] indicated that due to shorter internodal length modern rice plants were shorter than local ones.

3.1.2 Number of total tillers $plant^{-1}$

Substantial variation was observed on the number of total tillers $plant^{-1}$ in the rice varieties. Among the different rice varieties, BRRI dhan46 (50 DAT and at harvest) and Ranjay (75 DAT) showed the maximum number of tillers $plant^{-1}$ than that of other varieties (Table 1). Genetic potential is responsible for the differential tillering in the genotype. Wang, et al. [14] suggested that the selection of genotypes with tillering capacity is important for obtaining higher yield in rice. The indigenous cultivars used in our study were also of high tillering capacity. Ramasamy. et al. [15] stated that the number of tillers m^{-2} differed due to varietal differences.

Table 1. Plant height and number of tillers hill^{-1} of *aman* rice varieties at various days after transplanting (DAT) and at final harvest

Variety	Plant height (cm)				Number of tillers hill^{-1}			
	25 DAT	50 DAT	75 DAT	At harvest	25 DAT	50 DAT	75 DAT	At harvest
Kanchancni	62.21 a	105.57 a	133.2 a	135.53 a	6.33 a	14.08 ab	9.67 ab	15.00 bc
Chinisagar	59.62 a-c	95.93ab	121.48 b	125.20 b	5.33 a	11.58 b	6.67 c	12.67 c
Sunashail	50.35 d	94.25 b	133.73 a	138.43 a	6.00 a	12.5 ab	8.00 bc	13.67 bc
Ranjay	54.34 b-d	90.04 b	125.59 ab	130.73 ab	6.67 a	12.92 ab	11.7 a	20.00 a
Lohadang	52.84 cd	97.42 ab	134.15 a	139.03 a	4.67 a	12.42 ab	6.00 c	11.67 c
Haldijan	59.71 ab	98.66 ab	129.37 ab	133.79 ab	6.67 a	9.75 b	7.67 bc	15.67 bc
Kohabinni	49.85 d	79.53 c	105.45 c	110.53 c	7.00 a	14.00 ab	11.0 a	14.00 bc
BRRI dhan46	41.06 e	78.17 c	93.17d	97.33 d	6.67 a	16.33 a	8.00 bc	21.00 a
BR11	34.92 e	67.22 d	83.80 de	111.00 c	6.00 a	12.08 ab	7.67 bc	13.67 bc
BRRI dhan51	39.28 e	64.40 d	76.04 e	104.33 cd	5.67 a	12.67 ab	7.67 bc	17.00 ab
$LSD_{0.05}$	6.84	9.65	10.65	9.37	3.30	4.55	2.40	4.03
CV (%)	7.91	6.46	5.46	4.45	31.50	20.69	16.65	15.23

Values followed by same letter(s) did not differ significantly at 5% level of probability

3.1.3 Number of leaves hill^{-1}

The number of leaves hill^{-1} differed considerably in the rice varieties. The total number of leaves was continued to increase up to 75 DAT and there after declined. Among the different rice varieties, BRRI dhan46 (25 DAT), Kohabinni (50 DAT and 75 DAT) and Ranjay (at harvest) showed the maximum number of leaves hill^{-1} than that of other varieties (Table 2). The number of leaves plant^{-1} was higher in conventional cultivars than HYV varieties. The present study inferred that HYV produced shorter leaves than those of local cultivars. This result was supported by the finding of Aktar [16] and Sarker, et al. [13] who revealed that leaf number was shorter in HYV compared to local cultivars. This might be due to the genotypic variation.

3.1.4 Flag leaf area (cm^2)

Substantial influence was found on the flag leaf area by different varieties of rice. Results revealed that the maximum flag leaf area was observed from the conventional cultivar Lohadang than that of other varieties (Table 2). Rumana [17] found that local varieties have a greater diameter area of flag leaf than HYV.

3.1.5 Flag leaf dry weight (g)

Flag leaf dry weight was varied significantly due to different varieties of rice. It was noted that the maximal flag leaf dry weight was observed from the conventional cultivar Kanchancni than that of other varieties (Table 2). This might be due to the thickness of leaf at local cultivars. Haque, et al. [18] also found a similar result with the present study. Though the flag leaf area was higher in local cultivars than HYV varieties so flag leaf weight was higher in local cultivars because due to the thickness of leaf [17].

3.1.6 Crop growth rate (g cm^{-2} day^{-1})

Crop growth rate (CGR) of different rice varieties varied significantly among the conventional cultivars and HYV rice varieties. The conventional cultivars Sunashail exhibits the highest CGR than that of other varieties (Fig. 1). Though the plant height was higher in conventional cultivars than HYV varieties that's why CGR was recorded higher in conventional cultivars. These results are consistent with the result of Rumana [17] and Piranhas, et al. [19] who reported that varietal differences of CGR were significant at the different growth stages.

