J Bangladesh Agril Univ 18(4): 963–967, 2020 https://doi.org/10.5455/JBAU.25243

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

Screening of Rice Cultivars Suitable for Early Transplanting in Haor Agriculture

A.K.M. Golam Sarwar✉, Sontosh Chandra Chanda, Md. Mozahidul Islam and Jannat-E-Tajkia

Laboratory of Plant Systematics, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ARTICLE INFO

Article history
Received: 04 Nov 2020
Accepted: 19 Dec 2020
Published: 30 Dec 2020

Keywords
Low-temperature stress, Hybrid rice, Growth and yield descriptors, Haor agriculture

Correspondence
A.K.M. Golam Sarwar
✉: drsarwar@bau.edu.bd

ABSTRACT

An experiment was conducted at the farmer's field in Dowarabazar, Sunamganj during November 2018 to April 2019 to find out suitable cultivar(s) for early transplanting mediated low-temperature stress tolerance in boro season to avoid the flash flooding. Twelve hybrid rice cultivars, *viz*. BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan5, SL-8H, Hybrid LP-70, Agomoni JBS-17(4), Win-302, Winall Hybrid 2, Nobin IS-1, Ispahani 1, Durbar IS-2 and Ispahani 2, were used as experimental materials. The field experiment was laid out in a randomized complete block design with three replications. The standard rice cultivation procedure was followed. Growth and yield contributing descriptors e.g., plant height, number of effective tillers, panicle length, grain yield, etc. differed significantly among the cultivars. Among the studied cultivars, BRRI hybrid dhan5 produced maximum grain yield (5.90 t ha^{-1}) followed by cultivar Nobin IS-1 (5.88 t ha^{-1}). The lowest yield was recorded from Ishpahani 2 (3.44 t ha^{-1}) and the other cultivars produced intermediate yield. It would be concluded that among the studied cultivars, BRRI hybrid dhan5 and Nobin IS-1 could be recommended for early transplanting within the haor area.

Introduction

The haor is a wetland ecosystem, *ca*. 8,600 sq km, characterized by the presence of large bowl-shaped floodplain depressions, which are located within the north-eastern region of Bangladesh and seasonally inundated during the monsoon period (CEGIS 2012). "Haor Agriculture" supports the country's economy by two ways – as a boro rice production base during the dry season and as a fishing ground filled with ample fish during the rainy season. In haor areas, the boro rice is sandwiched by two adverse conditions, the low temperature at the beginning of the growing season and flash flood at the ending. If rice crop damaged by the flash floods, the livelihoods, food and nutritional security of the people in haor areas get threatened. The region often experiences food insecurity due to poor access of food to the markets, especially during the flood season; and also for isolation from traders and services along with crop losses due to early or flash floods and erosion (Caldwell and Ravesloot, 2011). Flash floods occur at the beginning of the rainy season (late April), caused by river water flowing into the Meghna river from the mountainous regions in India and resulting in flood damage in the river basin. The devastating flash flood destroyed the boro rice completely cultivated on 0.29 m ha haor areas which consist of the 6% of the country's total boro cultivation in the year 2017 (Islam, 2017).

The possible remedies to avoid the flash flood-related rice crop yield loss might be to cultivate short-duration cultivars and/or the early transplanting of popular rice cultivars. Unfortunately, a cultivar with a higher yield, shorter growth duration and tolerant to low temperature is yet to be developed (Biswas, 2017). On contrary, researchers have identified cold injury due to early transplanting, especially in haor agriculture to avoid the flash flood, as one of the probable causes of grain sterility during boro season (Biswas, 2011; Sarwar *et al*., 2017). The critically low temperature, normally below 20°C, differ according to the growth stage, cultivar, duration of critical temperature, diurnal changes, and physiological status of the plant (Yoshida, 1981). For example, temperatures below 20°C at about the reduction division stage of the pollen mother cells usually induces a high percentage of spikelet sterility in rice. Low temperature (as low as 12 ^{0}C), continuously prevailing for 6 days or more, may induce about 100% grain sterility in rice (Yoshida, 1981; Kabir *et al*., 2008; BRRI 2017). In our previous studies, it was observed that

Cite This Article

Sarwar, A.K.M.G., Chanda, S.C., Islam, M.Z., Tajkia, J.E. 2020. Screening of Rice Cultivars Suitable for Early Transplanting in Haor Agriculture. *Journal of Bangladesh Agricultural University*, 18(4): 963–967. https://doi.org/10.5455/JBAU.25243

the hybrid rice cultivars were relatively more tolerant, in respect of yield loss, to low temperature-induced spikelet sterility compared to modern rice cultivars (Sarwar and Islam, 2013; Sarwar *et al*., 2017). The present research was, therefore, undertaken to find out rice cultivar(s) suitable for early transplanting mediated low-temperature stress tolerance in boro season among the existing (hybrid) cultivars of Bangladesh.

