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Allelopathic Effect of *Albizia Lebbeck* (*Koroi*) leaf residues on the weed growth performance of *Boro* Rice

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Abstract
Allelopathy is a biological phenomenon of chemical interaction between plants, and this phenomenon has great potential to be used as an effective and environmentally friendly tool for weed control in field crops. The present experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from November 2022 to May 2023 to study the allelopathic effects of leaf residues of *Albizia Lebbeck* (*Kooroi*) on weed growth and yield performance of *boro* rice. The field experiment consisted of two rice varieties *viz*., BRRI dhan28, BRRI dhan29, and five treatments of leaf residues *Albizia lebbeck* such as 0, 1.0, 2.0, 3.0 and 4.0 t ha^{-1}. The experiment was carried out in a randomized complete block design (RCBD) with three replications. Nine weed species belonging to seven families infested the experimental plots. Weed density was significantly affected by the variety and residues treatment. Weed dry weight was significantly affected by the variety and residues treatment at 50 days after transplanting (DAT) but non-significantly affected by the variety at 25 DAT. The minimum weed growth was found in BRRI dhan29 when leaf residues were applied at the rate of 3.0 t ha^{-1}, while the maximum was found in BRRI dhan28 with the application of 0 t ha^{-1} leaf residues (Control). Therefore, *Albizia lebbeck* residue may be used as an alternative tool for weed management effectively for sustainable crop production.

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Keywords: Allelopathic effect, *Albizia Lebbeck*, leaf residues, weed growth, *Boro* Rice

Introduction

Rice (*Oryza sativa* L.) stands as the cornerstone of sustenance in Bangladesh serving as the staple food crop. Bangladesh has a long history of rice cultivation. Rice is grown throughout the country except in the Southeastern hilly areas. The agro-climatic conditions of the country are suitable for growing rice year-round. In Bangladesh, farmers cultivate rice in three different seasons, namely *boro*, *aus*, and *aman*. About 78.42% of the land is occupied by rice cultivation. Among the three rice growing seasons, most of the area is taken by *boro* rice comprising approximately 41.94% of the total rice growing area (BBS, 2022) [3]. Agriculture sector contributes about 13.91% of its gross domestic product (GDP) in the economy of Bangladesh. However, the national average rice yield is much lower (3.12 t ha^{-1}) than that of other rice-growing countries (BBS, 2022) [3]. The country has 14.86 million ha of land area with 8.52 million ha under cultivation (Shelley *et al*. 2016) [22]. As a result of the increasing population of the country, the amount of cultivable land is decreasing day by day. To meet up the food demand of the increasing population it needs to increase crop production.

Weed is considered a major constraint in degrading the rice crop yield. Weed is a plant growing where it is not wanted. They compete with the crop plants for nutrient, space and light. They take up the nutrients and reduce the growth of the crop and thus, crop yield and quality are reduced (Chauhan, 2020) [5]. Weed control is necessary to increase the crop production. There are some methods of weed control such as physical, chemical and biological. In Bangladesh, the traditional method of weed control is hand weeding which is very much laborious and time consuming. Mechanical weeding and herbicides are the alternatives to hand weeding (Hossain *et al*. 2024) [12].

The chemical method is most effective but it has a negative impact on human, animal and the environment. Furthermore, due to using of chemical herbicides for weed control different weed species are becoming increasingly resistant to synthetic herbicides (Moss *et al.* 2019) [16]. It has been reported that 267 weeds throughout the world show resistance to synthetic herbicides, such as the common herbicide glyphosate (Heap and Duke, 2018) [10]. To mitigate the problem researchers emphasized biological weed control instead of using chemical herbicides.

