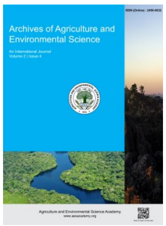
Archives of Agriculture and Environmental Science 7(2): 261-266 (2022)
https://doi.org/10.26832/24566632.2022.0702015

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

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Weed suppressive ability of BRRI released popular monsoon rice varieties

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ARTICLE HISTORY

Received: 06 April 2022
Revised received: 10 June 2022
Accepted: 20 June 2022

Keywords

Aman rice,
Bangladesh
Competitiveness
HYV
Weed management

ABSTRACT

Develoment of weed competitive crop cultivars is an attractive low-cost strategy of integrated weed management program that can reduce the heavy dependence of crop cultivation to chemical herbicides. Hence, to evaluate the weed competitiveness Bangladesh Rice Research Institute (BRRI) released selected monsoon rice varieties, a field experiment was conducted during July to December 2018 at the Agronomy Field Laboratory of Bangladesh Agricultural University. Thirty-three rice varieties were grown under season long weedy and weed-free conditions. Plots without rice plants were also maintained to investigate the natural growth of weed in absence of rice. The experiment was conducted following randomized complete block design with three replicates. The results showed that rice varieties varied widely in yielding ability and weed competitiveness. Among rice varieties, BRRI dhan31 allowed the minimum weed growth (32.5 g m^{-2}) while BRRI dhan51 allowed the maximum weed growth (155.3 g m^{-2}). Grain yield ranged between 3.6 t ha^{-1} (BRRI dhan49) and 7.5 t ha^{-1} (BR10) under weed-free condition and between 2.2 t ha^{-1} (BRRI dhan70) and 3.9 t ha^{-1} (BRRI dhan34) under weedy condition. Weed imposed relative yield loss ranged from 10.2 to 66.9% among the rice varieties. BRRI dhan34 allowed the least yield penalty (10.2%) while BRRI dhan70 had the maximum yield penalty (66.9%) due to competition with weeds. Although BR10 appear as the most productive variety (7.5 t ha^{-1}) its weed imposed relative yield loss was higher (51.3%) than many other varieties with low yield potential. On the other hand, BRRI dhan34 appeared as the most weed competitive variety (only 10.2% relative yield loss) with productivity of 3.9 t ha^{-1}. Considering the yield, BR10 was the best but for weed suppressive ability BRRI dhan34 performed well.

Citation of this article: Mou, M. A., Yeasmin, S., Abedin, M. A., Anwar, M. P., & Islam, A. K. M. M. (2022). Weed suppressive ability of BRRI released popular monsoon rice varieties. *Archives of Agriculture and Environmental Science*, 7(2), 261-266, https://dx.doi.org/10.26832/24566632.2022.0702015

INTRODUCTION

Rice (*Oryza sativa* L.) is the major food crop of about 160 million people of Bangladesh. Rice provides approximately 48% of rural employment, and about two-third and one-half of the total calorie supply and protein intake of an average person in Bangladesh, respectively (Rahman *et al*., 2020). Total rice production in Bangladesh has increased from 10.59 million tons (1971) to 36.28 million tons to feed her 160 million people (BRKB, 2019). Bangladesh is now the world's fourth largest rice producing country after China, India and Indonesia (GRiSP, 2013). There are three distinct classes of rice in the country based on season of cultivation for example, *aus* (summer), *aman* (monsoon) and *boro* (winter). Monsoon rice covers 52% areas of Bangladesh and produce 13.99 million metric ton (average yield of 2.52 M t ha^{-1}) (BBS, 2019). This yield per unit area is much lower than that of other rice growing countries of the world. Weeds are considered as one of the major constrains among the several factors that hinders higher rice production of the country. Weeds cause 40 – 60% average yield losses in rice which may go up to 94 – 96% with uncontrolled weed growth (Chauhan and Johnson, 2011, Dass *et al*., 2017, Islam *et al*., 2021). It has also been reported that unchecked weed growth reduced crop yield by up to 57% in puddled transplanted rice and 82% in dry direct seeded rice (Mahajan *et al*., 2009). In direct seeded early summer rice weeds reduce the grain yield by 68–100%, in transplanted late summer (monsoon) rice by 16-48%, and in irrigated winter rice by 22–36% in Bangladesh (Rashid *et al*., 2007). Although weed management strategies differ among the countries, now mostly rely on herbicides because of outmigration of agricultural labour, escalating labor wages and drudgery involved. The agricultural labour availability in Bangladesh decreased (almost 2-folds) from 70% (1991) to 39% (2018) which influence the increased consumption (71-folds) of herbicide from 99 MT/ kL (1991) to 6997 MT/ kL (2018) (BBS, 2021). Integrated weed management strategies suggest several options but risks of environmental hazard (Aktar *et al*., 2009, Dass *et al*., 2017) and developing resistant weed biotypes resulting from indiscriminate herbicides use (Heap, 2022). On the other hand, labor-intensive manual weeding methods demand an environment-friendly and less labor-intensive weed management system for rice production in sustainable agriculture. It has been reported that the performance of herbicides can be enhanced if crop varieties with higher weed competitiveness are used especially in herbicide-dominant systems (Mahajan and Chauhan, 2011). The competitive cultivar could be used, as an element of integrated weed-management strategy to increase or sustain rice productivity. However, to date very few work has been done to examine the weed competitive ability Bangladeshi monsoon rice varieties to fight against weeds under puddled transplanted system of cultivation. In this context, the present study was conducted to investigate the variation in weed competitive ability among selected monsoon rice varieties released from Bangladesh Rice Research Institute.