Materials and Methods

The experiment was conducted at the farmer's field in Dowarabazar, Sunamganj during November 2018 to April 2019. Twelve hybrid rice cultivars, *viz*. BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan5, SL-8H, Hybrid LP-70, Agomoni JBS-17(4), Win-302, Winall Hybrid 2, Nobin IS-1, Ispahani 1, Durbar IS-2 and Ispahani 2, were used as experimental materials. The experiment was laid out in a randomized complete block design with three replications. The agro-climatic conditions i.e. monthly values of maximum, minimum and average of temperature (°C), average relative humidity (%), total rainfall (mm), total sunshine (hr) and average air pressure (mbar) at Sunamganj, the nearest position (data available) to the experimental site, during the study period have been presented Table 1.

Table 1. Weather data of Sunamganj, nearest to experimental site, during the period of the experiment in 2018 – 2019†

Month	Temperature (°C)			RH (%)‡	Rainfall (mm)+	Sunshine (hr)+	Air pressure (mbar)‡
	High	Low	Average				
November 2018	28	17	22	65	4.9	225.0	1014.8
December 2018	25	15	19	60	17.11	218.5	1015.6
January 2019	29	17	24	50	0.7	232.5	1016.6
February 2019	29	14	24	53	129.5	180.5	1015.2
March 2019	32	20	27	52	93.5	273.5	1012.1
April 2019	36	25	31	57	363.3	275.0	1009

†Source: https://www.worldweatheronline.com/sunamganj-weather-history/bd.aspx; RH Relative Humidity; ‡ Monthly average; + Monthly total

Thirty days old healthy rice seedlings were transplanted in the experimental plot on 21 November 2018 following standard rice cultivation procedure (BRRI 2017). The crop was harvested at the maturity stage, 80% of grains attained golden colour on 8 April 2019 and data regarding growth and yield contributing descriptors, *viz*. plant height, tiller number, number of effective and non-effective tillers, length and width at the widest portion of flag leaf, panicle length, number of primary and secondary branches of panicle, number of filled and un-filled grains panicle^{-1}, 1000-grain weight, grain yield (t ha^{-1}). The leaf area was calculated following Ribeiro *et al*. (2019).

$$LA = 0.78 \times L \times W$$

Where, LA Leaf area, L Leaf length, W Leaf width

The collected data were analyzed following the ANOVA using the statistical computer package program MSTAT-C. The mean differences of different parameters among the cultivars were adjudged with Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

There were significant variations in all growth and yield contributing descriptors, *viz*. plant height, tiller number, number of effective and non-effective tillers, length and width of flag leaf, panicle length, number of primary and secondary branches, number of filled and un-filled grains panicle^{-1}, 1000-grain weight, grain yield (t ha^{-1}), among the cultivars studied (Table 2). The plant height varied from 75.4 cm to 61.7 cm. The total, effective and non-effective number of tillers varied between 15.8 – 11.0, 14.1 – 10.0 and 2.6 – 0.4, respectively. Among the cultivars, Nobin IS-1 produced the longest and widest flag leaf (23.65 cm and 13.2 mm, respectively), on contrary shortest (16.15 cm) and narrowest (10.3 mm) of flag leaf observed in Hybrid LP-70 and BRRI hybrid dhan2, respectively (Table 2; Figure 1). The growth and yield of rice crop depend upon its genetic potential and growing/environmental condition (Yoshida, 1981; Sarwar and Chanda, 2020). These morphological descriptors are mostly controlled by the genetic make-up of the rice cultivar (BRRI 2017). The longer and wider flag leaf could produce more photosynthates (starch) which can help crop growth and development consequently production of higher grain yield (Figure 1; Rahman *et al*., 2013).