3.1.7 Absolute grain growth rate (mg plant^{-1}day^{-1})

The absolute grain growth rate of different rice varieties differed considerably among the conventional cultivars and hybrid rice varieties. The conventional cultivars Sunashail gave the highest AGGR than that of other varieties (Fig. 2). Higher grain growth helps to give a better yield. The result of the present study is in agreement with the result of Sarkar [20] who stated that the higher AGGR was existed during the vegetative stage and declined rapidly near maturity.

Table 2. Number of leaves hill^{-1}, flag leaf area and flag leaf dry weight of different *aman* rice varieties

Variety	Number of leaves hill^{-1}				Flag leaf area (cm^2)	Flag leaf dry weight (g)
	25 DAT	50 DAT	75 DAT	At harvest		
Kanchancni	14.00 d	44.17 b	44.33 c-e	33.02 ab	42.63 c	0.27 a
Chinisagar	15.33 cd	33.25 d	33.67 f	33.24 ab	53.17 ab	0.26 ab
Sunashail	17.33 b-d	52.00 a	52.33 bc	22.33 c	49.70 b	0.26 ab
Ranjay	22.33 ab	42.08 bc	47.00 b-d	34.87 a	27.62 e	0.16 c
Lohadang	15.33 cd	36.33 d	37.00 ef	33.93 ab	56.20 a	0.25 ab
Haldijan	20.00 bc	34.00 d	35.00 f	29.62 a-c	36.77 d	0.23 b
Kohabinni	20.67 a-c	56.67 a	60.67 a	30.11 ab	23.59 e	0.14 c
BRRI dhan46	26 .00 a	53.67 a	54.67 ab	30.94 ab	36.69 d	0.17 c
BR11	17.67 b-d	42.00 bc	49.67 bc	32.13 ab	32.74 d	0.14 c
BRRI dhan51	17.67 b-d	38.00 cd	41.33 d-f	26.58 bc	27.08 e	0.23 b
$LSD_{0.05}$	5.37	5.18	8.02	7.65	4.70	0.03
CV (%)	16.86	6.99	10.26	14.55	7.10	9.15

Values followed by same letter(s) did not differ significantly at 5% level of probability

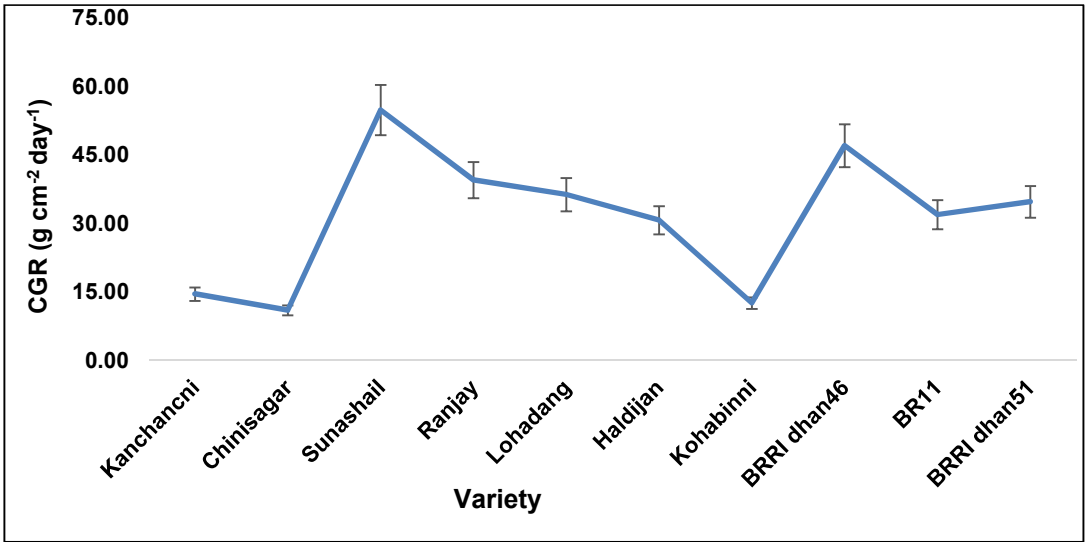

Fig. 1. Crop growth rate of different *aman* rice varieties

3.1.8 Specific leaf weight (mg cm^{-2})

Specific leaf weight was varied remarkably due to different rice varieties (Fig. 3). The highest specific leaf weight was found in BRRI dhan51 than that of other varieties. Amanullah [21] and Liu, et al. [22] found that specific leaf weight was higher in HYV than local cultivars.

