Progressive Agriculture 30 (4): 379-386, 2019 **ISSN: 1017 - 8139**

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Allelopathic potential of marshpepper residues for weed management and yield of transplant *Aman* rice

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from June to December 2016 to evaluate the effect of marshpepper (*Polygonum hydropiper* L.) crop residues on weed management and crop performance of transplant *aman* rice. The experiment consisted of three cultivars viz. BR11, BRRI dhan33 and BRRI dhan49 and five marshpepper crop residues treatment such as 0, 1.0, 2.0, 3.0 ton ha^{-1} and hand weeding. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Five weed species belonging to four families infested the experimental plots. Weed population and weed dry weight were significantly affected by cultivar and crop residues treatment. The highest percent inhibition of all the studied weed was found by hand weeding. The second highest percent weed inhibition was found with the application of marshpepper residues at 3.0 t ha^{-1} which was 63.43, 63.43, 52.85, 52.40 and 59.12 percent for sabuj nakful (*Cyperus difformis*), chesra (*Scirpus juncoides*), shama (*Echinochloa crusgalli*) panikachu (*Monochoria vaginalis*) and panishapla (*Nymphaea nouchali*) respectively. The maximum weed growth was noticed with the cultivar BRRI dhan33 variety and the minimum was found in the cultivar BRRI dhan49. The grain yield as well as the yield contributing characters produced by BRRI dhan49 was the highest among the studied varieties. The highest reduction of grain yield was obtained in no crop residue treatment. The highest number of effective tillers $hill^{-1}$, number of grains $panicle^{-1}$, 1000-grain weight, grain and straw yields were observed in marshpepper residues in hand weeding followed by 3.0 t ha^{-1} marshpepper crop residue. BRRI dhan49 produced the highest grain and straw yields under hand weeding followed by marshpepper residues 3.0 t ha^{-1} treatment. Results of this study indicate that marshpepper residues showed potentiality to inhibit weed growth and it has a significant effect on the yield of transplant *aman* rice. Therefore, marshpepper residues might be used as an alternative way for weed management effective and sustainable crop production.

Key words: Rice varieties, number of weeds, inhibition, yield and harvest index

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Introduction

Rice (*Oryza sativa* L.) is the main food crop in Asia and the staple food of the majority of the population in many regions of the world. Rice is the most important food, eaten by more than half of the world's population. In the 2015-16 financial years, about 10.4 million ha of land of Bangladesh is used for rice cultivation with annual production of 33.83 million tons (BBS, 2015). The prevailing climatic and edaphic

conditions are very much favorable for luxuriant growth of numerous species of weeds that strongly compete with rice plant. High competitive ability of weeds exerts a serious negative effect on crop production causing significant losses in crop yield. Herbicides in combination with hand weeding would help to obtain higher crop yield but it creates high cost of production (Prasad and Rafy, 1995; Sathyamoorthy *et al*., 2004). Residue management is receiving a great deal of attention because of its diverse effects on soil physical, chemical, and biological properties. Besides weed control the quantities of nutrients that can be returned annually to soils as residues of common cultivated crops are considerable, requiring worthwhile consideration. Exploitation of allelopathic potential of different crop/plant species for weed management under field conditions is one such approach. Marshpepper (*Poligonum hydropiper*) is one of the strongest allelopathic weed through incorporation of its residue in soil to control weed. Crop allelopathy controls weeds by the release of allelochemicals from the living plants and/or through decomposition of phytotoxic plant residues (Belz, 2004; Khanh *et al*., 2005). Breeding programs to select strains that have allelopathic effects on weeds are in progress in some crops (Putnam and Duke, 1974). Cultivation of such strains may lead to decrease herbicide use and will be very helpful for sustainable agriculture. Total *aman* production of financial Year 2015-16 has been estimated 13.48 million tons compared to 13.19 million tons of financial year 2014-15 which is 2.22% higher (BBS, 2015). During *aman* season, uprooting of weeds at the critical periods is difficult due to unfavorable weather and peak labor demand that is way, weed infestation reduces the grain yield by 30-40% for transplanted *aman* rice cultivars (BRRI, 2008). By using phototoxic crop residues, our resource poor farmer will be benefited through reduction of weed control costs as well as maintain the good soil condition and no technical knowledge is needed to adapt this technique. Control of weeds in *T. aman* rice with environmentally sound weed management practices will increase crop productivity along with economically suitable practice Information regarding marshpepper residues for weed management is limited in Bangladesh. However, in the country, so far, a little approach has been done to work for feasible weed control achievements in this area. So the study deserves to keep the significance in the current research interest in home and abroad of marshpepper residual effects on weed control and yield performance to evaluate the effectiveness of marshpepper residues for suppressing weed growth and to determine the efficiency of marshpepper residues on yield performance in transplant *aman* rice.

