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Evaluation of Allelopathy of Agricultural Land Associated Trees on Weed Growth and Yield Performance of *Boro* Rice

Md. Shafiqul Islam[1], Md. Parash Mia[1], Md. Rakibul Hasan Sanet[2], Musfika Sultana[3], Subarna Devi Pali[1], Fauzia Akter Neshe[4]

[1]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2200

[2]Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2200

[3]Metropolitan Agriculture Officer, Kamrangirchar, Dhaka, Department of Agricultural Extension, Ministry of Agriculture, People's Republic of Bangladesh

[4]Department of Agroforestry, Bangladesh Agricultural University, Mymensingh-2200

ABSTRACT: We conducted an experiment at the Agronomy Field Laboratory, BAU, Mymensingh to evaluate the allelopathic effect of *Mangifera indica*, *Artocarpus heterophyllus*, *Albizia lebbeck* and *Shorea robusta* on the weed growth and yield performance of *boro* rice. The experiment consisted of one cultivar i.e. BRRI dhan29 and five different extract's treatments such as no leaf extracts (T_1), *Mangifera indica* leaf extracts(T_2), *Artocarpus heterophyllus* leaf extracts(T_3), *Albizia lebbeck* leaf extracts (T_4) and *Shorea robusta* leaves extract (T_5) @20:200 (w/v) ratio concentration. The experiment was laid out in a Completely Randomized Design with four replications. Weed population, weed dry weight were significantly affected by different treatments. The highest weed population and dry weight for all weed species were found in no tree leaf extracts treatments (T_1) and *Shorea robusta* leaf extracts (T_2) respectively. The lowest weed population and weed dry weight were recorded in *Artocarpus heterophyllus* leaf extracts (T_3). The highest grain yield as well as the yield contributing characters was recorded in *Albizia lebbeck* leaf extracts (T_4). The highest reduction of grain yield was observed in T_1 (no tree leaf extracts) treatment. The longest plant height, highest number of total tiller hill^{-1}, highest number of effective tillers hill^{-1}, number of grains panicle^{-1}, 1000-grain weight, grain and straw yields were observed in *Albizia lebbeck* leaf extracts (T_4) treatment and the lowest was observed in T_1. Results of this study indicates that *Artocarpus heterophyllus* (T_3) and *Albizia lebbeck* (T_4) leaf extracts showed potentiality in yield contributing characters of *Boro* rice. Therefore, *Artocarpus heterophyllus* and *Albizia lebbeck* leaf extracts might be used as an alternative way for weed management and sustainable crop production.

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Corresponding Author: Md. Shafiqul Islam

KEYWORDS: allelopathy, cropland tree, extract, weed management, rice yield.

INTRODUCTION

The majority of people, in Bangladesh, are engaged with agriculture and agriculture belongs 14.10% of the GDP. The principal food source in Bangladesh and the crop that is grown there the most extensively is rice. A person's total caloric intake is made up of 49% rice, wheat, and maize, with rice making up 23%, wheat 17%, and maize 9%. Consequently, around 25% of the calories consumed by people worldwide come from rice. (Subudhi *et al*., 2006). Rice production occupied about 11.41 million hectares of cropped area of Bangladesh, with annual production of 36.60 million metric tons (BBS, 2020). In Bangladesh, Rice farming has been practiced extensively. Rice is grown all over the nation except for the steep southeast. As the area of rice cultivation is going to be lower day by day, so it is very important to enhance the rice production for the betterment of the whole nation. Bangladesh has three rice-growing seasons: *aus, aman,* and *boro*. These three seasons account for all of the country's rice production. It is noteworthy that the average yield of *boro* rice, which accounts for around 41.94% of the total rice area, is the greatest for a single crop (4.29 metric t ha^{-1}) (BBS, 2021). The great step toward rice system in Bangladesh is the production (20.7 million tonnes) of *boro* rice in 2021(MoA, 2021).The primary estimates of the Bangladesh Bureau of Statistics showed rice output was above 36.3-million tonnes in FY21. For marketing year (MY) 2021-22, rice production in Bangladesh may be 35.5-million tonnes on 11.42-million hectares which are

