Weed Turf. Sci. 9(3):259-265
https://doi.org/10.5660/WTS.2020.9.3.259

Print ISSN 2287-7924
Online ISSN 2288-3312

RESEARCH ARTICLE

Investigation of Different Herbicides on Weed Infestation and Yield Performance of Transplant Binadhan-14 (*Oryza sativa* L.) in Bangladesh

Md. Shahidul Islam[1†], Md. Monjurul Islam[1], Md. Habibur Rahman[1], Sakina Khanam[2], Md. Shahidul Haque Bir[3†], Le Thi Hien[3†], and Kee Woong Park[3*]

[1]Agronomy Division and, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh

[2]Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh

[3]Department of Crop Science, Chungnam National University, Daejeon 34134, Korea

[†]These authors contributed equally to this work.

ABSTRACT

This study was carried out at the agronomy farm of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh, between November 2015 and May 2016, to investigate the weed control on rice growth and yield performance of transplant *Binadhan-14* (*boro* rice). Six selected herbicides (H_1: bensulfuron methyl 4% + acetachlor 14% 18 wettable powder [WP] 500 g·ha^{-1}, H_2: pyrazosulfuron-ethyl 10 WP 125 g·ha^{-1}, H_3: metsulfuron-methyl 20 water dispersible granule [WDG] 50 g·ha^{-1}, H_4: pretilachlor 500 emulsifiable concentrate [EC] 1 L·ha^{-1}, H_5: 2, 4 D amine 480 soluble liquid [SL] 1.8 L·ha^{-1}, H_6: butachlor 5 granule [G] 25 kg·ha^{-1}) were tested along with two hand weedings. Weed density, fresh and dry weight of weeds were taken from eight weed species (*Echinochloa colonum*, *Paspalums crobiculatum*, *Monochoria vaginalis*, *Leersia hexandra*, *Scirpus mucronatus*, *Digitaria sanguinalis*, *Cyperus rotundus* and *Eclipta alba* Hassk) belonging to five families were found to grow in the experimental plots. Among the weed control treatments highest grain yield (5.00 T·ha^{-1}) was obtained with the treatment pretilachlor 500 EC 1 L·ha^{-1} followed by two hand weedings (4.97 T·ha^{-1}). It was observed that yield was increased due to application of herbicide contributed mainly from increasing the yield contributing characteristics of rice like, number of total tillers and effective tillers per plant, filled grains per panicle and 1000-seed weight (g). Maximum benefit- cost ratio with pretilachlor 500 EC 1 L·ha^{-1} suggested that this herbicidal treatment can be used for effective in controlling weeds as an alternative when labor was crisis in producing for better yield of transplant Binadhan-14 (*Oryza sativa*) rice cultivar.

Key words: Grain yield, Herbicide, Profitability, Transplanted *boro* rice, Weed infestation

***Corresponding Author:**
Tel) +82-42-821-7823
Fax) +82-42-822-2631
E-mail) parkkw@cnu.ac.kr

Received: August 31, 2020
Revised: September 17, 2020
Accepted: September 18, 2020

INTRODUCTION

World-wide food demand is raising accompanying with the rapidly growth of world economic, increase of population, mainly in developing countries (FAO, 2011). Rice is one of the most important food for the world populations, especially in Asia, almost 90% of the global rice production is consumed (FAO, 2008). Bangladesh known as an agro- based country. Rice cultivation of Bangladesh is favorable due to geographic and agronomic conditions. The people in Bangladesh depend on rice (*Oryza sativa* L.) as staple food. Julfiquare et al. (1998) reported that rice alone contributes of 95% of the food grain production in Bangladesh. The increasing population of Bangladesh is 1.37% and decreasing of agriculture land is 1% per annum limit the horizontal expansion of rice area (BBS, 2013). Approximately 84.67% of cropped area of Bangladesh issued for rice grown in 10.4 million ha of land with annual production of 30.42 million tons (BBS, 2013). In Bangladesh, transplanted *Boro* rice production of 18.60 million metric tons from 4.68 million hectare of land (USDA Foreign Agricultural Service, 2015).