Materials and Methods

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh from June 2016 to December 2016, located at $24^0$75' N latitude and 90^o50' E longitude at an elevation of 18 m above the mean sea level characterized by non-calcareous dark grey floodplain soil belonging to the Old Brahmaputra Floodplain, (AEZ-9). The soil of the experimental field was more or less neutral in reaction with pH value 6.8, low in organic matter and fertility level. The land type was medium high with silty loam in texture. The experiment consists of two factors including three varieties viz. V_1- BR11, V_2- BRRI dhan33 and V_3- BRRI dhan49 and five crop residues e.g. W_0- no crop residues (control), W_1- marshpepper crop residues 1.0 t ha^{-1}, W_2- marshpepper crop residues 2.0 t ha^{-1}, W_3- marshpepper crop residues 3.0 t ha^{-1} and W_4 -hand weeding in two times. A piece of land was selected for raising seedlings where the sprouted seeds were sown in three different nursery beds on 22 June 2016. After the preparation of the experimental land, uprooted seedlings were immediately transferred on 30 July 2016 as per treatment specifications. The experiment was laid out in a randomized complete block design with three replications. Thirty eight days old seedlings were transplanted in the well prepared field @ three seedlings $hill^{-1}$ maintaining row and hill distance were

25 cm and l5 cm, respectively. After collection of marshpepper crop residues, it was dried under shade in the covered threshing floor of Agronomy Field Laboratory of BAU. The studied crop residues were cut as small as possible by using sickle. Marshpepper residues were applied at 7 days before transplanting of rice at the time of final land preparation.

Data were collected on the basis of different parameters of rice and weeds. Among them percent inhibition shows the suppressing ability of marshpepper crop residues on weed.

Inhibition (%) =

$$\frac{\text{Dry weight of weed at control} - \text{Dry weight of weed from treatment}}{\text{Dry weight of weed at control}} \times 100$$

Data were also collected from rice on yield basis such as grain yield, straw yield, harvest index etc which showed the yield performance of rice. The recorded data were compiled and tabulated for 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.

Results and Discussion

***Infested weed species in the experimental field*:** Five weed species belonging to four 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.

Table 1. Infested weed species found growing in the experimental plots in rice.

Sl. No.	Local name	Scientific name	Family	Morphological type	Life cycle
1	Shama	*Echinochloa crusgalli*	Poaceae	Grass	Annual
2	Panisapla	*Nymphaea nouchali*	Nymphaeaceae	Broad leaved	Annual
3	Panikachu	*Monochoria vaginalis*	Pontederiaceae	Broad leaved	Perennial
4	Sabuj nakful	*Cyperus difformis*	Cyperaceae	Sedge	Annual
5	Chesra	*Scirpus juncoides*	Cyperaceae	Sedge	Annual

***Effect of variety on number and percent inhibition on different weeds*:** Variety shows the significant effect on number of weed population for all weed species. The lowest number of weeds was found in different varieties for different weeds (Table 2). On the other hand, percent inhibition was significantly affected by variety for all weed species. Shama (46.06), panisapla (42.98), sabuj nakful (54.32), chesra (46.55) were showed highest percent inhibition for V_3 and pani kachu (47.85) was found in V_2 variety (Table 2).

***Effect of marshpepper crop residues on number and percent inhibition on different weeds*:** Numbers of weed populations are significantly affected by the treatments for all weed species. Lowest weed population was found in W_4 treatments (Hand weeding) followed by W_3 treatment (Table 3). Highest percent inhibition was also found in W_4 treatment which is followed by W_3 treatment where bishkatali crop residues applied at $3tha^{-1}$. Numerically 52.85, 59.12, 59.40, 62.29, and 63.43 percent inhibition were found in shama, panisapla, panikachu, sabuj nakful, chesra respectively for W_3 treatment (Table 3). Percent inhibition of weed was the highest in buckwheat

residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1} (Afroz *et al.*, 2018).

***Combined effect of variety and marshpepper crop residues on number and percent inhibition on different weeds*:** Numbers of weed populations are significantly affected by the combined effect of variety and treatments for all weed species except shama. On the other hand, highest percent inhibition was also found in the V_3W_4 combination (Table 4).

Table 2. Effect of variety on number and percent inhibition on different weeds.