2.2 per cent and 2.1 per cent respectively lower than the USDA's official forecast earlier, according to the latest USDA report. Among the rice yield limiting reasons, weed is regarded one of the main issues. It causes serious problem in agriculture as it interferes with natural resources and is one of the main and oldest obstacles to maximizing rice output (Varanasi *et al.,* 2015). In the weed-crop competition, weeds outcompete crops because of their superior capacity to absorb light, water, nutrients, and space. Furthermore, because of their prolific seed production, dormancy, and environmental tolerance, weeds pose a major danger to agriculture (Tanveer *et al.,* 2010; Harun *et al.,* 2014; Islam and Kato-Noguchi, 2014). Weeds' high level of competition has an adverse impact on crop productivity, resulting in significant yield losses. One of the main causes of a decline in rice yield is inappropriate weed management. In our nation, weed infestation affects the grain production of modern *boro* rice by 22–36%, transplanted *aman* rice by 30%–40%, and *aus* rice by 70–80% (BRRI, 2008). To get the most out of the rice crop, the soil needs to be kept free of weed infestation. As a result, small farmers in Bangladesh devote more time and energy to weed control than to any other aspect of farming. The main rice-growing regions of Bangladesh are usually cleared by hand. Nowadays, there are fewer people available due to the diversity of their jobs. The manual weeding method of weed control has grown more costly and difficult due to the lack of labor (Hasanuzzaman *et al.,* 2009, Rashid *et al.,* 2007). Many contemporary weed control methods are currently in use; in Bangladesh, for example, weeds are controlled through the use of mechanical, chemical, biological, physical, cultural, and allelopathic approaches. Among these, farmers frequently used chemical weed control techniques, which have negative effects on the environment and human health. Herbicides and automated weeding are viable alternatives to hand weeding. However, it is costly to control weeds in transplant rice using a mechanical or cultural method (Mitra *et al.* 2005). Herbicide application has become the most widely used method for controlling weeds, which is essential for healthy crop production in the current environment. However, their negligent use also has detrimental effects on soil, water, air, human health, and animal health. Water used for human and animal consumption, both surface and groundwater, may contain herbicides. Chemical pesticide residues from plants or soil can make their way up the food chain and pose a threat to people and animals by dispersing diseases. The various problems associated with chemical weed control have prompted concerns regarding the continued use of herbicides. It is necessary to examine other solutions that do not have similar problems. Experts are now investigating several biological approaches to minimize weeds in rice growing. In these circumstances, a biological remedy would be plant allelopathy (Fay and Duke, 1977; Soltys *et al*., 2013). Plant physiologist Hans Molisch of the University of Vienna in Austria is credited for coining the term allelopathy. The Greek terms allelon, which means "each other," and pathos, which means "suffering," Elroy L. Rice's 1974 publication of the first English-language book on allelopathy sparked renewed interest in the concept. His definition of allelopathy states that toxins released into the environment by one plant affects other plants. This definition, which includes both positive (growth-promoting) and negative (growth-inhibiting) effects, is generally accepted. (Weidenhamer and Callaway, 2010). Allelopathy is any direct or indirect effect of plants on other plants caused by chemical release (2001) according to Kohli et al. (1998).Allelopathy, as defined by Nishida et al. (2005) and Batish et al. (2007), is a widespread biological phenomena in which biochemicals generated by one organism impact the growth, survival, reproduction, and development of other species. Allelosubstances are a class of compounds that can affect the target organisms in a favorable or bad way. Lately, a great deal of research has been done on these allelopathic interactions between the plants. Allelopathic characteristics have been reported for several plant species. Allelochemicals are present in practically all plant tissues, including leaves, flowers, fruits, stems, roots, rhizomes, and seeds, but little is known about these compounds' properties or mechanisms of action (Parvin et al, 2011). Certain plant extracts and residues have been demonstrated to have weed-suppressive properties (Weston 1996, Semidey, 1999). More leaves fall from trees during the rabi season than at any other time of the year. Along the edges of rice fields, trees including *Shorea robusta*, *Albizia lebbeck*, *Mangifera indica*, and *Artocarpus heterophyllus* are grown. Even though the humus formed by falling leaves increases the fertility of the soil, it is likely that certain tree species emit allelochemicals. The purpose of this study is to evaluate the effects of four often found trees linked with agricultural land (*Albizia lebbeck*, *Mangifera indica*, *Shorea robusta*, and *Artocarpus heterophyllus*) on crop and weed growth as well as the production performance of *boro* rice.