MATERIALS AND METHODS

Details of the experimental site

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (24°4308.3N, 90° 25041.2E and height from the sea level is 18m), Mymensingh, Bangladesh. This site belongs to the non–calcareous dark grey floodplain soil of Sonatola series under the Agro Ecological Zone 9 (AEZ9) known as Old Brahmaputra Floodplain (FAO-UNDP, 1988). The experimental field soil was silt loam in texture and around neutral in reaction (pH 6.7), low organic matter content (1.29%), and fairly level with well drainage facilities. During experimentation (July to November), the average minimum and maximum temperatures, rainfall and relative humidity were 24 ° C, 32 °C, 114 cm and 85%, respectively.

Details of the experiments

The experiment was factorial, where, factor A comprised two weeding regimes, *i.e.*, season long 'weed free'; and season long 'weedy'. On the other hand, factor B comprised 33 Bangladesh Rice Research Institute (BRRI) released rice varieties. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 5.0 m^2(2.5 m × 2.0 m). Furthermore, three plots without rice were maintained to study the growth, diversity and abundance of weeds under the field experimental settings.

Table 1. Brief description of the varieties used in the experiment (BRRI, 2019).

S. N.	Varieties	Released year	Plant height (cm)	Life duration (days)	Average yield (t ha^{-1})
1	BR10	1980	115	150	6.5
2	BR11	1980	115	145	6.5
3	BR22	1988	125	150	5.0
4	BR25	1992	138	135	4.5
5	BRRI dhan30	1994	120	145	5.0
6	BRRI dhan31	1994	115	141	5.0
7	BRRI dhan32	1994	120	130	5.0
8	BRRI dhan33	1997	100	118	4.5
9	BRRI dhan34	1997	117	135	3.5
10	BRRI dhan37	1998	125	140	3.5
11	BRRI dhan38	1998	125	140	3.5
12	BRRI dhan39	1999	106	120	4.5
13	BRRI dhan40	2003	115	145	4.5
14	BRRI dhan41	2003	115	148	4.0-4.5
15	BRRI dhan44	2005	125-130	145	6.5
16	BRRI dhan46	2007	105	150	4.7
17	BRRI dhan49	2008	100	135	5.0
18	BRRI dhan51	2010	90	140-145	4.0-4.5
19	BRRI dhan52	2010	116	140-145	4.5-5.0
20	BRRI dhan54	2010	115	135	5.5
21	BRRI dhan56	2011	115	105-110	4.5-5.0
22	BRRI dhan57	2011	110-115	100-105	4.0-4.5
23	BRRI dhan62	2013	98	100	3.5-4.5
24	BRRI dhan66	2014	118-120	110-115	4.5-5.0
25	BRRI dhan70	2015	125	130	4.8
26	BRRI dhan71	2015	107-108	114-117	5.0-6.0
27	BRRI dhan72	2015	116	125-130	5.7-7.5
28	BRRI dhan75	2016	101-110	110-115	4.5-5.5
29	BRRI dhan76	2016	140	153	4.5-5.0
30	BRRI dhan77	2016	140	145	4.5-5.0
31	BRRI dhan78	2016	120	135	5.0-5.5
32	BRRI dhan79	2017	112	135	4.0-4.5
33	BRRI dhan80	2017	120	130-135	4.5-5.0

Description of cultivar

A brief description of the varieties used in the experiment are given in Table 1.