Allelopathy is a biological process in which one component (organism or plant) releases certain kinds of secondary metabolites that are harmful to the growth, germination, reproduction, and survival of other plants or organisms (Islam *et al*. 2024) [13]. Various plant parts such as roots, leaves, stems, flowers, and fruits possess secondary metabolites (allelopathic compounds). These allelopathic compounds affect different physiological and chemical functions of surrounding plants or organisms (Mushtaq *et al*. 2019) [17]. The compounds are less harmful to humans and possess fewer negative effects than chemical herbicides, and scientists have been investigating their phytotoxic potential for many years (Ustuner *et al.* 2020) [24]. Plant allelopathy might be an option to control weed. The extracts of some plant species are used to control weeds as well as to reduce the proliferation of weeds without harming cultivated plants (Mendes and Rezende, 2014) [15]. Allelopathic strategy can be used to overcome the problem of weed growth and reduce the reliance on herbicides (Narwal, 2000) [18]. Crop allelopathy controls weeds by the release of allelochemicals from the living plants and/or through decomposition of phytotoxic plant residues (Khanh *et al.* 2005) [14]. Crop residues can interfere with weed development and growth through alteration of soil physical, chemical, and biological characteristics. Recently, researchers are giving more emphasis using different residues to suppress weed growth (Farhat *et al.* 2023) [7].

Albizia lebbeck leaf aqueous extracts caused both stimulatory and inhibitory effect on germination, root and shoot elongation and development of lateral roots of receptor plants (Hossain *et al.* 2013) [11]. Leaf residues of *Albizia lebbeck* released allelochemicals and affect both weeds and rice crops negatively and/or positively, but such has been conducted in laboratory condition. Before going to farmers field, it is mandatory to check its suitability in field trial. Therefore, this experiment is taken to find out the negative and/ or positive allelopathic effect of *Albizia lebbeck* leaf residues on weed growth and yield performance of *boro* rice.

Materials and Methods

Experimental Location

The experimental field was located at 24°25' N latitude and 90°50'E longitude at an elevation of 18m above the sea level belonging to non-calcareous dark grey floodplain soil under the Sonalota series of the Old Brahmaputra Floodplain, which falls under the Agro-ecological region of the Old Brahmaputra Flood-plain (AEZ-9) (FAO and UNDP, 1988) [6].

Experimental Soil

The soil of the experimental land belongs to the Sonatola series of non- calcareous dark grey floodplain soil under the Old Brahmaputra Alluvial Tract. The experimental field was medium high land with well drained condition. The soil was silty loam in texture having a soil pH value of 6.5, moderate in organic matter content.

Experimental Treatments

The experimental treatment consisted of two factors. They are as follows: Factor A: Variety (2): BRRI dhan28 (V_1), BRRI dhan29 (V_2). Factor B: *Albizia lebbeck* (*Koroi*) leaf residues (5): 0 t ha^{-1} (R_1), 1.0 t ha^{-1} (R_2), 2.0 t ha^{-1} (R_3), 3.0 t ha^{-1} (R_4), 4.0 t ha^{-1} (R_5).

Experimental Design

The experiment will be laid out in Randomized Complete Block Design (RCBD) with three replications. Thus, the total number of plots will be 30. Each plot size was 5 m^2 (2.5 m × 2.0 m).

Description of the rice variety

BRRI dhan28: BRRI dhan28 variety was developed by Bangladesh Rice Research Institute (BRRI) and released in 1994. It attains an average plant height of 90 cm. Its life cycle is 140 days. This variety gives an average yield of 6 t ha^{-1} BRRI (2015) [4].

BRRI dhan29: BRRI dhan29 variety was developed by Bangladesh Rice Research Institute (BRRI) and released in 1994. It attains an average plant height of 95 cm. Its life cycle is 160 days. This variety gives an average yield of 7.5 t ha^{-1} BRRI (2015) [4].

Collection and preparation of residues

Albizia lebbeck leaf residues were used in this study. The residues were collected from the Sutiakhali village, Mymensingh Sadar, Mymensingh. After collection, the residues were dried under shade in the covered threshing floor of the Agronomy Field Laboratory at BAU. Then the plant leaves residues were cut to small pieces by using a sickle.

Rice Seed Collection

Rice seeds of the investigated varieties (BRRI dhan28 and BRRI dhan29) were collected from the Agronomy Field Laboratory, BAU, Mymensingh.