3.2 Physiological Performance

3.2.1 SPAD value of flag leaf at anthesis stage and grain filling stage

SPAD value of flag leaf at the anthesis stage and grain filling stage showed remarkable variation due to different varieties of rice. The highest SPAD value of flag leaf at the anthesis stage and grain filling stage was found from the hybrid variety BRRIdhan51 than that of other varieties (Table 3). The result of the SPAD value under the present study was in agreement with the findings of Haque, et al. [18]. Rumana [17] observed that the SPAD value of flag leaf at the anthesis stage and grain filling stage are higher in HYV than local cultivars.

3.2.2 Days to first anthesis

Days to the first anthesis was varied considerably due to different varieties of rice. The minimum days to anthesis were observed from the variety of BRRI dhan46 than that of other varieties (Table 3). Our observations are in agreement with Haque, et al. [23] who reported that wide genotypic variation in phenological

events among 14 *aus* cultivars. Ahmed, et al. [24] demonstrated significant differences in attaining phenological stages due to varieties along with variable management practices. Rumana [17] demonstrates an experiment and observed that HYV and local cultivars need different time for the first anthesis.

3.2.3 Duration from anthesis to maturity

Days from anthesis to maturity was influenced significantly due to various rice varieties. The minimum days from anthesis to maturity was observed from the cultivar Kanchancni than that of other varieties (Table 3). Rumana [17] showed that local and HYV varieties give different days to maturity at different stages.

3.2.4 Life duration from germination to maturity

Significant influence was observed on total life duration from germination to maturity by different rice varieties. Results showed that a cultivar of Kanchancni exposed minimum life duration than that of other varieties (Table 3). Similar results were also observed by Rumana [17] and Siddiquee, et al. [25] who found that HYV and local cultivars have different life duration due to their genetic and environmental variation.

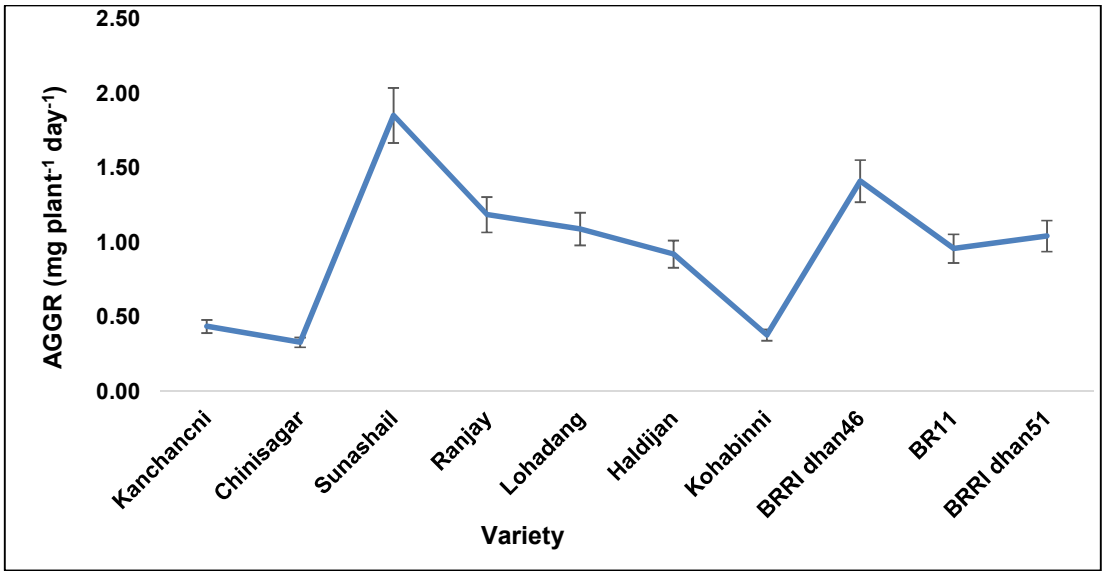

Fig. 2. Absolute grain growth rate of different *aman* rice varieties

Table 3. SPAD value of flag leaf, days to first anthesis, duration from anthesis to maturity and life duration from germination to maturity of different *aman* rice varieties

