Fundamental and Applied Agriculture
Vol. 7(2), pp. 131–138: 2022
doi: 10.5455/faa.98646

AGRONOMY | ORIGINAL ARTICLE

Effect of weed management practices on the performance of rice cv. Nizershail

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ARTICLE INFORMATION

Article History
Submitted: 31 May 2022
Accepted: 19 Jun 2022
First online: 30 Jun 2022

Academic Editor
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ABSTRACT

An experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 2018 to study the effect of weed management practices on the performance of rice cv. Nizershail. The experiment included five weeding treatments i.e., (i) no weeding (T0), (ii) hand weeding at 15 and 35 days after transplanting (DAT) (T1), (iii) application of pre-emergence herbicide (T2), (iv) application of early post-emergence herbicide (T3), and (v) application of post-emergence herbicide (T4). The experiment was laid out in a randomized complete block design (RCBD) with three replications. All plant and yield contributing characters (except 1000-grain weight), and yields were significantly affected by weed control approaches. The application of early post-emergence herbicide Super power 10WP (T3) showed the promising results in controlling weeds in Nizershail rice. The highest values for plant height, panicle length and grain yield (1.41 t ha^{-1}) were obtained from applying post-emergence herbicide Super power 10WP. However, application of pre-emergence herbicide (Glycel 48SL) and two hand weeding at 15 and 35 DATs gave statistically similar grain yield. The results of the study showed that fifteen weed species belonging to six families infested the experimental plots. Weed density and dry matter were significantly affected by weed control methods. Both early post-emergence and post-emergence herbicides could effectively control the weed density and biomass.

Keywords: Herbicide, manual weeding, aman rice, local variety, Nizershail

Cite this article: Khatun MS, Islam MS, Uddin FMJ, Paul SK, Sarkar SK, Bhuiya MSU, Rashid MH. 2022. Effect of weed management practices on the performance of rice cv. Nizershail. Fundamental and Applied Agriculture 7(2): 131–138. doi: 10.5455/faa.98646

1 Introduction

Rice yield losses due to pests has been reported to 40%; however, weed alone pose the greatest risk of inflicting yield loss (32%) in rice (Rao and Nagamani, 2007). It has been also reported that yield loss in rice due to weeds is much higher than those caused by other stress, *viz.*, nitrogen deficiency, pests, or diseases (WARDA, 1996; Rao and Nagamani, 2007; Kumar et al., 2009; Chauhan et al., 2012). Globally, rice yield losses due to weeds have been estimated at about 10% of total production (Oerke and Dehne, 2004). Ramzan (2003) reported a potential rice yield loss of up to 48%, 53%, and 74% in transplanted, direct-seeded in wet conditions, and direct-seeded in dry soils, respectively. Unchecked weed growth caused average yield losses of 60% in rainfed lowland rice (Moody, 1990; Moorthy and Rao, 1991) and 80–100% in upland rice (Akobundu and Ahissou, 1985). It has been estimated that rice yield decreases by 0.75 kg for every 1 kg of weed biomass produced (Anonymous, 2003).

According to Kropff et al. (1993), the significance of weed and crop densities and their relative time of emergence must also be considered. Weed infestation is particularly severe in the early stages when the crop grows under an aerobic upland environment. In the later stages, aquatic weeds emerge and grow mostly at or below the water surface, particularly when the crop stand is poor. Season, magnitude, type and duration of weed association, fertilization practices, competitive ability of the genotype, weed and rice density dynamics, and cultural management practices are a few of the aspects related to weed–crop competition in DSR (Kim, 1996; Rao and Nagamani, 2007; Rodenburg and Johnson, 2009; Kumar and Ladha, 2011).

Weed control in transplanted rice by mechanical and cultural means are expensive methods. Especially at the time of peak period of labor crisis sometimes weeding becomes late causing drastic losses in grain yield. Herbicidal weed control methods offer an advantage to save labour and money, as a result, it is regarded as cost effective (Suria et al., 2011; Anwar et al., 2012, 2013; Zahan et al., 2018). Chemical weed control has been gaining popularity in Bangladesh in recent years (Islam et al., 2018) leading to high growth rate in herbicide use in rice cultivation (BBS, 2019). The main reasons are scarcity of labour during peak growing season, and also a lower weeding cost by using herbicides. A number of studies (Anwar et al., 2012, 2013; Matloob et al., 2015; Zahan et al., 2018; Islam et al., 2018) showed that weed control through both traditional and chemical methods influence crop growth and yield attributes of rice. Keeping the above points in views, the present study was undertaken to compare the efficacy of different weed management practices in transplanted aman rice cv. Nizershail.