Crop husbandry

Thirty-day old seedlings of 33 rice varieties were transplanted in the puddled field on 15 July 2018 at 25 cm × 15 cm spacing with 3 seedlings hill^{-1}. The plots were fertilized with the BRRI recommended dose of fertilizer *i.e.* 220, 120, 75, 60 and 10 kg ha^{-1} as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate, respectively. Except urea all other fertilizers were applied as basal where, urea was applied in three equal splits at 15, 30 and 45 days after transplanting (DAT). No irrigation was provided because the rice was grown as rainfed. There was no remarkable insect or diseases infestation during the experimentation and therefore, no crop protection measures were taken for controlling insects and diseases.

Data recording

Weed related: At 45 DAT, a quadrat (0.5 m × 0.5 m) was placed unbiased in three different places of each season-long weedy plot for collecting weed samples. Weed were clipped at ground level, identified and counted by species, and dried in an oven at 70 °C until the weight become constant. Weed density and biomass were expressed as number per square meter and gram per square meter, respectively. The summed dominance ratio (SDR) was computed to identify the dominant weed species as per Janiya and Moody (1989).

$$SDR\ of\ a\ weed\ species = \frac{Relative\ density + Relative\ weed\ biomass}{2}$$

Where,

$$Relative\ density\ (\%) = \frac{Density\ of\ a\ given\ weed\ species}{Total\ weed\ density} \times 100$$

$$Relative\ weed\ biomass\ (\%) = \frac{Biomass\ of\ a\ given\ weed\ species}{Total\ weed\ biomass} \times 100$$

Relative contribution of broad-leaved, grasses and sedges to the weed vegetation in terms of relative density and biomass were also calculated. Finally, relative yield loss (%RYL) was calculated as per Islam *et al.* (2017).

$$RYL\ (\%) = \frac{Weed\ free\ yield - Treatment\ yield}{Weed\ free\ yield} \times 100$$

Crop data: The whole plot was harvested when 90% of the grains became golden yellow in color. The harvested crop of each plot was separately bundled, properly tagged and brought to the threshing floor. The crop was threshed by pedal thresher. The grains were cleaned by winnower and sun dried to 14% moisture content. The straw was also sun dried. At the end, grain and straw yield plot^{-1} were recorded and converted to t ha^{-1}.

Statistical analysis

The data were then compiled digitally and tabulated for statistical analysis. Analysis of variance was performed through computer package programme Statistix 10. The mean differences among the treatments were evaluated with Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Weed dynamics

Seven weed species belonging to five different families were observed in weedy plots, among which three were broadleaves, three grasses and one sedge (Table 2). Based on summed dominance ratio (SDR), the five most dominant weed species encountered were *Pistia stratiotes*, *Panicum disticum*, *Marsilea quadrifolia*, *Cyperus difformis*, *Echinochloa crusgalli*. Broadleaf weeds contributed 50% of the total dry matter and 50% of total density compared to grasses (48% and 27%, respectively) and sedges (2% and 23%, respectively) (Figure 1). Similar type of variation in SDR values in different weeds were also reported by Juraimi *et al.* (2011), Hia *et al.* (2017), Islam *et al.* (2017), Rahman *et al.* (2017) and Islam *et al.* (2021).

Weed density and dry matter varied significantly among varieties (Figure 2 & 3). Weed density ranges from 88.9 to 174.2. The highest weed density was observed in BRRI dhan33 (174.2) and the lowest one in BRRI dhan34 (88.9). Maximum weed dry matter was observed in weed monoculture. Weed dry matter ranged from 32.5 to 155.3 g m^{-2}. The highest weed dry matter was found in BRRI dhan51 (155.3 g m^{-2}) and the lowest one in BRRI dhan31 (32.5 g m^{-2}) (Figure 3). Weed pressure and density variation among the varieties were also reported by many authors. For example, Hia *et al.* (2017) observed highest weed density and dry weight in local variety Kalijira and that of lowest in BRRI dhan38 during monsoon season. From another experiment, Islam *et al.* (2018) reported that inbred rice BRRI dhan49 allowed highest number of weeds per square meter at any growth stages compared to other varieties, whereas hybrid variety Agrodhan-12 allowed the lowest.