	Number of weed per quadrate (25×25) cm^2					% Inhibition				
Weed name	**Shama**	**Panisapla**	**Panikachu**	**Sabuj nakful**	**Chesra**	**Shama**	**Panisapla**	**Panikachu**	**Sabuj nakful**	**Chesra**
Variety										
v_1	5.13b	6.93b	11.33b	6.67b	14.47b	42.55b	37.96b	40.02b	51.47a	27.88b
v_2	6.73a	12.73a	15.07a	13.40a	23.47a	35.49c	39.35b	47.85a	38.56b	45.50ab
v_3	2.71c	3.13c	6.733c	4.00c	6.67c	46.06a	42.98a	47.52a	54.32a	46.55a
Level of significance	**	**	**	**	**	**	*	**	**	*
CV (%)	12.05	7.43	7.61	10.06	6.00	10.85	12.04	8.33	12.39	6.36

** =Significant at 1% level of probability, * =Significant at 5% level of probability, NS = Non significant; V_1 = BR 11, V_2 = BRRI dhaan33, V_3 = BRRI dhan49

Table 3. Effect of aqueous extract of marshpepper on number and percent inhibition on different weeds.

	Number of weed per quadrate (25×25) cm^2					% Inhibition				
Weed name	**Shama**	**Panisapla**	**Panikachu**	**Sabuj nakful**	**Chesra**	**Shama**	**Panisapla**	**Panikachu**	**Sabuj nakful**	**Chesra**
Treatments										
W_O	5.89a	10.22a	16.67a	10.33a	18.56a	0.00d	0.00c	0.00e	0.00d	0.00d
W_1	5.56a	7.77b	10.22b	9.22b	16.33b	30.68c	28.86b	28.91d	29.03c	28.01c
W_2	4.56b	8.22b	9.89b	7.44c	14.56c	49.09b	42.92b	50.29c	56.90bc	47.20c
W_3	4.28b	6.89c	9.67b	6.89cd	13.22d	52.85b	59.12a	59.40b	62.29ab	63.43b
W_4	4.02b	4.89d	8.78c	6.22d	11.67e	62.22a	59.12a	70.05a	67.37a	67.91a
Level of significance	**	**	**	**	**	**	**	**	**	**
CV (%)	12.05	7.43	7.61	10.06	6.00	10.85	12.04	8.33	12.39	6.36

In a column, figures with the same letter do not differ significantly as per DMRT. W_0 = No residudes, W_1 = marshpepper crop residues at 1.0 t ha^{-1}, W_2 = marshpepper crop residues at 2.0 t ha^{-1}, W_3 = marshpepper crop residues at 3.0 t ha^{-1}, W_4 = Hand weeding.

***Effect of variety on yield and yield contributing characters of rice*:** Varietal effect on yield and yield contributing characters of rice showed the significant effect**.** Highest number of total tillers and effective tillers hill^{-1}, higher number of grain panicle^{-1}, higher number of filled grain panicle^{-1}, highest straw yield was found in V_3 (BRRI dhan49) variety **(**Table 5). The highest grain yield (5.01 tha^{-1}) was obtained in V_3 followed by V_1 (4.81 tha^{-1}) (Figure 1).

Table 4. Combined effect of variety and aqueous extract of marshpepper on number and percent inhibition on different weeds.

	Number of weed per quadrate (25×25) cm^2					% Inhibition				
Weed name	**Shama**	**Panisapla**	**Panikachu**	**Sabuj nakful**	**Chesra**	**Shama**	**Panisapla**	**Panikachu**	**Sabuj nakful**	**Chesra**
Treatments										
V_1W_0	6.00	8.67e	15.00b	8.67d	18.00e	0.00g	0.00d	0.00h	0.00e	0.00f
V_1W_1	5.66	8.00e	11.33ef	7.67d	17.00e	44.21ef	38.34c	42.46g	59.54c	40.11e
V_1W_2	5.00	7.00f	10.33fg	6.00e	14.33f	50.00de	44.76c	43.36g	62.77bc	40.93e
V_1W_3	4.66	6.00g	10.33fg	5.67ef	12.33g	53.49cd	60.72b	55.00cde	67.00abc	68.75a
V_1W_4	4.33	5.00h	9.67g	5.333ef	10.67h	65.06b	45.97c	59.29bc	68.05abc	69.60a
V_2W_0	8.00	17.33a	21.67a	17.67a	28.33a	0.00g	0.00d	0.00h	0.00e	0.00f
V_2W_1	7.66	15.33b	14.00bc	15.33b	24.67b	41.13f	38.97c	48.87efg	41.80d	53.77c
V_2W_2	6.33	13.33c	13.33cd	12.00c	22.67c	43.55ef	40.27c	56.30cd	44.13d	53.85c
V_2W_3	6.00	11.00d	14.00bc	11.33c	21.67c	44.35ef	58.43b	60.00bc	48.04d	58.98b
V_2W_4	5.66	6.67fg	12.33de	10.67c	20.00d	48.39def	59.09b	74.08a	58.81c	60.90b
V_3W_0	3.66	4.67h	13.33cd	4.67efg	9.33h	0.00g	0.00d	0.00h	0.00e	0.00f
V_3W_1	3.33	0.00k	5.33h	4.67efg	7.33i	42.69ef	39.27c	46.40fg	60.76bc	50.14cd
V_3W_2	2.33	4.33hi	5.33h	4.33fg	6.67ij	53.70cd	43.72c	51.20def	63.79bc	46.83d
V_3W_3	2.16	3.67ij	5.33h	3.67gh	5.67jk	60.72bc	59.62b	63.19b	71.81ab	62.55b
V_3W_4	2.06	3.00j	4.33h	2.667h	4.33k	73.20a	72.31a	76.79a	75.26a	73.23a
Level of significance	NS	**	**	**	**	**	**	**	*	**
CV (%)	12.05	7.43	7.61	10.06	6.00	10.85	12.04	8.33	12.39	6.36