2 Materials and Methods

2.1 Experimental duration and site

The experiment was conducted during the period from July to December 2018 at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh. The experimental field was located at 24°43′11.1″N, 90°25′42.2″E and at an altitude of 18 meter above the sea level. The experimental area belongs to the non-calcareous dark grey soil under Agro-ecological Zone of the Old Brahmaputra Floodplain (AEZ-9). The land was medium high and well drained with silt-loam texture. The soil of the experimental field was more or less neutral in reaction (pH 6.7), low in organic matter content (1.29%) and the general fertility level of the soil was low (1% total N, 26 ppm available P and 0.14 me % exchangeable K). The experimental area was located under the subtropical climate, which is specialized by moderately high temperature and heavy rainfall during April to September and low rainfall with moderately low temperature during October to March. The monthly values of maximum, minimum and average temperature (°C), relative humidity (%), and monthly total rainfall (mm) received at the experimental site during the study period were 32.5 °C, 13.3 °C, 26.3 °C, 85.3%, 190.1 mm, respectively.

2.2 Experimental material

Rice cv. Nizershail was used as the experimental material in this study. It is one of the old introduced varieties of transplant aman rice. Nizershail was introduced from Nigeria long ago and recommended for cultivation in transplant Aman season. It is highly photosensitive in nature. It is a tall, late variety, fairly lodging resistant with wide adaptability. The grains of Nizershail are of small, milk white and palatable. Owing to good taste, this rice is sold at a higher price in the market. The life cycle is 165-175 days. The average yield is 3- 3.5 t ha^{-1}.

2.3 Experimental treatments

The experimental treatment consisted of five weeding treatments as follows: (i) no weeding (T0), (ii) hand weeding at 15 and 35 days after transplanting (DAT) (T1), (iii) application of pre-emergence herbicide (T2), (iv) application of early post-emergence herbicide (T3), and (v) application of post-emergence herbicide (T4). The details of the experimental treatment are presented in Table 1.

2.4 Experimental design and layout

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each. Treatment combinations were assigned at random to a block. Total numbers of unit plots were 18. Each plot size was 8 m × 4 m. The distance maintained between the main plot was 1.0 m, respectively.

2.5 Crop husbandry

Seed of Nizershail was obtained from the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh. Healthy seeds were placed in water bucket for 24 h and then kept tightly in gunny bags. The seeds started sprouting after 48 h. After 72 hours seeds were sown in the nursery bed. During the last week of August the nursery beds were prepared. Sprouted seeds were sown in raised nursery bed of 1.0 m length and 1.0 m width. The experimental land was prepared by a power tiller 10 days before transplanting. It was then puddled well with the help of a country plough to make the soil nearly ready for transplanting. Weeds and stubbles were removed and the field was then leveled by laddering. Well decomposed compost was applied @ 5 t ha^{-1} before final land preparation. The field was fertilized with 190 kg, 50 kg, 80 kg and 60 kg ha^{-1} of urea, triple superphosphate (TSP), muriate of potash (MoP), and gypsum, respectively. After one week of transplantation, seedlings of some of the hills died off and were replaced by gap filling with healthy seedlings by planting same aged seedlings. The full doses of

Table 1. Details of the treatments (weed management practices) used in the experiment