Crop performance mainly depends on weed growth control. Agriculture production is facing serious trouble due to unfavorable weed infestation events. Weed infestation is one of the significant causes for yield reduced of transplanted *boro* rice. Weeds not only cause huge reduction in crop yields but also increase cost of cultivation, reduce input use efficiency, reduce grain quality, serve as alternate hosts for pests, reduces aesthetic picture of ecosystem, reduce biodiversity and affect human and cattle health. Gnanavel et al. (2014) and Sharma (2014) reported that continuous use of the similar group of herbicides over a certain period of time on a same piece of land make ecological imbalance in terms of weed shift, weed distribution, herbicide resistance in weeds and environmental pollutions.

In Bangladesh, BBS (2008) reported that weed infestation reduces the grain yield by 22-36% for modern *boro* rice cultivars (winter). Yield reduce is greater due to weed infestation than that of combined losses of insect pests and diseases. This loss is a serious threat for agriculture rice production as well as the food deficit countries like Bangladesh. In Bangladesh, traditional methods of weed control practice by hand weeding. But this method of weed control is very much laborious, time consuming and costly. Generally, 2-3 hand weeding is usually required for growing a rice crop depending upon the nature of weeds and their intensity of infestation. On the other hand, herbicides are used successfully for weed control in rice fields for rapid effect, easier to apply and low cost involvement in comparison to the traditional methods of hand weeding (Mian and Mamun, 1969). Furthermore, globally synthetic herbicides have been used to control weeds in major field crops (Bo et al., 2017). In such situation, herbicides are promising alternatives in controlling weeds (De Datta, 1990).

Now-a-days the chemical methods of weed control are gaining popularity world-wide due to their efficacy but most of the herbicides are very new in Bangladesh. Bensulfuron methyl 4%+acetachlor 14% 18 wettable powder (WP), pyrazosulfuron-ethyl 10 WP, metsulfuron-methyl 20 water dispersible granule (WDG), pretilachlor 500 emulsifiable concentrate (EC), 2, 4 D amine 480 soluble liquid (SL), butachlor 5 granule (G) are good selective herbicides with post-emergence activity against mono- and dicotyledonous weeds in rice field. Many studies have noticed that herbicide activity on weeds control, but a very little information is available on the effectiveness of the herbicides mentioned above in controlling weeds in rice, especially in transplanted Binadhan-14 cultivar in Bangladesh. The present study, therefore, undertaken to find out the weed control efficacy of different herbicides in transplanted Binadhan-14 and to assess the effect of herbicides on growth and compare the yield performance of transplanted *boro* rice (Binadhan-14).

MATERIALS AND METHODS

Experimental site

An experiment was conducted at the Agronomy field of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh under wet land condition during November 2015 to May 2016. The aim of this study was to investigate of different herbicide on weed infestation and yield performance of transplanted *boro* rice.