MATERIALS AND METHODS

The experimental was conducted at the Agronomy Field Laboratory Bangladesh Agricultural University, Mymensingh-2202. The experiment was laid out in a Completely Randomized Design with four replications. The total number of pots were 20. The experimental treatment consisted of two factors. They are as follows- Factor A: Leaves extracts i. Control; ii. *Albizia lebbeck* leaves extract @ 20:200 (w/v) ratio concentration; iii. *Mangifera indica* leaves extracts @ 20:200 (w/v) ratio concentration; iv. *Artocarpus heterophyllus* leaves extract @ 20:200 (w/v) ratio concentration; v. *Shorea robusta* leaves extract @ 20:200 (w/v) ratio concentration and, Factor B: Cultivar; i. BRRI dhan29.

Harvest index of each plot was calculated by using the following formula:

$$\text{Harvest index (\%)} = \frac{Grain\ yield}{Biological\ yield} \times 100$$

The analysis of variance was done with the help of computer package MSTAT-C program. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT) as laid out by Gomez and Gomez (1984).

RESULT AND DISCUSSION

PLANT HEIGHT

The plant height varied significantly among the different treatments (Appendix III). The tallest plant height (78.32 cm) was found in *Albizia lebbeck* (T4) and shortest plant height (69.58 cm) was observed in Control treatment (T1) (Table 1). Plant height is a genetic constituent of the constituent of the cultivar, therefore, plant height was different among the different treatments. The results are consistent with the findings of Bisne *et al*. (2006) who observed plant height differed significantly among the different treatments.

NUMBER OF TOTAL TILLERS HILL^{-1}

Effect of different tree leaf extract on number of total tillers hill^{-1} was significant at 1% level of probability (Table 1). The highest number of total tillers hill^{-1} (32.05) was found in Albizia lebbeck (T4). The second highest number of total tillers hill-1 (27.07) was observed in Shorea robusta (T5). The lowest number of total tillers hill-1 (21.09) was found in control treatment (Table 4).

NUMBER OF EFFECTIVE TILLERS HILL^{-1}

Effect of different tree leaf extract on number of effective tillers hill-1 was significant at 1% level of probability (Table 1). The highest number of effective tillers hill-1 (29.33) was found in *Albizia lebbeck* (T4) (Fig. 1). The lowest number of effective tillers hill-1 (15.62) was found in control treatment. The results are consistent with the findings of Uddin and Pyon (2010) who reported the similar results, where different plant residues influenced the crop performance.

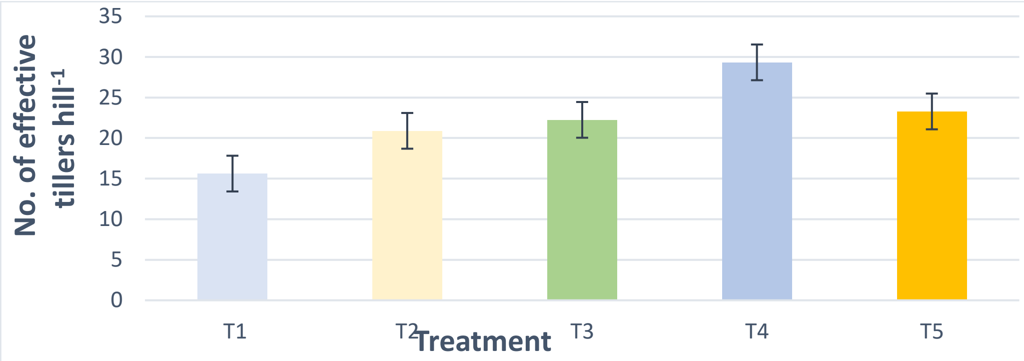

Fig. 1. No. of effective tillers hill^{-1} as influenced by different treatments (Bar represents standard error mean).
Here T$_1$= Control, T$_2$= *Mangifera indica*, T$_3$= *Artocarpus heterophyllus*, T$_4$= *Albizia lebbeck* and T$_5$= *Shorea robusta*