Treatment name and abbreviation	Description
No weeding (T0)	Weeds were allowed to grow up to the harvesting of the crop and no weeding was done from transplanting to harvesting the crop.
Hand weeding at 15 and 35 DATs (T1)	In this treatment, weeds were allowed to grow with the crop for the first 14 DAT. Next day one hand weeding was done. Therefore, weeds were allowed to grow with the crop till 34 DAT and thus at 35 DAT, another hand weeding was given and afterwards no weeding was done till harvesting.
Application of pre-emergence herbicide (Glycel 48SL) (T2)	In this treatment 3.75 L ha^{-1} Glycel 48SL (glyphosate) was applied before transplanting in 4-5 cm standing water in the plots. Thereafter no weeding was done till harvesting.
Early post-emergence herbicide (Super power 10 WP) (T3)	In this treatment, 781.25 g ha^{-1} Super power was applied by hand sprayer at 10 DAT in 4-5 cm standing water in the plots and thereafter no weeding was done till harvesting. It belongs to the chemical group of pyrazosulfuron. After applying super power10 WP in the field., the growth of weed seedling is hampered and this is also effective against all kinds of weed in the rice field.
Application of post emergence herbicide (Granite 240SC) (T4)	In this treatment, 105 mL ha^{-1} Granite 240SC (Penoxsolum) was applied by hand sprayer at 15 DAT in 4-5 cm standing water in the plots and thereafter no weeding was done till harvesting.

TSP, MoP and gypsum were applied before transplanting. Urea was top dressed in three equal splits, at 7, 30 and 45 days after transplanting (DAT). Weeding was done as per the experimental treatments. The experimental plots were irrigated as and when it was necessary and excess water was drained out at the time of heavy rain. There were some incidence of insects specially stem borer and brown plant hopper which was controlled by spraying carbotaf 5G @ 2 mL L^{-1} and regent 3GR @ 2 mL L^{-1}.

2.6 Weed sampling

Data on weed density were collected from each plot at vegetative growth stages of the rice plants by using 0.5 m $\times$ 0.5 m quadrat. The quadrat was placed in three spots at random outside 1 m^2 central areas, kept for taking yield data. The weeds within the quadrat were counted species-wise, averaged and converted to number m^2 multiplying by four. After counting the weed density, the weeds inside each quadrat were uprooted, cleaned, separated species-wise and dried first in the sun and then in an electrical oven for 72 hours at a temperature of 60 °C. The dry weight of each species was taken by an electrical balance and expressed in g m^{-2}.

2.7 Sampling and harvesting of rice

The crop was harvested at full maturity on 18 December 2018. This was the time when about 80% of the seeds became golden yellow in color. Five hills (excluding border hills) were randomly selected in each plot and uprooted before harvesting for recording the necessary data on various plant characters. The crops were harvested from each plot manually to record the yields of grain and straw. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The crops were threshed manually. Grains were sun dried and cleaned. Straws were also sun dried properly. Finally, grain yield was adjusted to 14% moisture and converted to t ha^{-1}..

2.8 Data analysis and visualization

The recorded data were statistically analyzed using open source statistical environment 'R' (R Core Team, 2021). For the Analysis of Variance (ANOVA) were conducted using 'agricolae' package of 'R'. The differences among treatment means were adjudged by Tukey's post hoc test. Plots presenting growth and yield of maize were prepared by 'ggplot2' library (Wickham, 2016) of 'R'.

3 Results and Discussion

3.1 Plant height

Plant height differed significantly among all weed management practices at 5% level of significance (Table 2).The tallest plant height (80.33 cm) was obtained from T3 (application of early post-emergence herbicide Superpower @ 781.25 g ha^{-1}) while the shortest plants (74.73 cm) were obtained from plot where 2 hand weeding was performed. However, T0 and T4 also produced plants with statistically similar height. Other researchers (Dass et al., 2017; Jabran and Chauhan, 2015; Hakim et al., 2015) also reported that weeding management can affect rice height to a great extent and no weeding or poor weed management results in shorted rice plants.

3.2 Tillering ability

Tillering ability is one of the important traits of rice which is severely affected by weed infestation (Matloob et al., 2015; Awan et al., 2015). Therefore, early weeding in rice increases its tillering ability and subsequently the grain yield (Mola and Belachew, 2015). In our study, number of total tillers hill^{-1} was significantly influenced by different weeding practices at 5% level of significance (Table 2). The highest number of total tillers hill^{-1} (15.56) was observed in T2 (application of pre-emergence herbicide Glyphosate @ 3.75 L ha^{-1}) treatment which was statistically different to T1 (13.89, hand weeding at 15 and 35 DAT). The lowest number of total tillers hill^{-1} were obtained from no weeding plots (11.33). In no weeding treatment weed-crop competition was higher and weed suppressed the rice plant growth, ultimately tiller number was reduced.