Grain yield is the function of panicle number m^{-2}, spikelet number panicle^{-1}, filled spikelets (%) and 1,000-grain weight (g) (Yoshida, 1981). The early transplanting reduced the numerical values of all of the studied descriptors except the number of unfilled grains (sterile spikelets) panicle^{-1} which may one of the causes of low yield due to early transplantation. The traits of panicle among the hybrid cultivars differed significantly and thus variation in panicle length ranged from 17.85 to 23.63 cm number of primary branches from 8.1 to 10.6, number of secondary branches from 12.2 to 29.6, total number of grains from 83.5 to 160.1, total number of unfilled grains from 21.3 to 47.9 and spikelets sterility from 20 – 41% (Table 3). However, 1000-grain weight varied from 31.89 g to 25.97 g and did not differ significantly among the cultivars. This variation panicle characters could be

attributed to the effect of low temperature prevailing during early growth and reproductive stages of rice plant (Table 1). It is well established that the low temperature-induced spikelets sterility due to a reduction in viable pollen grains numbers (Biswas, 2011; Sarwar *et al*., 2017; Zeng *et al*., 2017). During the development of male gametophyte, low temperature causes disruption of meiosis, tapetal hypertrophy, stunted development of pollen grain, anther protein degradation, pollen sterility, pollen tube deformation which ultimately leads to spikelet sterility in rice (Nishiyama, 1995; Zeng *et al*., 2017).

Among the cultivars, BRRI Hybrid dhan5 produced the maximum grain yield (5.90 t ha^{-1}) followed by the cultivar Nobin IS-1 (5.88 t ha^{-1}) with no statistical difference. The highest grain yield in the two cultivars might correspond to the larger flag leaf, longer panicle length, higher number of primary and secondary branches, and filled grain panicle^{-1} (Table 2 and 3). The lowest yield was recorded from Ishpahani 2 (3.44 t ha^{-1}) and the other cultivars produced intermediate yield (Table 3). The grain yield of some cultivars was sometimes up to 48% lower compared to previous year's yield when all the growth conditions were optimum i.e. no low-temperature stress and without the occurrence of a flash flood (Sarwar, unpublished data). These lower yields might be due to the integration of low-temperature stress-related spikelets sterility, higher incidence of insect and disease pests, hail storms just a few days before harvesting (1 April 2018), etc. those prevailed in the growing period (Sarwar, personal observation). Farmer's attitude was one of the major constrains early transplanting of boro rice in haor area. It was so difficult to motivate farmer(s) to early transplanting. Other farmers were still in critique during the time of transplanting operation of rice seedling underway in the experimental plots. Another challenge was birds attack especially at the ripening stage when plants of all other rice fields were in milk-dough or grain filling stage. A combined effort, early transplanting in a large land area, may be helpful to overcome this situation. This might also be helpful to reduce insect and disease pest incidence.

Table 2. Growth descriptors of 12 hybrid rice cultivars grown in haor area of Sunamganj

Cultivars	Plant height (cm)	Number of tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Flag leaf	
					Length (cm)	Width (mm)
BRRI hybrid dhan2	62.4 de	14.6 a	13.3 ab	1.3 bc	18.20 b-d	10.3 e
BRRI hybrid dhan3	65.0 c-e	15.8 a	14.1 a	1.7 a-c	19.15 b-d	11.2 c-e
BRRI hybrid dhan5	74.1 ab	11.0 c	10.0 d	1.0 bc	21.70 ab	11.9 bc
SL-8H	64.2 c-e	13.1 a-c	11.0 b-d	2.1 ab	19.31 b-d	12.0 a-c
Durbar IS-2	66.4 cd	14.1 ab	13.1 a-c	1.0 bc	17.20 cd	10.4 de
Nobin IS-1	75.4 a	12.7 a-c	12.1 a-d	0.4 c	23.65 a	13.2 a
Hybrid LP-70	61.7 e	14.1 ab	12.7 a-c	1.4 bc	16.15 d	11.1 c-e
Ispahani 1	65.1 c-e	14.8 a	12.2 a-d	2.6 a	19.35 b-d	12.5 ab
Ispahani 2	66.8 cd	12.7 a-c	11.3 a-d	1.4 bc	20.40 a-c	11.5 b-d
Winall hybrid-2	63.0 de	14.1 ab	12.2 a-d	1.9 ab	18.05 b-d	10.5 de
Agomani JBS-17(4)	63.2 de	11.8 bc	10.4 cd	1.4 bc	19.45 b-d	12.2 a-c
Win-302	69.9 bc	11.8 bc	11.3 a-d	0.5 c	20.20 a-c	10.7 de
$LSD_{0.05}$	4.95	2.99	2.67	1.27	3.92	1.17