NUMBER OF NON-EFFECTIVE TILLERS HILL^{-1}

Effect of different tree leaf extract on non-effective tillers hill^{-1} was significant at 1% level of probability (Table 1). The highest number of non-effective tillers hill^{-1} (5.47) was found in control and the second highest number of non-effective tillers hill^{-1} (4.23) was found in *Mangifera indica* (T$_2$). The lowest number of non-effective tillers hill^{-1} (2.72) was observed in *Albizia lebbeck* (T$_4$) and the second lowest number of non-effective tillers hill^{-1} (3.59) was obtained in *Artocarpus heterophyllus* (T$_3$).

NUMBER OF GRAINS PANICLE^{-1}

Different tree leaf extract showed significant effect on number of grains panicle^{-1} at 1% level of probability. The highest number of grains panicle^{-1} (116.95) was observed in *Albizia lebbeck* (T$_4$) and the lowest number of grains panicle^{-1} (89.59) was found in control (T$_1$) treatment (Fig. 2). It indicates that the different tree leaves extracts encourages the number of grains panicle^{-1}. De Datta (1990) observed that different crop residues increased number of grains due to more availability of water, nutrients and light.

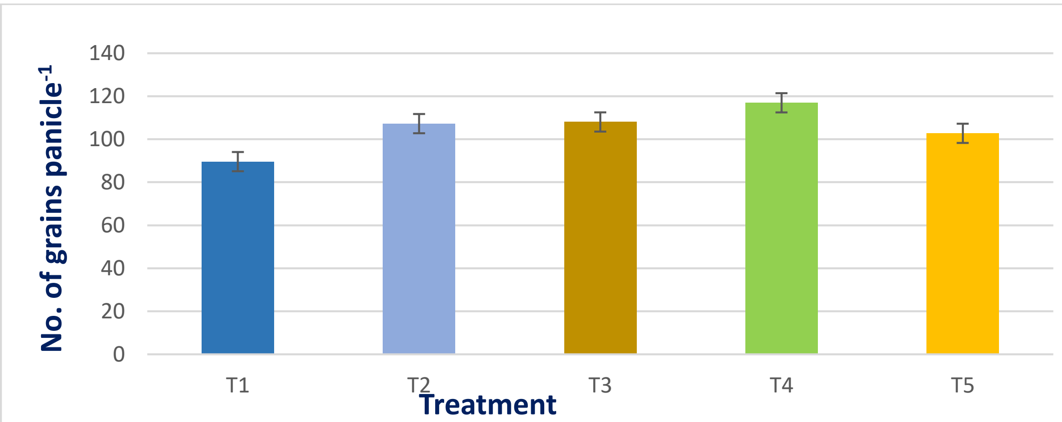

Fig. 2. No. of grains panicle-1 as influenced by different treatments (Bar represents standard error mean)
Here T$_1$= Control, T$_2$= *Mangifera indica*, *T$_3$= Artocarpus heterophyllus*, *T$_4$= Albizia lebbeck* and T$_5$= *Shorea robusa*

NUMBER OF STERILE GRAINS PANICLE^{-1}

Effect of different tree leaf extract on number of sterile grains panicle^{-1} was significant at 1% level of probability. The highest number of sterile grains panicle^{-1} (21.34) was observed in control treatment (T_1) and the lowest number of sterile grains panicle^{-1} (8.672) was found in *Albizia lebbeck* (T_4).

1000 Grains Weight

All the treatments under study were significant at 5% level of probability for their 1000 grains weight. The highest thousand grains weight (22.19 g) was recorded in *Artocarpus heterophyllus* (T3). The lowest thousand grains weight (19.71 g) was found in control treatment (T_1).