Relative yield loss

The lower the relative yield loss, higher the degree of weed tolerance, since weed tolerance refers to the ability to maintain high yield in the presence of weed competition. The rice variety showed wide diversity in relative yield loss which ranged from 10.2 to 66.9% (Figure 4). The relative yield loss was lowest in BRRI dhan34, followed by BRRI dhan62 and BRRI dhan76 which exhibited high weed tolerance, whereas BRRI dhan70 had the lowest tolerance to weeds with a yield penalty of 66.9% closely followed by BRRI dhan56 and BRRI dhan38. Islam et al. (2021) also reported a wide variation in weed suppressive ability 42 monsoon and 28 winter rice varieties of Bangladesh under puddled transplanted condition. In addition, variation in weed suppressive ability of Bangladeshi winter rice varieties under aerobic and semi-aerobic condition were reported by Rahman *et al.* (2017) and Arefin *et al.* (2018), respectively.

Table 2. Dominant weed species with family name, type, relative density (RD), relative dry weight (RDW) and summed dominance ratio (SDR).

Scientific name	Family name	Weed type	RD (%)	RDW (%)	SDR (%)
Pistia stratiotes	Araceae	Broad leaf	31.7	23.3	27.5
Panicum disticum	Poaceae	Grass	8.5	32.3	20.4
Marsilea quadrifolia	Marsileaceae	Broad leaf	13.4	20.7	17.0
Cyperus difformis	Cyperaceae	Sedge	23.2	2.2	12.7
Echinochloa crusgalli	Poaceae	Grass	7.3	15.0	11.2
Paspalum scrobiculatum	Poaceae	Grass	11.0	0.4	5.7
Eichhornia crassipes	Pontederiaceae	Broad leaf	4.9	6.2	5.5

Here, RD = Relative density, RDW = Relative dry weight, SDR = Summed dominance ratio.

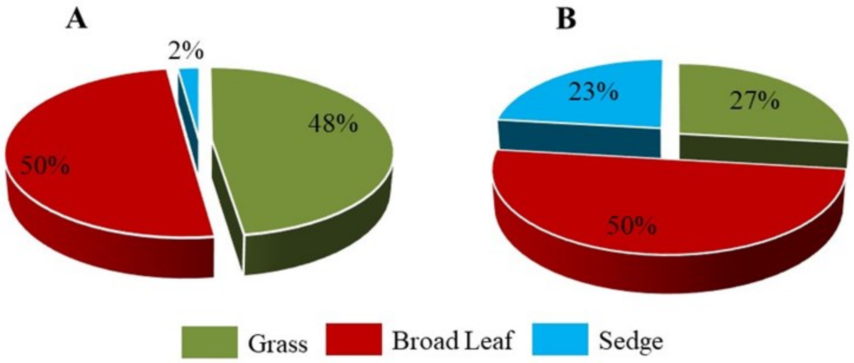

Figure 1. *Relative dry weight (A) and Relative density (B)of different weed groups.*