In a column, means having different letter(s) differ significantly ($p \leq 0.05$)

Table 3. Yield contributing descriptors of 12 hybrid rice cultivars grown in haor area of Sunamganj

Cultivars	Panicle length (cm)	Num. of primary branches panicle^{-1}	Num. of secondary branches panicle^{-1}	Num. of total grains panicle^{-1}	Num. of unfilled grains panicle^{-1}	Spikelet sterility (%)	1000-grain weight (g)	Grain yield (t ha^{-1})
BRRI hybrid dhan2	20.10 cd	8.5 bc	13.5 ef	89.5 de	25.9 d	28	26.76	3.85 e
BRRI hybrid dhan3	20.67 b-d	7.8 c	12.2 f	83.5 e	28.7 cd	34	29.24	4.14cd
BRRI hybrid dhan5	22.94 a	10.6 a	29.6 a	160.1 a	47.9 a	29	31.89	5.90 a
SL-8H	17.85 f	9.0 bc	18.6 cd	92.6 c-e	34.1 a-c	37	25.97	4.05 d
Durbar IS-2	21.24 b	8.4 bc	14.8 d-f	105.5 cd	21.3 d	20	26.97	4.25 c
Nobin IS-1	23.63 a	10.5 a	26.0 ab	140.7 b	35.4 a-c	25	28.10	5.88 a
Hybrid LP-70	19.95 d	8.1 c	13.9 ef	93.1 c-e	29.4 cd	31	26.66	4.32 b
Ispahani 1	20.10 cd	8.5 bc	16.4 d-f	93.5 c-e	30.8 a-d	33	28.24	4.52 b
Ispahani 2	18.58 ef	9.5 ab	22.9 bc	109.0 c	44.6 ab	41	26.96	3.44 g
Winall hybrid-2	21.01 bc	8.4 bc	15.6 d-f	90.6 de	32.9 a-d	36	29.36	3.68 f
Agomani JBS-17(4)	20.25 cd	8.2 bc	17.2 de	105.4 cd	31.2 b-d	29	27.93	4.15cd
Win-302	19.02 e	8.6 bc	24.5 b	107.7 cd	30.4 b	28	28.51	4.06cd
$LSD_{0.05}$	0.88	1.33	4.75	19.59	17.2	n.d.	-	0.15

In a column, means having different letter(s) differ significantly ($p \leq 0.05$). n.d. Not discern

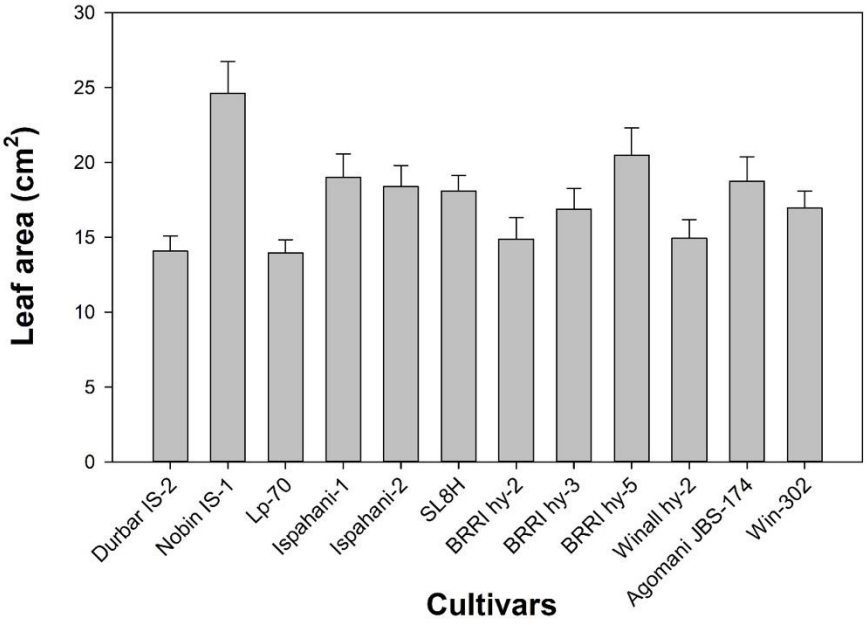

Figure 1. Leaf area of 12 hybrid rice cultivars grown in haor area of Sunamganj

Conclusion

It might be concluded that among the studied cultivars, BRRI Hybrid dhan5 and Nobin IS-1 could be recommended for early transplanting in the haor area. Although the grain yield was relatively lower in the early transplanting practice, it might be better compared to the complete crop damage by an early flash flood due to farmer's traditional practices. Further studies with other hybrids and/or short-duration inbreed rice cultivars are recommended to reach a confident conclusion.