Variety	SPAD value of flag leaf		Days to first anthesis (Days)	Duration from anthesis to maturity (Days)	Life duration from germination to maturity (Days)
	Anthesis stage	Grain filling stage			
Kanchancni	38.80 cd	39.13 b	84.67 a	56.00 e	141.00 e
Chinisagar	41.97 c	38.50 b	77.67 b	69.33 b	147.33 cd
Sunashail	38.50 cd	31.90 c	77.67 b	67.67 bc	145.67 cd
Ranjay	42.53 c	38.63 b	84.67 a	63.67 cd	148.67 c
Lohadang	37.57 cd	40.07 b	77.67 b	76.33 a	154.33 b
Haldijan	40.73 c	31.50 c	84.67 a	74.33 a	159.33 a
Kohabinni	34.33 d	36.77 b	84.67 a	62.33 d	147.33 cd
BRRI dhan46	40.67 c	36.73 b	67.67 c	78.33 a	143.33 de
BR11	49.50 b	39.67 b	77.67 b	66.00 b-d	144.00 de
BRRI dhan51	60.20 a	49.77 a	77.67 b	68.00 b	146.00 cd
$LSD_{0.05}$	5.73	3.59	0.15	4.22	4.23
CV (%)	7.87	5.47	0.23	3.61	1.67

Values followed by same letter(s) did not differ significantly at 5% level of probability

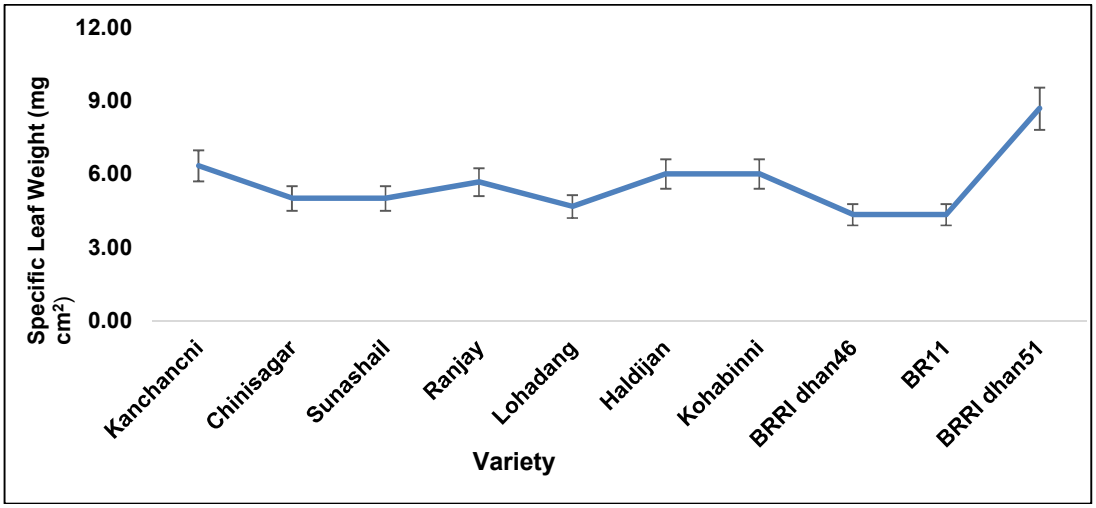

Fig. 3. Specific leaf weight of different *aman* rice varieties

4. CONCLUSION

From the above study, it can be concluded that among the conventional cultivar Kanchancni and incase of HYV variety BRRI dhan46 showed better performance on growth and developmental attributes at all planting dates. Kanchancni showed better performance due to fewer days taken for the duration from anthesis to maturity, lowest days taken from germination to maturity, flag leaf dry weight and high specific leaf weight. BRRI dhan46 performed better due to its highest leaf number, highest crop growth rate, highest absolute grain growth rate, lowest days taken to first anthesis and duration from anthesis to maturity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Asbur Y. Effect of seedling number per hill and seedling age on plant growth and grain yield Ciherang rice. 2nd Int. conf. Multidisciplinary Res. Banda Aceh, Indonesia. 2013;3(3):9-10.
2. Hossain M, Jaim WMH, Paris TR, Hardy B (editors). Adoption and diffusion of modern rice varieties in Bangladesh and eastern India. Los Banos, Philippines: International Rice Research Institute (IRRI); 2012.
3. Cabanilla VL, Hossain M. Khush GS. Diffusion of breeding materials and genetic composition of improved rices in South and Southeast Asia: 1965-1998. Social Science Division Working Paper. Los Banos, Philippines: International Rice Research Institute; 2000.
4. Hargrove TR. The diffusion and adoption of semi-dwarf rice cultivars as parents in Asian rice breeding programs. Crop Sci. 1979;19:571-574.
5. Shahjahan M, Wahab AE, Ekhtyar ME, Zaed BA. Response of some hybrid rice varieties to irrigation intervals under different dates of sowing. Bangladesh J. Agric. 2007;32(2):82-85.
6. Hossain M, Jaim WMH. Diversity and diffusion of rice varieties: A data base for Bangladesh. Report submitted to IFPRI, Harvest Plus Project; 2009.
7. Alam MS, Islam MM, Hassan L, Begum SN, Gupta R. Study of correlation, magnitude of genetic diversity and selection indices in popular rice (*Oryza sativa* L.) landraces of Bangladesh. Intl. J. Innovat. Appl. Studies. 2014;8(3):1329-1338.
8. Awal, MA, Habib AK, Hossain MA. A study on comparative performance of hybrid and conventional rice varieties in *aman* season. J. Agric. Rural Dev. 2007;5(1&2):13-16.
9. BRRI (Bangladesh Rice Research Institute). Annual report for 2016. Bangladesh Rice Res. Inst., Joydebpur, Gazipur. 2016;138.
10. Gomez KA. Gomez AA. Statistical procedure for agricultural research. Jihn Willey and Sons Ltd. New York. 1984;28-192.