Number of effective tiller hill^{-1} was significantly influenced by different weeding practices at 5% level of significance (Table 2). The highest number of effective tiller hill^{-1} (11.78) was observed in T2 (application of pre-emergence herbicide Glyphosate @ 3.75 L ha^{-1}) treatment which was statistically identical to 2 manual weeding. The lowest number of effective tillers hill^{-1} (8.56) was found in no weeding treatment. In no weeding treatment weed-crop competition was higher and weed suppressed the rice plant growth, ultimately tiller number was reduced. Antralina et al. (2015) reported that method of weed control do not affect the number of effective tillers hill^{-1}. However, our results are in agreement with that of Maimunah et al. (2021) who reported that increase in weeding frequency in rice not only increase total tillers but also effective tiller number.

3.3 Panicle length

Length of panicle differed significantly influenced by different weed management practices at 5% level of significance (Table 2). Here, the highest panicle length (17.62 cm) was observed in T2 (application of pre-emergence herbicide Glyphosate @ 3.75 L ha^{-1}) treatment which was statistically identical to T3 (17.02 cm, application of early post-emergence herbicide). All other treatments had similar effect on panicle length of rice, through numerically the shortest panicles (15.26 cm) were recorded in plots with no weeding was done. Other researchers (Choudhary and Dixit, 2018; Islam et al., 2018) have reported that panicle length is affected by weeding regimes and they have also shown that the largest panicle was obtined where the the weed population is kept at minimum. Choudhary and Dixit (2018) found the largest panicle in cases of two hand weeding, whereas Phukan et al. (2021) reported the same in chemical weed control.

3.4 Number of filled grains panicle^{-1}

Number of filled grains panicle^{-1} differed significantly influenced by different weed management practices at 1% level of significance (Table 2). The highest number of filled grains panicle^{-1} (42.24) was observed in T2 (application of pre-emergence herbicide Glyphosate @ 3.75 L ha^{-1}). Both early post-emergence (T3) and post-emergence (T4) treatments had similar effects on grain filling of rice. The lowest number of filled grains panicle^{-1} (36.70) was recorded in no weeding plots. However, two hand weeding (T1) also gave statistically similar result. This finding is in agreement with that of Antralina et al. (2015) who reported higher grain yield with herbicidal weed control in comparison to manual weeding.

3.5 Weight of 1000 grains

Thousand grain weight of rice did not differ significantly due to different weed management practices at 5% level of significance (Table 2). However, Here, numerically the highest thousand grain weight (19.78 g) was observed in T4 (application of post-emergence herbicide) treatment. There are mixed reports about the effect of weeed control methods on weight of 1000 grains of rice. Some researchers (Singh et al., 2016; Sinha et al., 2018) found that weeding regimes affect this trait, whereas others (Sahu et al., 2015; Islam et al., 2018) reported that it did not vary due to weed control methods.

3.6 Grain yield

Grain yield of rice was significantly influenced by different weed management practices at 1% level of significance (Fig. 1a). The highest grain yield (1.41 t ha^{-1}) was observed in T3 (application of early post-emergence herbicide) treatment which was statistically similar to T2 (1.39 t ha^{-1}, application of pre-emergence herbicide Glyphosate @ 3.75 L ha^{-1}) and T1 (1.32 t ha^{-1}, 2 manual had weeding). The lowest grain yield (1.05 t ha^{-1}) was obtained from non-weeded plots. The results of grain yield as affected by weeding methods are consistent with those of yield contributing characters (Table 2). In a previous work

Table 2. Effect of weed managment practices on plant and yield contributing characters of rice cv. Nizershail

Treatment	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Filled grains panicle^{-1}	WTS (g)
T0	75.11 b	11.33 c	8.56 c	15.26 b	36.70 c	19.26
T1	74.73 b	13.89 ab	11.11 a	15.75 b	35.92 c	19.42
T2	77.44 ab	15.56 a	11.78 a	17.62 a	42.24 a	19.63
T3	80.33 a	13.11 b	10.33 b	17.02 a	41.46 ab	19.46
T4	75.78 b	13.00 b	10.00 b	15.62 b	40.36 b	19.78
Sig. level	*	*	*	*	**	NS

Values are mean of three replications. ** = Significant at 1% level of probability, * =Significant at 5% level of probability, NS = Non-significant. In a column figures with same letter or without letter do not differ significantly whereas figure with dissimilar letter differ significantly as per Tukey's *post hoc* test.