Experimental details

Six selected herbicides treatment viz. H_1=bensulfuron methyl 4%+acetachlor 14% 18 WP 500 g·ha^{-1}, H_2=pyrazosulfuron-ethyl 10 WP 125 g·ha^{-1}, H_3=metsulfuron-methyl 20 WDG 50 g·ha^{-1}, H_4=pretilachlor 500 EC 1 L·ha^{-1}, H_5=2, 4 D amine 480 SL 1.8 L·ha^{-1}, H_6=butachlor 5 G 25 kg·ha^{-1}, two hand weeding (HW) 30 days after transplanting and 45 days after transplanting (DAT), and control treatments (H_0). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The sprouted seeds of transplanting *boro* rice cv. Binadhan-14 was sown in nursery bed on 2 October, 2015 which were transplanted in the main field on November 17, 2015. The size of each unit plot was 3 m×3 m. The distance maintained between the individual plot and replications was 0.5 m and 1.0 m. respectively. The planting distance was maintained at 20×15 cm. Chemical fertilizer was applied at the rate of 100, 30, 60, 20 and 5 kg·ha^{-1} of urea, TSP, MoP, gypsum, and ZO_4 respectively. The entire amount of all fertilizers without urea was applied in the soil at final land preparation. Urea was applied in 3 equal split at 12, 30 and 45 days after transplanting. At 7-10 day after transplanting of rice, all cases herbicides were applied in to the plots when standing water was 4-5 cm. In case of manual weeding treatment, data regarding weeds were recorded at 30 and 45 DAT. Weed population was collected and counted species wise from each plot at vegetative stage of rice locations per plot using a 0.5 m×0.5 m quadrate. After counting the weed density, dry weight of weeds was taken by drying them in electric oven for 72 hours at a temperature of 80℃ followed by weighing and expressed in g·m^{-2} by digital balance. Rice grain yield was recorded at maturity of the crop. Data were compiled and subjected to ANOVA using M- stat program (Gomez and Gomez, 1984) and the means were separated by least significant difference (LSD).

RESULTS AND DISCUSSION

Results of this study include the effect of different herbicide on weed management and crop performance of transplant *boro* (Binadhan-14) rice. Eight particular of important weed species such as *E. colomum*, *P. scrobiculatum*, *M. vaginalis*, *L. hexandra*, *S. mucronatus*, *D. sanguinalis*, *E. rotundus* and *E. alba Hassk*, infested the experimental plots which belonging to five families. The weeds that grown in transplanted *boro* rice field, which can withstand water logging and usually enough to reduction crop yield very considerably if do not controlled timely (Mian and Gaffer, 1968). Among the 8 species of weeds included four grasses, two broad leaves, and two were sedges. The local name, scientific name, family, morphological characters and life cycle of weed in the experimental plots were presented in Table 1.

The density, fresh and dry weight of weeds varied considerably in different weed control treatments are presented in Table 2. Weed management practice mainly depends on the weed density. The highest weed density·m^{-2} was obtained in the weedy check treatment, showing the highest weed density value was 23.3 m^{-2} and the lowest weed density·m^{-2} was found in the treatment with the recommended dose of pretilachlor 500 EC 1 L·ha^{-1} when the value was 4.9 m^{-2} followed by two hand weeding (HW) (5.7 m^{-2}) at vegetative stage (Table 2). However, the weed density was highest in the weed check condition, and weed density was decrease under different weed management treatments. Rekha et al. (2003) reported that all herbicidal treatments reduced weed density significantly compared with weedy check. Furthermore, Al-Kothayri and Hasan (1990) noticed that weed density was lower in all weed control treatments compared to the weedy check condition.

Table 1. Infesting weed species found in the experiment plots of transplanted *boro* rice (vegetative growth stage).

No.	Local name	Scientific name	Family	Morphological type	Life cycle
1	Shama	*Echinochloa colomum*	Gramineae	Grass	Annual
2	Angta	*Paspalum scrobiculatum*	Gramineae	Grass	Perennial
3	Panikachu	*Monochoria vaginalis*	Pontederiaceae	Broad-leaves	perennial
4	Arail	*Leersia hexandra*	Gramineae	Grass	Annual
5	Chechra	*Scirpus mucronatus*	Cyperaceae	Sedge	Perennial
6	Choto Angule ghash	*Digitaria sanguinalis*	Gramineae	Grass	Annual
7	Purple nutsedge	*Eyperus rotundus*	Cyperaceae	Sedge	Annual
8	Keshuti	*Eclipta alba Hassk.*	Compositae	Broad leaved	Perennial

Table 2. Effect of herbicide and hand weeding on the weed density, weed fresh and dry weight at vegetative stage and grain yield at harvest.