GRAIN YIELD

The studied different treatments (tree leaf extracts) differ significantly in grain yield (Appendix III). The highest grain yield (72.29 g pot^{-1}) was obtained in *Albizia lebbeck* (T_4) .The second highest grain yield (70.25 g pot^{-1}) was found in *Artocarpus heterophyllus* (T_3). The increased yield due to the lowest number of grains panicle$^{-1.}$ The lowest grain yield (45.55 g pot^{-1}) was recorded in control treatment (T_1) (Fig: 3). Uddin and Pyon (2010) also reported the similar results, where crop residues influenced in crop performance.

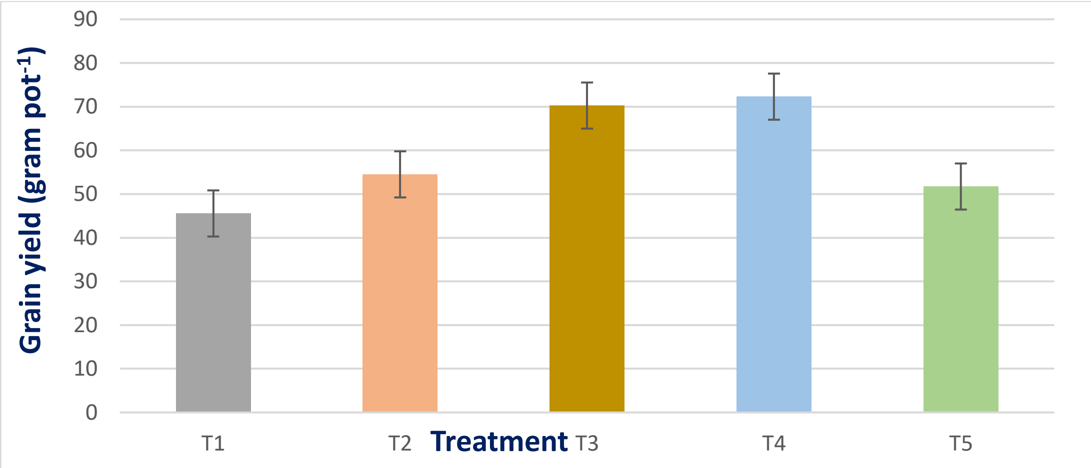

Fig. 3. Grain yield (gram pot^{-1}) as influenced by different treatments (Bar represents standard error mean).
Here T_1= Control, T_2= *Mangifera indica, T_3= Artocarpus heterophyllus, T_4= Albizia lebbeck* and T_5= *Shorea robusa*

STRAW YIELD

Straw yield was significantly influenced by different tree leaf extracts .The highest straw yield (146.51 g pot-^{1}) was obtained in *Albizia lebbeck* leaf extract (T_4) and the second highest straw yield (136.46 g pot^{-1}) was fund in *Artocarpus heterophyllus* (T_3). The lowest straw yield (114.82 g pot^{-1}) was observed in *Shorea robusta* leaf extract (T_5). (Fig.4). These results are in conformity with that obtained by Chowdhury *et al*. (1993) who reported the differences in the straw yield among the treatments.