Seed Sprouting

Healthy seeds of the collected varieties were selected by specific gravity method. Seeds were immersed in water in a bucket for 24 hours. After that these were taken out of water and kept thickly in gunny bags. The seeds started sprouting after 48 hours and got ready to sow.

Preparation of seedling nursery bed and seed sowing

A piece of land was selected for raising seedlings. The land was puddled well with a tractor, followed by leveling with a ladder. The sprouted seeds were sown uniformly in a well-prepared nursey bed on 29 November, 2022. Proper care was taken to raise the healthy seedlings in the nursery bed. Weeds were removed and irrigation was given in the nursery bed as and when necessary.

Preparation of the experimental land

The field was prepared on 27 December, 2022. The field was ploughed with a tractor-drawn disc plough followed by laddering. The layout of the field was made after final land preparation. Weeds and stubbles were removed and cleaned from individual plots. After the final land preparation, the field layout was made on 4th January 2023.

Fertilizer Application

The experimental plots were fertilized with Urea, Triple Super Phosphate, Muriate of potash, Gypsum and Zinc Sulphate @ 240, 120, 120, 110 and 10 kg ha^{-1}, respectively. The entire amount of Triple Super Phosphate, Muriate of Potash, Gypsum and Zinc Sulphate were applied at the time of final land preparation. Urea was applied in three equal installments at 15, 30 and 45 days after transplanting (DAT).

Application of *Albizia lebbeck* Leaf Residues

Albizia lebbeck leaf residues were applied at 7-day before transplanting of rice at the time of final land preparation. After that crop residues were mixed well to the respective plots by a spade.

Uprooting Seedlings

The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on 11 January 2023 and they were immediately transferred to the main field. Healthy and similar sized seedlings were selected for transplanting.

Transplanting of Seedlings

43-day old seedlings were transplanted in the well-prepared puddled field on 11 January at the rate of three seedlings hill maintaining row and hill distance of 25 cm and 15 cm, respectively.

Irrigation and Drainage

Experimental field was given flood irrigation to maintain a constant level of standing water up to 6 cm in early stage to enhance tillering and 10-12 cm at later stage to discourage late tillering. Water was finally drained out before 15-day of harvest to enhance maturity. A total of 8 irrigations were needed throughout the growing season.

Data Collection at Different Growth Stages

Weed Density

Data on weed population were collected from each plot of the rice plants at 25 DAT and 50 DAT by using 0.25 m x 0.25 m quadrate as per method described by Cruz *et al*. (1986). The weeds within the quadrate were counted accordingly.

Weed Dry Weight

After counting the weed all, the weeds inside each quadrate were uprooted, cleaned, separated species-wise and dried first in the sun and then in an electric oven for 72 hours at a temperature of 80°C. The dry weight of each species was taken by an electric balance.

Statistical Analysis

The data were compiled and tabulated in proper form and subjected to statistical analysis. 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) [9].

Results and Discussion

Infested Weed Species in the Experimental Field

Nine weed species belonging to seven families infested the experimental field. Local name, scientific name, family, morphological type and life cycle of the weed in the experimental plot have been presented in Table 1. The weeds of the experimental plots were Shama (*Echinochloa crusgalli*), Sabuj nakful (*Cyperus difformis*), Panikachu (*Monochoria vaginalis*), Angta (*Paspalum scrobiculatum*), Pani Chaise (*Eleocharis atropurpurea*), Khude pana (*Azolla pinnata*), Anguli (*Digitaria sanguinalis*), Amrul shak (*Oxalis corniculata*) and Keshuti (*Eclipta Prostrata*). Among the weed species four were grass, two were sedge and three were broad leaf type morphology. There were three perennial and six annual weed species in the experimental plot. Salam *et al.* (2013) [21] reported eight weed species infested in their experimental field, among the eight-weed species Shama (*Echinochloa crusgalli*), Angta (*Paspalum scrobiculatum*), Amrul shak (*Oxalis europaea*), and Sabuj nakful (*Cyperus difformis*) were the most important weeds.