Treatment	Weed density (no. m^{-2})	Weed fresh weight (g·m^{-2})	Weed dry weight (g·m^{-2})	Grain yield (T·ha^{-1})
H_0=control	23.3	15.61	7.76	3.47
H_1=bensulfuron methyl 4%+acetachlor 14% 18 WP 50 g·ha^{-1}	21.7	13.55	6.99	4.90
H_2=pyrazosulfuron-ethyl 10 WP 125 g·ha^{-1}	13.00	5.76	2.84	4.67
H_3=metsulfuron-methyl 20 WDG 50 g·ha^{-1}	6.33	5.24	2.84	4.17
H_4=pretilachlor 500 EC 1 L·ha^{-1}	4.90	2.86	1.51	5.00
H_5=2, 4 D amine 480 SL 1.8 L·ha^{-1}	13.00	10.46	5.82	4.30
H_6=butachlor 5 G 25 kg·ha^{-1}	9.00	5.75	2.96	4.60
HW=hand weeding (30 DAT and 45 DAT)	5.70	2.90	1.89	4.97
LSD0.05	11.60	7.62	5.12	0.78
CV (%)	11.00	16.52	13.12	4.10

WP: Wettable powder; WDG: Water dispersible granule; EC: Emulsifiable concentrate; SL: Soluble liquid; G: Granule; DAT: Days after transplanting of rice; LSD: Least significant difference; CV: Coefficient variance.

The weed management practices at vegetative stage had a significant effect on the total fresh and dry weight. The highest weed fresh weight was found in the weedy check condition, showing the highest fresh weight value was 15.61 g·m^{-2} and the lowest weed fresh weight was found in the condition of recommended dose of pretilachlor 500 EC 1 L·ha^{-1}, showing the lowest fresh weight of weed vale was 2.86 g·m^{-2} (Table 2). There was a significant effect on weed dry weight in Binadhan-14. Similarly, the highest dry weight of weed was found in the control treatment and the lowest dry weed of weed was found with the recommended dose of pretilachlor 500 EC 1 L·ha^{-1} showing the highest and lowest value of 7.76 and 1.51 g·m^{-2} respectively (Table 2). However,

pretilachlor 500 EC 1 L·ha^{-1} had lowest fresh and dry weight of weeds which resulted significant weed control than other herbicide and doses. Similar findings also observed by Bhuiyan et al. (2011), Gnanavel and Anbhazhagan (2010) and Mahajan et al. (2003).

The cultivar of rice (Binadhan-14) significantly influence the density, fresh and dry weight of weed. Among the weed control treatments were considered, the highest grain yield (5.00 T·ha^{-1}) was obtained in Binadhan-14 treated with pretilachlor 500 EC 1 L·ha^{-1} that was followed by statistically similar yield with two hand weedings (4.97 T·ha^{-1}). The results of this study suggest that Binadhan-14 variety could be grown with pretilachlor 500 EC 1 L·ha^{-1} followed by the treatments of two hand weeding (HW) to maximize yield of *boro* rice (Binadhan-14) (Table 2). The lowest grain yield produced in the weedy check condition due to the below performances of yield contributing characters such as number of tillers and grains panicle^{-1}. It was occurred because of severe weed infestation in the field. Gogoi et al. (2000) and Islam et al. (2001) observed that weed infestation occurred due to competition for moisture, nutrients between weed and rice plants. Higher yield may be obtained due to rice based cropping system and short growth period of rice (Kim et al., 2018).