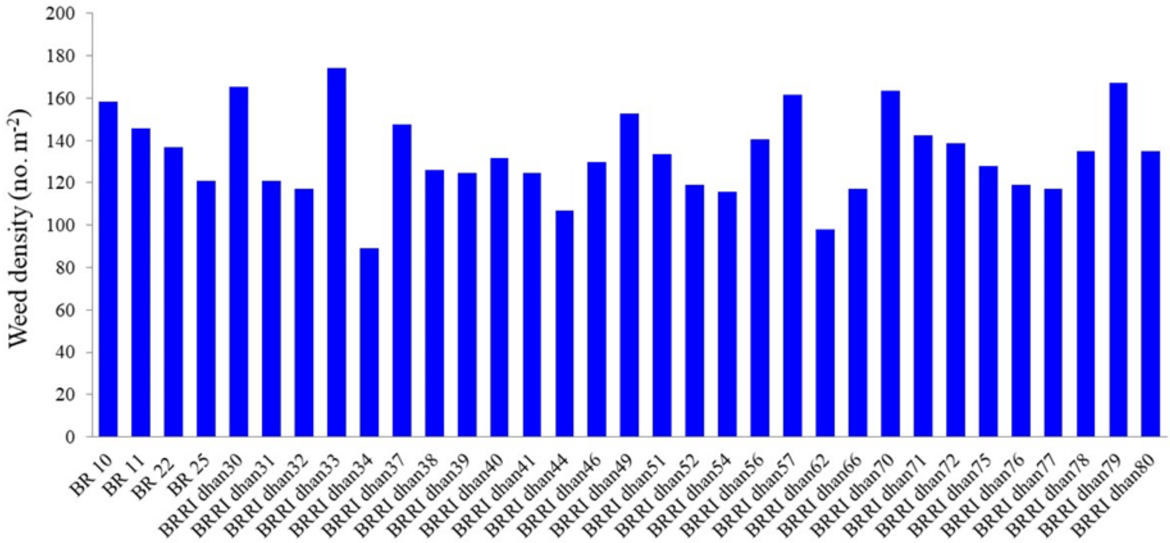

Figure 2. *Effect of selected BRRI released monsoon rice varieties on weed density (no.)*

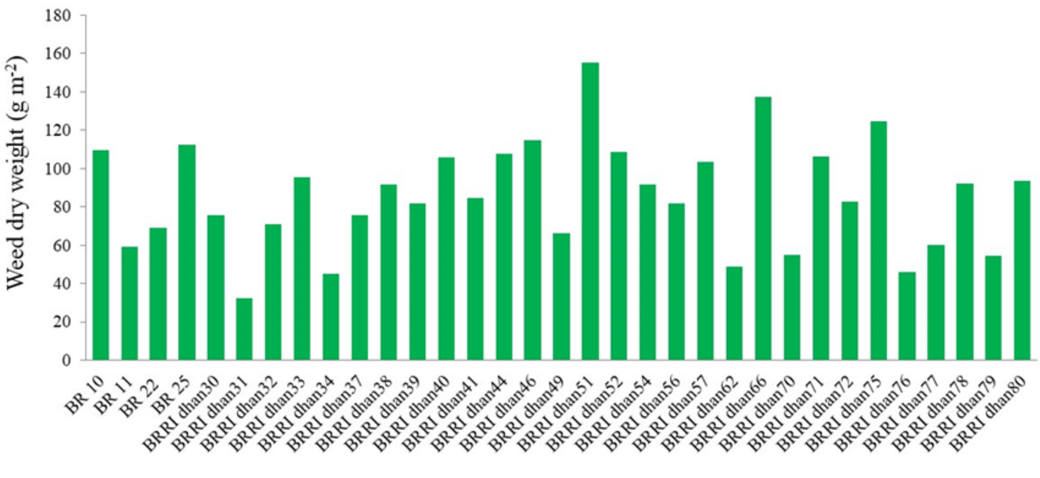

Figure 3. *Effect of selected BRRI released monsoon rice varieties on weed dry weight (g m^{-2}).*

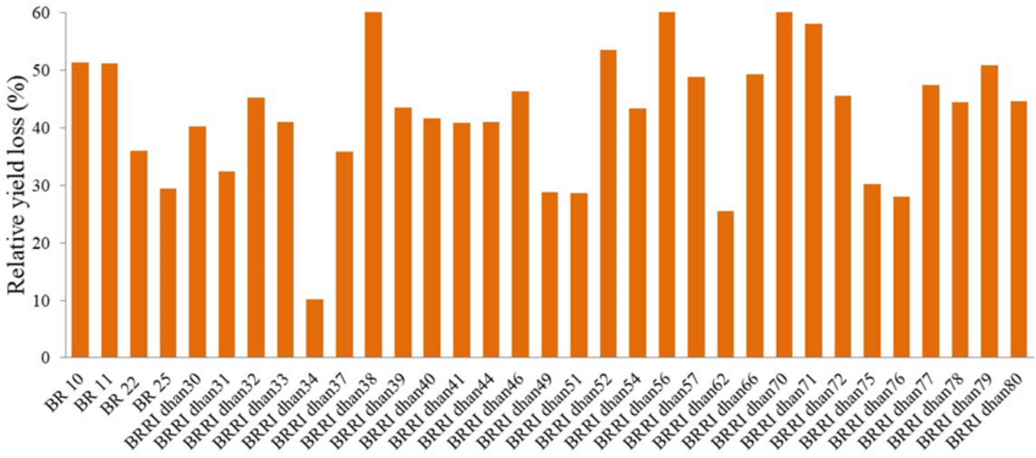

Figure 4. *Relative yield loss of selected BRRI released monoson rice varieties due to weed pressure.*