11. Rahman MS, Haque MM, Ahamed KU. Effect of soil enhancer (XXL) on the growth and developmental attributes of Brri Dhan 29 and Hybrid Dhan Taj-1 cultivars of rice in boro season. Inter. J. Plant Soil Sci. 2018;22(3):1-14.
12. Munshi RU. A comparative morpho-physiological study between two and two modern rice cultivars. M.S. Thesis, Department of crop Botany, Bangladesh Agriculture University, Mymensingh, Bangladesh; 2005.
13. Sarkar NAR, Siddique MS, Islam MS. Effect of variety and structural arrangement of rows on the yield and yield components of transplant *Boro* rice. Bangladesh J. Agril. Sci. 2013;19(3):43-51.
14. Wang F, Cheng F, Zhang G. Difference in grain yield and quality among tillers in rice genotypes differing in tillering capacity. Rice Sci. 2007;14(2):135-140.
15. Ramasamy S, Chandrasekaran B, Sankaran S. Effect of spacing and seedlings hill^{-1} on rice yield. International Rice Research Newsletter, Philippines. 1987;12(4):49-54.
16. Aktar MB. Morpho-physiological evaluation and characterization in four aman rice genotypes. M.S. Thesis, Dept. Crop Bot., Bangladesh Agricultural University, Mymensingh, Bangladesh; 2005.
17. Rumana A. Morpho-physiological study of different local and HYV rice varieties during *aman* season. M.S. Thesis, Dept. Agril. Bot., Sher-e-Bangla Agricultural University, Dhaka, Bangladesh; 2017.
18. Haque MM, Pramanik HR, Biswas JK. Physiological behavior and yield performances of hybrid rice at different planting dates in *Aus* Season. Bangladesh Rice J. 2013;17(1&2):7-14.
19. Piranhas S, Mani SC, Verma SK, Sharma RK. Genetic variability and character association for panicle traits in basmati rice. Department of Genetics and Plant Breeding, G.B. Pant University of Agriculture & Technology, Pantnagar-263145. India. Agric. Sci. 1997;17(3):142-145.
20. Sarkar SK, Sarkar MAR, Islam N, Paul SK. Yield and quality of aromatic fine rice as affected by variety and nutrient management. J. Bangladesh Agril. Univ. 2014;12(2):279–284.
21. Amanullah. Specific leaf area and specific leaf weight in small grain crops “wheat, rye, barley, and oats” differ at various growth stages and npk source. J. Plant Nutri. 2015;38(11):1694-1708.
22. Liu Xi, Li Yong. Varietal difference in the correlation between leaf nitrogen content and photosynthesis in rice (*Oryza sativa* L.) plants is related to specific leaf weight. J. Integrat. Agric. 2016;15:2002-2011.
23. Haque KMS, Karim MA, Bari MN, Islam MR. Genotypic variation in the effect of drought stress on phenology, morphology and yield of aus rice. Intl. J. Biosci. 2016;8(6):73-82.
24. Ahmed AR, Dutta BK, Ray DC. Response of some rice varieties to different crop management practices towards morpho-logical and yield parameters. Intl. J. Sci. Res. Pub. 2015;5(2):1-6.
25. Siddiquee MA, Biswas SK, Kabir KA, Mahbub AA, Dipti SS, Ferdous N, Biswas JK, Banu B. A comparative study between hybrid and inbred rice in relation to their yield and quality. Pakistan J. Biol. Sci. 2002;5:550-552.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/55141