It was observed by economic analysis that the highest cost of weeding was include in case of the treatment H_2- pyrazosulfuron-ethyl 10 WP 125 g·ha^{-1} (Table 3). Because of differences cost of weed management among the treatments, the entire cost of production was varied in this experiment. The treatment H_2– pyrazosulfuron-ethyl 10 WP 125 g·ha^{-1} involved the highest cost of production, whereas the lowest cost of production was involved in control treatment (Table 3). The gross return from Binadhan-14 cultivar was found to be the highest with the treatment H_4– pretilachlor 500 EC 1 L·ha^{-1} followed by two hand weedings (Table 3). Net profit was maximum from the treatment H4– pretilachlor 500 EC 1 L·ha^{-1} which was even higher than two hand weedings. The lowest net profit was obtained from control treatment due to its lowest production of yield. The economic analysis also showed that the application of H_4– pretilachlor 500 EC 1 L·ha^{-1} highest the profit and benefit: cost ratio (BCR) was the maximum in the treatment, showing at 1.71 (Table 3). The second highest BCR was obtained from two hand weedings in the treatment, showing 1.59 whereas the lowest BCR (1.18) was obtained from check treatment. This was due to the lowest yield of grain and straw.

Table 3. Effect of different herbicide and weed management on the cost of production, returns and benefit cost ratio (BCR) of transplant Binadhan-14.

Treatment[z]	Cost of production ($·ha^{-1})			Gross returns ($·ha^{-1}) (c)	Net profit ($·ha^{-1}) [c-(a+b)]	BCR
	Variable cost (a)	Weeding cost (b)	Total cost (a+b)			
H_0	792.06	0	792.06	937.21	145.15	1.18
H_1	792.06	24.49	816.55	1219.15	402.60	1.49
H_2	792.06	43.01	835.07	1207.20	372.14	1.44
H_3	792.06	17.92	809.98	1219.15	409.17	1.50
H_4	792.06	7.17	799.23	1369.67	570.45	1.71
H_5	792.06	25.09	792.06	1206.60	414.55	1.52
H_6	792.06	41.22	833.27	1243.04	409.77	1.49
HW	792.06	36.44	828.49	1314.72	486.23	1.59

BCR: Benefit cost ratio, $: US Dollar.

[z] H_0: Control; H_1: Bensulfuron methyl 4%+acetachlor 14% 18 WP 50 g·ha^{-1}; H_2: Pyrazosulfuron-ethyl 10 WP 125 g·ha^{-1}; H_3: Metsulfuron-methyl 20 WDG 50 g·ha^{-1}; H_4: pretilachlor 500 EC 1 L·ha^{-1}; H_5: 2, 4 D amine 480 SL 1.8 L·ha^{-1}; H_6: Butachlor 5 G 25 kg·ha^{-1}; HW: Hand weeding (30 DAT and 45 DAT); WP: Wettable powder; WDG: Water dispersible granule; EC: Emulsifiable concentrate; SL: Soluble liquid; G: Granule; DAT: Days after transplanting of rice.

From this results it can be concluded that hand weeding is less profitable than herbicide treatment. The use of herbicides may be an alternative in weed management more easily and cheaply when there is a labor crisis. From this study, it may therefore, be concluded that the treatment H_4– pretilachlor 500 EC 1 $L \cdot ha^{-1}$ was the most profitable treatment and can be used as an alternative when labor is a limiting factor in producing transplanted *Binadhan-14* cultivar as well as *boro* rice in Bangladesh.

Authors Information

Md. Shahidul Islam, Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh, Researcher

Md. Monjurul Islam, Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh, Researcher

Md. Habibur Rahman, Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh, Researcher

Sakina Khanam, Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh, Researcher

Md. Shahidul Haque Bir, Chungnam National University, Daejeon 34134, Korea, Researcher

Le Thi Hien, Chungnam National University, Daejeon 34134, Korea, Ph.D. student

Kee Woong Park, Chungnam National University, Daejeon 34134, Korea, Professor

REFERENCES

Al-Kothayri, G.R. and Hasan, A.A. 1990. Chemical control of annual weeds in irrigated onion Hadhramount valley. Arab J. Plant Protection (Lebanon) 8(1):49-54.