Table 1: Infesting weed species found growing in the experimental plots of rice

Sl. No.	Local Name	Scientific name	Family	Morphological type	Life cycle
1.	Shama	*Echinochloa crusgalli*	Poaceae	Grass	Annual
2.	Sabuj nakful	*Cyperus difformis*	Cyperaceae	Sedge	Annual
3.	Panikachu	*Monochoria vaginalis*	Pontederiaceae	Broad leaf	Perennial
4.	Angta	*Paspalum scrobiculatum*	Gramineae	Grass	Perennial
5.	Pani chaise	*Eleocharis atropurpurea*	Cyperaceae	Sedge	Annual
6.	Khude pana	*Azolla pinnata*	Azollaceae	Broad leaf	Perennial
7.	Anguli	*Digitaria sanguinalis*	Poaceae	Grass	Annual
8.	Amrul shak	*Oxalis corniculata*	Oxalidaceae	Grass	Annual
9.	Keshuti	*Eclipta Prostrata*	Asteraceae	Broad leaf	Annual

Weed Density

Effect of variety

Weed density was significantly affected by variety at 25 DAT and 50 DAT. The highest weed density (33.58) was found in BRRI dhan28 and the lowest weed density (28.57) was found in BRRI dhan29 at 25 DAT. At 50 DAT, the highest weed density (40.83) was found in BRRI dhan28 and the lowest weed density (36.65) was found in BRRI dhan29 (Fig. 1). Similar findings were reported by Arefin *et al.* (2018) [2], who found that BRRI dhan29 had a lower weed density than BRRI dhan28.