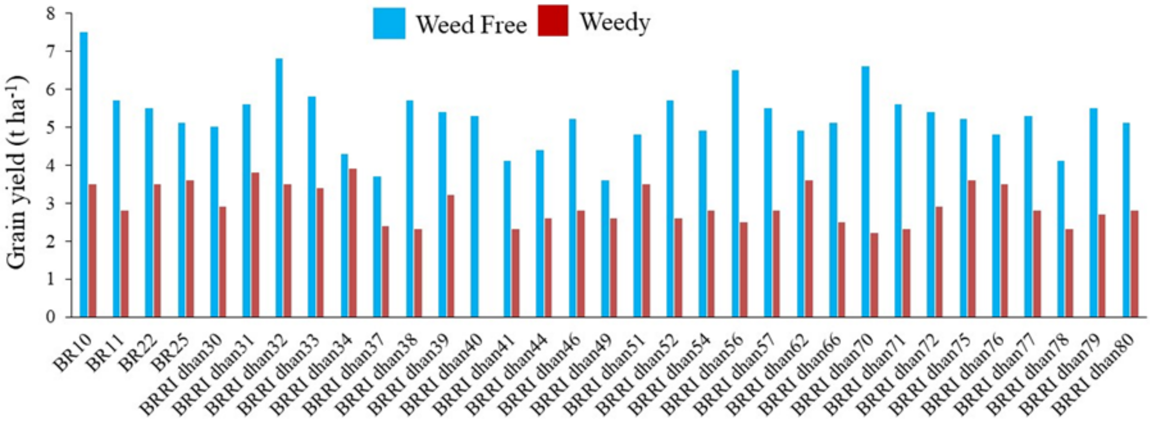

Figure 5. *Grain yield of selected BRRI released monoson rice varieties under weed free and weedy conditions.*

Grain yield

Grain yield was significantly affected by interaction between variety and weeding regime (Figure 5). The grain yield ranged from 2.2 to 7.5 t ha^{-1}. The highest grain yield was produced by BR10 (7.5 t ha^{-1}), followed by BRRI dhan32 (6.8 t ha^{-1}) in weed free treatment. On the other hand, the lowest grain yield (2.2 t ha^{-1}) was produced by BRRI dhan70, which was statistically identical with BRRI dhan38 (2.3 t ha^{-1}) in weedy condition (Figure 5).

Conclusion

Though this research identified some promising weed competitive varieties from the selected BRRI released rice varieties, those are not feasible in terms of yield and economic view point. Because the highly competitive variety of this study was not the high yielding one and vice versa. In addition, it is not feasible for the farmers to keep their rice field weed free throughout the season to achieve higher yield. Hence, before releasing any variety the rice breeder should consider the weed competitiveness of that variety along with its yield potential. Furthermore, as multi-location trials with these varieties were not conducted in this experiment, it is recommended to do these trials before drawing a final conclusion.

ACKNOWLEDGMENTS

Authors of the manuscript thankfully acknowledge the financial support provided by the Ministry of Science and Technology, Government of the People's Republic of Bangladesh for the project number: 39.00.0000.009.14.004.19/BS-18/29, dated 16-01-2019, under special allocation for science and technology, for the financial year 2018-2019. The authors also thankfully acknowledge the administrative support provided by Bangladesh Agricultural University Research Systems (BAURES) during the implementation of the project.

Conflicts of interest

The authors declare no conflict of interest.

REFERENCES

Aktar, M. W., Sengupta, D., & Chowdhury, A. (2009). Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary Toxicology*, *2*, 1–12. https://doi.org/10.2478/v10102-009-0001-7

Arefin, M. A., Rahman, M. R., Rahman, A. N. M. A., Islam, A. K. M. M., & Anwar, M. P. (2018). Weed competitiveness of winter rice (*Oryza sativa* L.) under modified aerobic system. *Archives of Agriculture and Environmental Science*, *3*(1), 1–14. https://doi.org/10.26832/24566632.2018.030101

BBS (Bangladesh Bureau of Statistics). (2019). Statistical Year Book Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government People's of Republic, Bangladesh, Dhaka.

BBS (Bangladesh Bureau of Statistics). (2021). Statistical Year Book Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government People's of Republic, Bangladesh, Dhaka

BRKB. (2019). Bangladesh Rice Knowledge Bank. Available online at: http://knowledgebank-brri.org/ (Accessed on 15 January 2022)

BRRI. (2019). *Adhunik Dhaner Chas (In Bengali)*. 22nd Special Edition. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. p. 96.