BBS (Bangladesh Bureau of Statistics). 2008. Statistical year book of Bangladesh. pp. 47-55. Bur. Stat. Div., Minis. Plan., Govt. People's Repub, Dhaka, Bangladesh.

BBS (Bangladesh Bureau of Statistics). 2013. Statistical year book of Bangladesh. p. 71. Bur. Stat., Stat. Div., Min. Plan., Govt. People's Repub, Dhaka, Bangladesh.

Bhuiyan, M.R., Rashid, M.M., Roy, D., Karmakar, B., Hossain, M.M. and Khan, M.A.I. 2011. Sound weed management option for sustainable crop production. Bangladesh J. Weed Sci. 1(1):25-29.

Bo, A.B., Won, O.J., Sin, H.T., Lee, J.J. and Park, K.W. 2017. Mechanisms of herbicide resistance in weeds. Kor. J. Agric. Sci. 44:001-015. DOI:https://doi.org/10.7744/kjoas.20170001

De Datta, S.K. 1990. Weed control in rice in South East Asia. Ext. Bull. No. 146 FFTC. Taiwan. pp. 1-24.

FAO (Food and Agriculture Organization). 2008. Food outlook global market analysis. pp. 23-28. FAO, Rome, Italia.

FAO (Food and Agriculture Organization). 2011. The state of food in security in the world. FAO, Rome, Italia.

Gnanavel, I. and Anbhazhagan, R. 2010. Bio-efficacy of pre and post emergence herbicides in transplanted aromatic basmati rice. Res. J. Agric. Sci. 1(4):315-317.

Gnanavel, I. and Natarajan, S.K. 2014. Eco-friendly weed control option for sustainable Agriculture- A review. Agri. Rev. 35:172-183.

Gogoi, A.K., Rajkhowa, D.J. and Kandali, R. 2000. Effect of varieties and weed control practices on rice productivity and weed growth. Indian J. Agron. 45(3):580-585.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedure for agricultural research. 2nd Edn. pp. 207-215. John Wiley and Sons, New York. USA.

Islam, T., Bhownick, M.K., Ghosh, R.K. and Sounda, G. 2001. Effect of pretilachlor on weed control and yield of transplanted paddy. Environ. Ecol. 19(2):265- 268.

Julfiquare, A.W., Haque, M.M., Enamul Haque, A.K. and Rashid, M.A. 1998. Current status of hybrid rice research and future programme in Bangladesh. A country report presented in the workshop on use and development of hybrid rice in Bangladesh. Held at BARC on 18-19 may, 1998.

Kim, S.Y., Seo, J.H., Bae, H.K., Hwang, C.D. and Ko, J.M. 2018. Rice cultivars adaptable for rice based cropping systems in a paddy field in the Yeongnam plain area of Korea. Kor. J. Agric. Sci. 45(3):355-363. (In Korean)

Mahajan, G., Boparai, B.S., Bra, L.S. and Sardana, V. 2003. Effect of Pretilachlor on weeds in direct seeded puddled rice. Indian J. Weed Sci. 35(1-2):128-130.

Mian, A.L. and Gaffar, M.A. 1968. Tok granular (2, 4-dichloroplenyl 4-nitrophenyl ether) as weedicide in transplanted aman rice in East Pakistan. J. Sci. Res 20(3):119-124.

Mian, A.L. and Mamun, A.A. 1969. Chemical control of weeds in transplant *aman* rice. The Nucleus. 6(3):155-163.

Rekha, K.B., Razu, M.S. and Reddy, M.D. 2003. Effect of herbicides in transplanted rice. Indian J. Weed Sci. 34:123-125.

Sharma, A.R. 2014. Weed management in conservation agriculture systems- problems and prospects. pp. 1-9. National Training on Advances in Weed Management.

USDA Foreign Agricultural Service. 2015. Bangladesh Grain and Feed Annula. http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Dhaka_Bangladesh_5-5-2015.pdfS (Accessed Jan. 10, 2020).