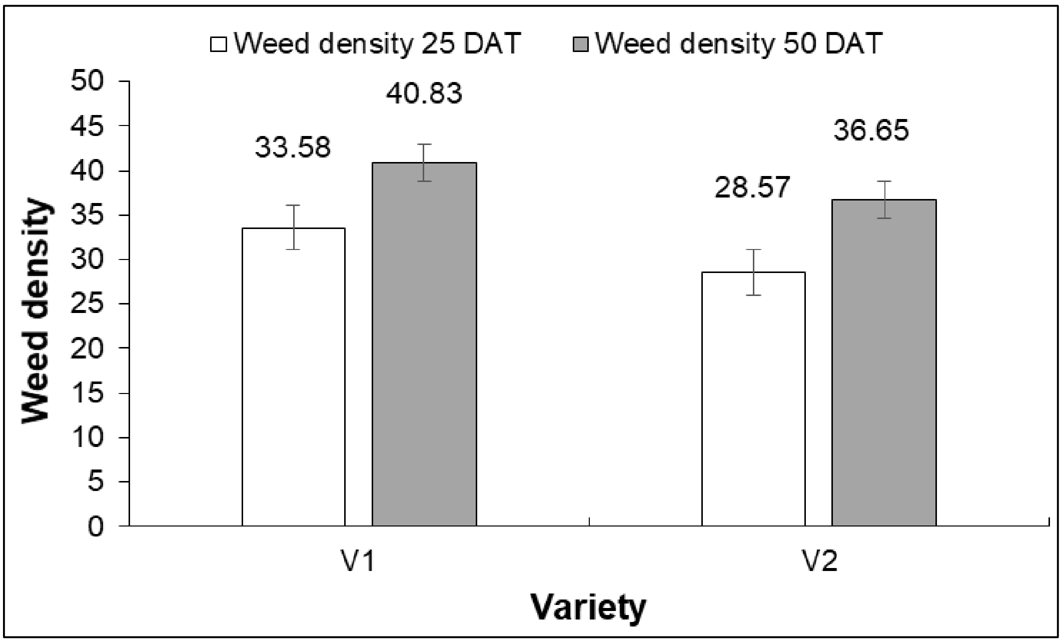

Fig 1: Effect of varieties on weed density V_1 = BRRI dhan28, V_2= BRRI dhan29

Effect of *Albizia lebbeck* residues

Weed density was significantly affected by *Albizia lebbeck* leaves residues at 25 DAT and 50 DAT. At 25 DAT, the highest weed density (37.83) was found in R_1 (residue @ 0 t ha^{-1}) treatment and the lowest weed density (25.36) was found in R_4 (residue @ 3.0 t ha^{-1}) treatment. At 50 DAT, the highest weed density (47.94) was found in R_1 (residue @ 0 t ha^{-1}) treatment and lowest weed density (32.74) was found in R_4 (residue @ 3.0 t ha^{-1}) treatment (Fig. 2). When *Albizia lebbeck* leaf residues are given @ 3.0 t ha^{-1}, lowest weed density is observed, because *Albizia lebbeck* leaf residues @ 3.0 t ha^{-1} have more negative effect on weeds. But when @ 4.0 t ha^{-1} *Albizia lebbeck* leaf residues were given negative effect on weed started to decrease. Singh *et al.* (2022) [23] also observed significant weed control efficacy with different crop residues.

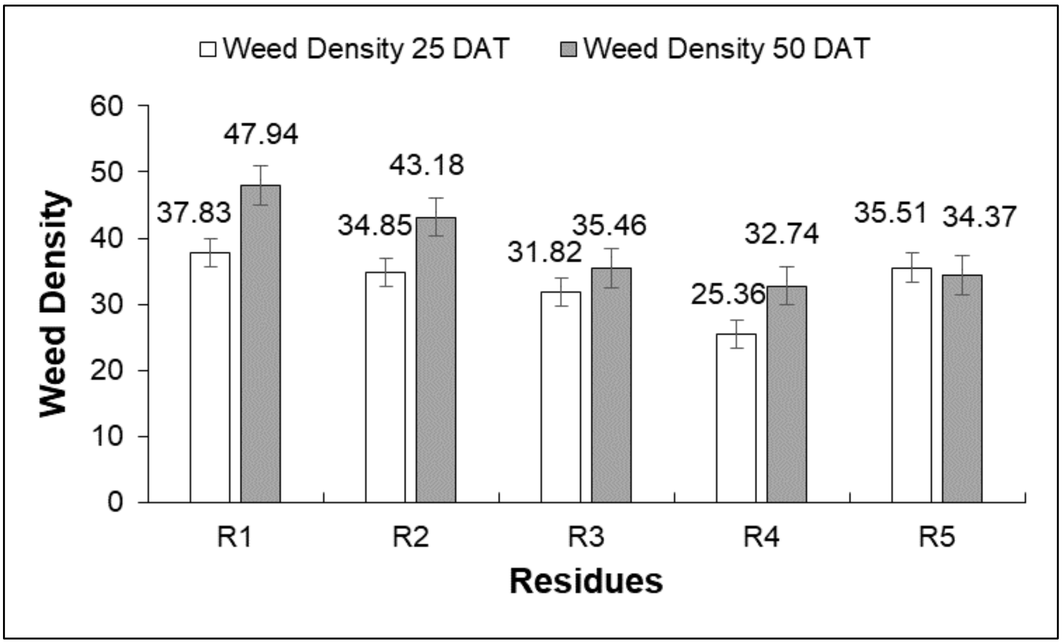

Fig 2: Effect of *Albizia lebbeck* residues on weed density R_1= 0 t ha^{-1}, R_2= 1.0 t ha^{-1}, R_3= 2.0 t ha^{-1}, R_4= 3.0 t ha^{-1}, R_5= 4.0 t ha^{-1}

Effect of interaction between variety and *Albizia lebbeck* residues

The effect of interaction between variety and *Albizia lebbeck* residues was significantly affected by weed density. The highest weed density (41.45) was found in V_1R_1 (BRRI dhan28 × residue @ 0 t ha^{-1}) and the lowest (23.06) was found in V_2R_4 (BRRI dhan29 × residue @ 3.0 t ha^{-1}) at 25 DAT. At 50 DAT, the highest weed density (51.23) was found in V_1R_1 (BRRI dhan28 × residue @ 0 t ha^{-1}) and the lowest (29.04) was found in V_2R_4 (BRRI dhan29 × residue @ 3.0 t ha^{-1}) (Table 2). Ferdousi *et al.* (2017) [8] observed that weed density was significantly influenced by interactions between variety and residues.