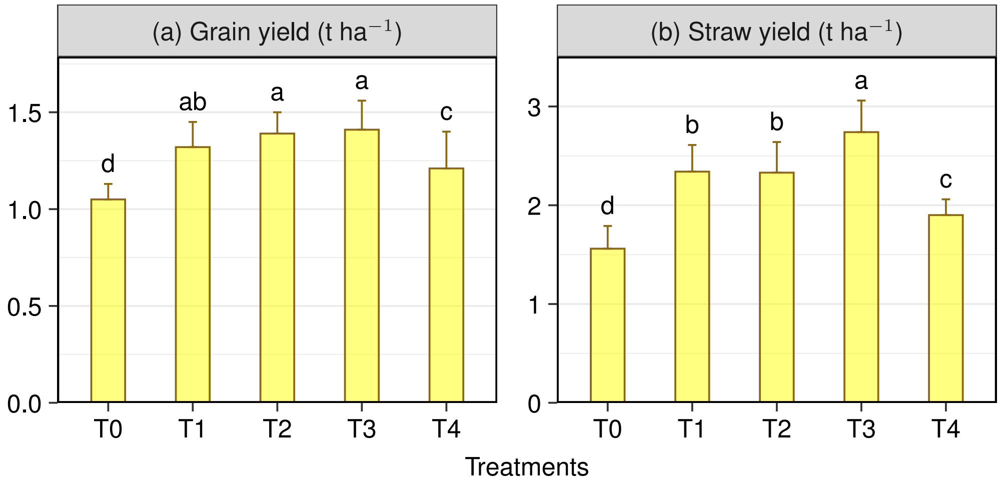

Figure 1. Effect of weed management practices on (a) grain yield and (b) straw yield of rice cv. Nizershail. Vertical line associated with individual bar is standard deviation. Bars with similar letter do not differ significantly at P = 0.05. T0: no weeding, T1: hand weeding at 15 and 35 days after transplanting (DAT), T2: application of pre-emergence herbicide, T3: application of early post-emergence herbicide, and T4: application of post-emergence herbicide.

Table 3. Infesting species of weed in the experimental field of rice cv. Nizershail

Sl. no.	Local name	Scientific name	Family	Morphology
1	Durba	*Cynodon dactyon*	Poaceae	Grass
2	Boro shama	*Echinochloa crusgalli* (L.)	Poaceae	Grass
3	Khude shama	*Echinochloa colonum*	Poaceae	Grass
4	Anguli	*Digitaria sanguinalis*	Poaceae	Grass
5	Mutha	*Cyperus rotundus* L.	Cyperaceae	Sedge
6	Guccho mutha	*Cyperus esculentus*	Cyperaceae	Sedge
7	Sabuj nakful	*Cyperus difformis* L.	Cyperaceae	Sedge
8	Pani kachu	*Monochoria vaginalis* (Burm. F.) C. Presl.	Pontederiaceae	Broad leaved
9	Matichech	*Fimbristylis diphylla*	Cyperaceae	Sedge
10	Hazardana	*Phylanthis niruri*	Euphorbiaceae	Broad leaved
11	Boro chucha	*Cyperus irria*	Cyperaceae	Sedge
12	Keshuti	*Eclipta prostrata*	Compositae	Broad leaved
13	Joyna	*Fimbristylis miliaceae*	Cyperaceae	Sedge
14	Guiccha	*Paspalum comersoni*	Poaceae	Grass
15	Sheyal leja	*Setaria viridis*	Poaceae	Grass