Acknowledgement

We acknowledge the active support of the Department of Agricultural Extension (Dowarabazar, Sunamganj) personnel during the period of this study. This work was supported by the Ministry of Science and Technology, Government of the People's Republic of Bangladesh (grant #39.00.0000.09.06.79.2017/2/BS-379) and the Bangladesh Agricultural University Research System, Bangladesh Agricultural University (grant #2017-252-BAU).

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Biswas, J.K. 2011. Cool-injury of rice: Modern *vs*. Traditional science (in Bangla). http://www.sangbad.com.bd/?view=details&type=gold&data=Entertainment&pub_no=597&menu_id=23&news_type_id=1&val=55338

Biswas, J.K. 2017. Harvesting rice prior to flash flood. http://www.daily-sun.com/printversion /details/224339/Harvesting-Rice-prior-to-Flash-Flood

BRRI (Bangladesh Rice Research Institute). 2017. Modern Rice Cultivation (in Bangla). 20th ed., BRRI, Gazipur. pp. 1-80.

Caldwell, R., Ravesloot, B. 2011. SHOUHARDO Baseline survey report. Dhaka, CARE Bangladesh: 203 pp.

CEGIS (Center for Environmental and Geographic Information Services). 2012. Master Plan of Haor Area. Vol. 1, Bangladesh Haor and Wetland Development Board, Government of the People's Republic of Bangladesh Ministry of Water Resources, Dhaka. 72 pp.

Gomez, K.A., Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. 2nd ed., John Wiley and Sons, New York.

Islam, A.K.M.S. 2017. Climate change and crops in haor areas. The Independent, 16 April 2017. http://www.theindependentbd.com/home/printnews/90337

Kabir, M.S., Howlader, M., Biswas, J.K., Mahbub, M.A.A., Nur-e-Elahi, M. 2008. Probability of low temperature stress at different growth stages of *Boro* rice. Paper presented at International Symposium on Climate Change and Food Security in South Asia, August 28-30, 2008, Dhaka. http://www.wamis.org/agm/meetings/rsama08/Bari203-Kabir_BRRI.pdf

Nishiyama, I. 1995. Damage due to extreme temperatures. In: Science of the Rice Plant. Matsuo T, Kumazawa K, Ishii R, Ishihara H, Hirata H (eds.). Food and Agriculture Policy Research Center, Tokyo, Japan. pp. 769-812.

Rahman, M.A., Haque, M.E., Sikdar, B., Islam, M.A., Matin, M.N. 2013. Correlation analysis of flag leaf with yield in several rice cultivars. Journal of Life and Earth Science, 8: 49-54. https://doi.org/10.3329/jles.v8i0.20139

Ribeiro, B.S.M.R., *da* Silva, M.R., Richter, G.L., Ribas, G.G., Streck, N.A., Zanon, A.J. 2019. Can leaf area in rice be defined by a mathematical model? Revista Ceres, 66: 191-199. https://doi.org/10.1590/0034-737X201966030005

Sarwar, A.K.M. Golam, Chanda, S.C. 2020. Growth and yield descriptors of rice influenced by transplanting date. Journal of Agriculture, Food and Environment 1: (in press)

Sarwar, A.K.M. Golam, Islam, M.A. 2013. Food security in Bangladesh – Effect of low temperature on pollination biology and grain yield in rice. BAU Research Progress, 24: 27.

Sarwar, A.K.M. Golam, Sohel, S.A., Islam, M.A., Ashrafuzzaman, M. 2017. Palynological features and grain yield of rice as influenced by air temperature and relative humidity. Bangladesh Journal of Botany, 46: 947-954.

Yoshida, S. 1981. Fundamentals of Rice Crop Science. International Rice Research Institute, Los Baños, Philippines.

Zeng, Y., Zhang, Y., Xiang, J., Uphoff, N.T., Pan, X., Zhu, D. 2017. Effects of low temperature stress on spikelet-related parameters during anthesis in *indica–japonica* hybrid rice. Frontier in Plant Sciences, 8:1350. https://doi.org/10.3389/fpls.2017.01350