Table 2: Effect of interaction of variety and *Albizia lebbeck* residues on weed density

Interaction	Weed density	
	25 DAT	50 DAT
V_1R_1	41.45a	51.23a
V_1R_2	29.00bc	38.43cd
V_1R_3	27.66bc	44.96b
V_1R_4	19.33d	29.82ef
V_1R_5	25.41bcd	39.69bc
V_2R_1	40.20a	44.66b
V_2R_2	38.10a	35.66cde
V_2R_3	38.24a	41.41bc
V_2R_4	23.06cd	29.04f
V_2R_5	29.57b	32.50def
$LSD_{(0.05)}$	6.31	5.93
Level of significance	**	**
CV%	11.83	8.93

In a column, figures with the same letter do not differ significantly as per DMRT. **= Significant at 1% level of probability. V_1= BRRI dhan28, V_2= BRRI dhan29, R_1= 0 t ha^{-1}, R_2= 1.0 t ha^{-1}, R_3= 2.0 t ha^{-1}, R_4= 3.0 t ha^{-1}, R_5= 4.0 t ha^{-1}

Weed Dry Weight

Effect of variety

Weed dry weight was non-significantly affected by variety at 25 DAT but significantly affected by variety at 50 DAT. At 50 DAT, the highest weed dry weight (11.53) was found in BRRI dhan28 and the lowest weed dry weight (9.57) was found in BRRI dhan29 (Fig. 3). Salam *et al.* (2020) [20] also reported that effect of weed dry weight on varieties were non-significantly varied at 20 DAT and also varied significantly at 40 and 60 DAT respectively.

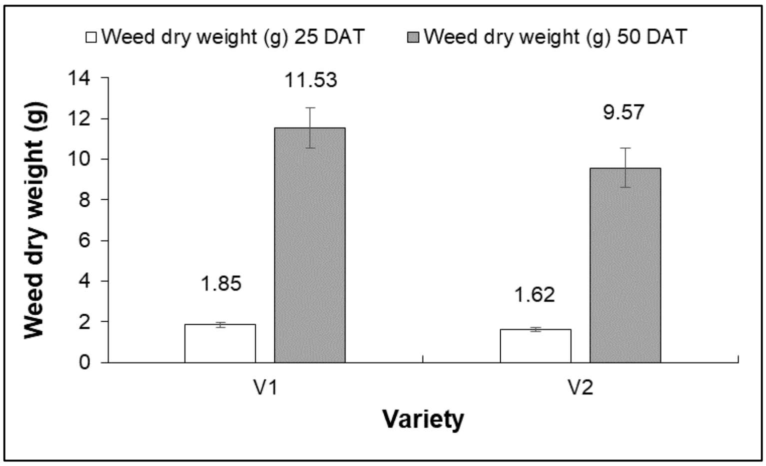

Fig 3: Effect of varieties on weed dry weight V_1 = BRRI dhan28, V_2= BRRI dhan29

Effect of *Albizia lebbeck* residues

Weed dry weight was significantly affected by *Albizia lebbeck* residues. The highest weed dry weight (2.12) was found in R_1 (residue @ 0 t ha^{-1}) treatment and the lowest weed dry weight (1.28) was found in R_4 (residue @ 3.0 t ha^{-1}) treatment at 25 DAT. In case of 50 DAT, the highest weed dry weight (15.45) was found in R_1 (residue @ 0 t ha^{-1}) treatment and the lowest weed dry weight (8.54) was found in R_4 (residue @ 3.0 t ha^{-1}) treatment (Fig. 4). Nomun *et al.* (2020) [19] reported significant weed control efficacy with different crop residues.