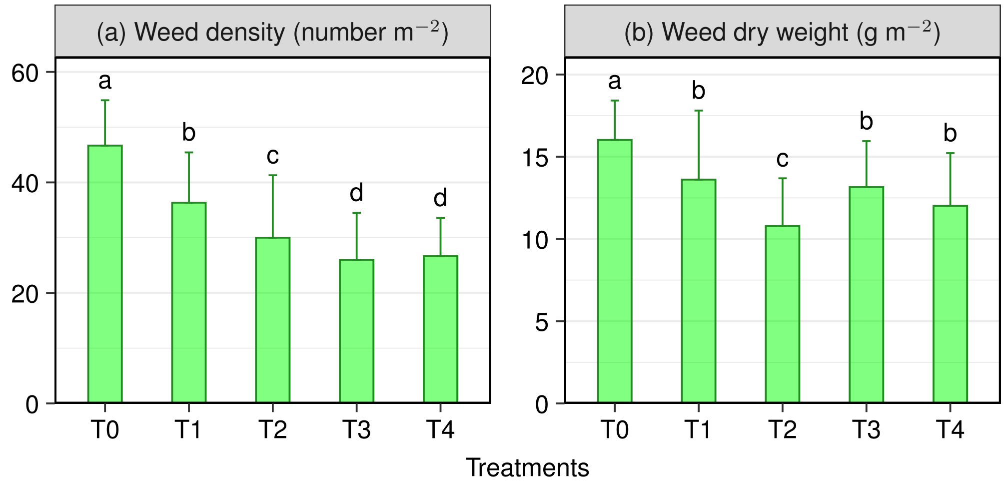

Figure 2. Effect of weed management practices on (a) weed density and (b) weeed dry weight in rice cv. Nizershail. Vertical line associated with individual bar is standard deviation. Bars with similar letter do not differ significantly at P = 0.05. T0: no weeding, T1: hand weeding at 15 and 35 days after transplanting (DAT), T2: application of pre-emergence herbicide, T3: application of early post-emergence herbicide, and T4: application of post-emergence herbicide.

(Islam et al., 2018), combination of pre- and post-emergence herbicides gave the highest yield in aromatic rice. Chauhan et al. (2015) reported that higher grain yield was obtained by applying Pretilachlor followed by fenoxaprop plus ethoxysulfuron plus 2,4-D. Singh et al. (2018), on the other hand, found that integrated weed management (stalebed with tillage, pendimethalin and bispyribac) gave the highest grain yield in rice in comparison to single weeding method.

3.7 Straw yield

Straw yield was significantly influenced by different weed management practices at 1% level of significance (Fig. 1b). The highest straw yield (2.73 t ha^{-1}) was observed in T3 (application of early post-emergence herbicide) whereas no weeding treatment produced the lowest straw yield (1.56 t ha^{-1}). Plant height was the highest and number of total tillers hill^{-1} was the second highest in T3 treatment (Table 2). These plant characters might have contributed to the highest straw yield in T3. Our result is in agreement with that of Awan et al. (2015) who found that herbicidal weed control in rice increased straw yield.

3.8 Weed composition

The experimental plots were infested with 15 weed species belonging to six families (Table 3). Five weed species were of the family Cyperaceae, one of the family Gramineae and one each of the family Pontederiaceae, Compositae, Euphorbiaceae, six weed species were of the family Poaceae. In general, conditions favourable for growing transplanted Nizershail rice are also favourable for the exuberant growth of a number of weed species that compete with crop plants. Weeds found in Nizershail rice field are aquatic, semi aquatic, broad leaved, grasses and a few sedges which could withstand water logging usually enough to depress crop yield very significantly if not timely controlled (Mian and Gaffar, 1960).

3.9 Weed density

Weed density in rice at vegetative stage was significantly affected by weed management practices at 1% level of significance (Fig. 2a). The highest weed density (46.67 m^{-2}) was found in T0 (non-weedy) treatment and the lowest density (26.00 m^{-2}) was observed in T3 (application of early post-emergence herbicide). However, T4 (application of post-emergence herbicide) also gave statistically similar result.

3.10 Weed dry weight

Weed dry weight (g m^{-2}) was significantly affected by weed management practices at 1% level of significance (Fig. 2b). The highest Weed dry weight (16.02 g m^{-2}) was found in T0 (non-weedy) treatment and the lowest density (10.79 m^{-2}) was observed in T2 (application of pre-emergence herbicide).

4 Conclusion

From the study results, it is evident that weed control method has significant effects on grain yield and weed infestation in transplant aman rice. It may be concluded that application of early post-emergence herbicide at 10 DAT might be the best option for controlling weed as well as obtaining higher grain yield in transplanted aman rice cv. Nizershail.

Acknowledgments

The first author received fellowship from the Ministry of Science and Technology (MoST) of government of the People's Republic of Bangladesh for conducting this research.

Conflict of Interest

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

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The Official Journal of the
Farm to Fork Foundation
ISSN: 2518–2021 (print)
ISSN: 2415–4474 (electronic)
http://www.f2ffoundation.org/faa