Chauhan, B. S., & Johnson, D. E. (2011). Competitive interactions between weedy rice and cultivated rice as a function of added nitrogen and competition. *Weed Management*, *11*, 202–209, https://doi.org/10.1111/j.1445-6664.2011.00421.x

Dass, A., Shekhawat, K., Choudhary, A. K., Sepat, S., Rathore, S. S., Mahajan, G., & Chauhan, B. S. (2017). Weed management in rice using crop competition-a review. *Crop protection*, *95*, 45-52. https://doi.org/10.1016/j.cropro.2016.08.005

FAO-UNDP (Food and Agriculture Organization-United Nations Development Programme). (1988). Land resources appraisal of Bangladesh for agricultural development. Agro ecological regions of Bangladesh, BGD/81/035. Technical Report No. 2, FAO, Rome, Italy.

GRiSP (Global Rice Science Partnership). (2013) Rice Almanac. 4th Edition, International Rice Research Institute, Los Baños.

Heap, I. (2022). The International Survey of Herbicide Resistant Weeds. Available at: http://www.weedscience.org (Accessed on 15 April 2022).

Hia, M. A. H., Islam, A. K. M. M., Sarkar, S. K., & Anwar, M. P. (2017). Effectiveness of integrated weed management in five varieties of aromatic rice in Bangladesh. *Archieves of Agriculture Environmental Science*, *2*(3), 308–314, https://doi.org/10.26832/24566632.2017.020411

Islam, A. K. M. M., Hia, M. A. H., Sarkar, S. K., & Anwar, M. P. (2018). Herbicide based weed management in aromatic rice of Bangladesh. *Journal of Bangladesh Agricultural University*, *16*(1), 31–40, https://doi.org/10.3329/jbau.v16i1.36478

Islam, A. K. M. M., Nasir, M., Mou, M. A., Yeasmin, S., Islam, M. S., Ahmed, S., Anwar, M. P., Hadifa, A., Baazeem, A., Iqbal, M. A., Juraimi, A. S., Sabagh, A. E. L. (2021). Preliminary reports on comparative weed competitiveness of Bangladeshi monsoon and winter rice varieties under puddled transplanted conditions. *Sustainability*, *13*, 5091, https://doi.org/10.3390/su13095091

Islam, A. K. M. M., Popy, F. S., Hasan, A. K., & Anwar, M. P. (2017). Efficacy and economics of herbicidal weed management in monsoon rice of Bangladesh. *Journal of Scientific Agriculture*, *1*, 275–293, https://doi.org/10.25081/jsa.2017.v1.834

Janiya, J. D., & Moody, K. (1989). Weed populations in transplanted and wet seeded rice as affected by weed control method. *Tropical Pest Management*, *35*(1), 8–11, https://doi.org/10.1080/09670878909371311

Juraimi, A. S., Saiful, A. H. M., Uddin, M. K., Anuar, A. R., & Azmi, M. (2011). Diversity of weed under different water regimes in bertam irrigated direct seeded rice field. *Australian Journal of Crop Science*, *5*, 595–604

Mahajan, G., & Chauhan, B. S. (2011). Effects of Planting Pattern and Cultivar on Weed and Crop Growth in Aerobic Rice System. *Weed Technology*, 25, 521–25

Mahajan, G., Chauhan, B. S., & Johnson, D. E. (2009). Weed management in aerobic rice in Northwestern Indo-Gangetic Plains. *Journal of Crop Improvement*, *23* (4), 366-382, https://doi.org/10.1080/15427520902970458

Rahman, A. N. M. A., Islam, A. K. M. M., Arefin, M. A., Rahman, M. R., & Anwar, M. P. (2017). Competitiveness of winter rice varieties against weed under dry direct seeded conditions. *Agricultural Science*, *8*, 1415–1438, https://doi.org/10.4236/as.2017.812101

Rahman, S.H., Uddin, M.R., Salam, M.A., Sarker, U.K., Rasul, S., & Hasan, M. (2020). Weed management and crop performance of rice as influenced by different crop residues. *Archives of Agriculture and Environmental Science*, *5*(3), 275-282, https://dx.doi.org/10.26832/24566632.2020.050307

Rashid, M. H., Uddin, M. H., Islam, A. K. M. M., Alam, A. H. M. J., & Anwar, M. P. (2007). Efficiencies and economics of some weed control methods in transplant aman rice cv. BRRI dhan32. *Bangladesh Journal of Crop Science*, *18*(2), 259–64