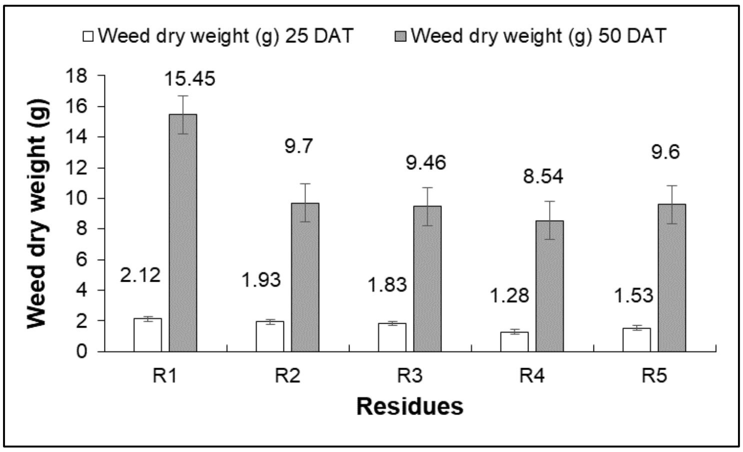

Fig 4: Effect of *Albizia lebbeck* residues on weed dry weight R_1= 0 t ha^{-1}, R_2= 1.0 t ha^{-1}, R_3= 2.0 t ha^{-1}, R_4= 3.0 t ha^{-1}, R_5= 4.0 t ha^{-1}

Effect of interaction between variety and *Albizia lebbeck* residues

The effect of interaction between variety and *Albizia lebbeck* residues was significantly affected by weed dry weight at 1% level of probability. The highest weed dry weight (2.70) was found in V_1R_1 (BRRI dhan28 × residue @ 0 t ha^{-1}) and the lowest (0.84) was found in V_2R_4 (BRRI dhan29 × residue @ 3.0 t ha^{-1}) combination at 25 DAT. At 50 DAT, the highest weed dry weight (15.58) was found in V_1R_1 (BRRI dhan28 × residue @ 0 t ha^{-1}) and the lowest (6.61) was found in V_2R_4 (BRRI dhan29 × residue @ 3 t ha^{-1}) combination (Table 3). Afroz *et al.* (2019) [1] supported these results and reported that weed dry weight was significantly influenced by interactions between varieties and residues.

Table 3. Effect of interaction between variety and *Albizia lebbeck* residues on weed dry weight

Interaction	Weed dry weight (g)	
	25 DAT	50 DAT
V_1R_1	2.70ab	15.58a
V_1R_2	2.58abc	10.59bcd
V_1R_3	0.99ef	12.59ab
V_1R_4	0.95ef	7.45de
V_1R_5	1.01ef	11.43bc
V_2R_1	1.73cde	15.31a
V_2R_2	1.68de	8.80cde
V_2R_3	1.28def	7.50de
V_2R_4	0.84f	6.61e
V_2R_5	1.05ef	9.64bcde
LSD $_{(0.05)}$	0.85	3.64
Level of significance	**	**
CV%	8.67	20.14

In a column, figures with the same letter do not differ significantly as per DMRT.
**= Significant at 1% level of probability. V_1= BRRI dhan28, V_2= BRRI dhan29
R_1= 0 t ha^{-1}, R_2= 1.0 t ha^{-1}, R_3= 2.0 t ha^{-1}, R_4= 3.0 t ha^{-1}, R_5= 4.0 t ha^{-1}

Conclusion

Weed density was significantly affected by the variety, leaf residues of *Albizia lebbeck* and interaction between variety with leaf residues of *Albizia lebbeck*. Weed dry weight were significantly affected by variety and *Albizia lebbeck* residues interaction though their individual treatment were non-significant by the variety at 25 DAT. Therefore, further experiments may be conducted with different doses of plant residues at Different Agro-ecological Zones of Bangladesh to draw a define conclusion.

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