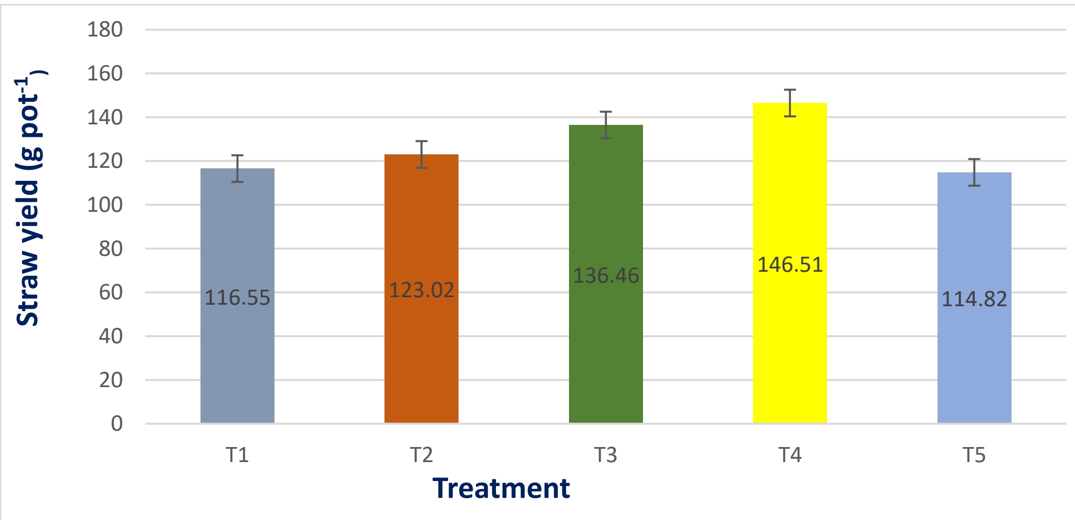

Fig. 4. Straw yield (gram pot-1) as influenced by different treatments (Bar represents standard error mean).
Here T_1= Control, T_2= *Mangifera indica, T_3= Artocarpus heterophyllus, T_4= Albizia lebbeck* and T_5= *Shorea robusa*

BIOLOGICAL YIELD

Effect of different tree leaf extract on biological yield was significant at 1% level of probability. The highest biological yield (218.80 g pot-1) was found in *Albizia lebbeck* (T4) and the lowest biological yield (162.10 g pot-1) was found in Control treatment (T1) (Table 1).

HARVEST INDEX (%)

There was significance difference in the effect of different tree leaf extracts in respect of harvest index (Appendix III). The highest harvest index (33.97 %) was found in *Artocarpus heterophyllus* leaf extract (T_3) followed by *Albizia lebbeck* leaf extract (T_4) and the lowest harvest index (28.09%) was observed in control treatment (Table 1).

Table 1: Effect of tree leaves extracts on yield and yield contributing characters of *boro* rice variety, BRRI dhan29

Treatment	Plant height (cm)	Total tillers (no.)	Non effective tillers (no.)	Sterile Grains Panicle (no.)	1000 grains weight (g)	Biological yield (g pot^{-1})	Harvest index %
T_1	69.58b	21.09c	5.47a	21.34a	19.71b	162.10d	28.09d
T_2	72.25b	25.12b	4.23b	17.83b	21.16ab	177.52c	30.67c
T_3	73.56ab	25.83b	3.59bc	11.98c	22.19a	206.71b	33.97a
T_4	78.32a	32.05a	2.72c	8.672d	21.35ab	218.80a	33.03ab
T_5	71.70b	27.07b	3.79b	11.33c	20.26ab	166.54d	31.04bc
LSD $_{(0.05)}$	5.51	2.00	1.02	2.51	2.07	8.16	2.06
Level of significance	**	**	**	**	*	**	**
CV (%)	5.00	5.06	17.18	11.68	6.58	2.91	4.36

Here, in a column, figures with the same letter (s) or without letter do not differ significantly, whereas figures with dissimilar letter differ significantly as per DMRT, ** = Significant at 1 % level of probability, *= significant at 5% level of probability, NS= Non-significant

Here, $T_{1=}$ Control and T_2 = *Mangifera indica*, T_3 = *Artocarpus heterophyllus*, T_4 =*Albizia lebbeck* and T_5 = *Shorea robusta*,

CONCLUSION

From the above result it was found that the *Albizia lebbeck* leaf extracts treatment (T_4) exhibited the superior effect followed by *Artocarcus heterophyllus* leaf extracts treatment (T_3). Result of the study showed that the application of *Mangifera indica, Artocarpus heterophyllus*, *Albizia lebbeck* and *Shorea robusta* leaf extracts for *boro* rice may reduce weed and it has positive effect on yield performance of *boro* rice. Therefore, the studied tree leaf extracts could be a prospective source of weed control tool for crop production in modern agricultural science.

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