In a column, figures with the same letter do not differ significantly as per DMRT; ** =Significant at 1% level of probability, * =Significant at 5% level of probability, NS = Non significant; V_1 = BR 11, V_2 = BRRI dhaan33, V_3 = BRRI dhan49; W_0 = No residudes, W_1 = marshpepper crop residues at 1.0 t ha^{-1}, W_2 = marshpepper crop residues at 2.0 t ha^{-1}, W_3 = marshpepper crop residues at 3.0 t ha^{-1}, W_4 = Hand weeding.

Table 5. Effect of variety on yield and yield contributing characters of rice.

Variety	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non effective tillers hill^{-}	Panicle length (cm)	No. of filled grains panicle^{-1}	1000 grain weight (gm)	Straw yield (t ha^{-1})	Harvest index (%)
V_1	107.5a	9.060b	6.87b	2.193b	21.29	117.2b	20.49b	5.83b	45.87a
V_2	90.31c	6.760c	4.71c	2.047b	21.03	114.1b	18.28c	5.18c	44.16b
V_3	95.9b	11.15a	8.29a	2.867a	21.43	125.5a	22.48a	6.23a	44.57b
Level of significance	**	**	**	**	NS	**	**	**	**
CV (%)	2.30	5.03	3.88	14.96	2.83	4.30	6.41	2.73	2.26

In a column, figures with 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, NS = Not significant. V_1 = BR 11, V_2 = BRRI dhaan33, V_3 = BRRI dhan49.

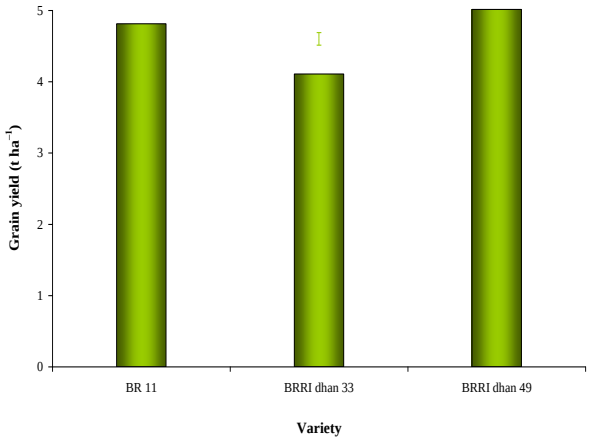

Figure 1. Grain yield as influenced by variety (Bar represents standard error mean)**;** V_1 = BR 11, V_2 = BRRI dhan33, V_3 = BRRI dhan49.

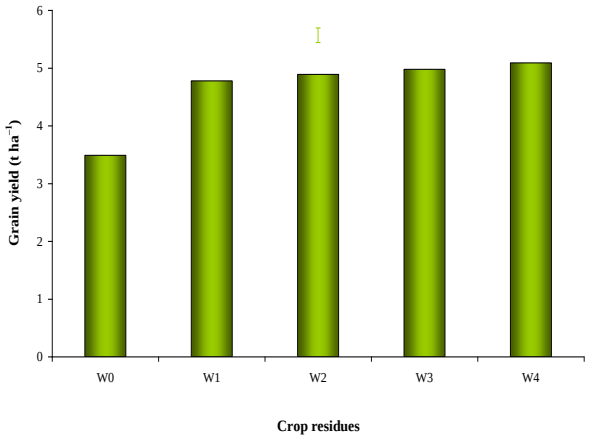

Figure 2. Grain yield as influenced by marshpepper residues treatment (Bar represents standard error mean); W_0= No residues, W_1= marshpepper residues at 1.0 t ha^{-1}, W_2= marshpepper residues at 2.0 t ha^{-1}, W_3= marshpepper residues at 3.0 t ha^{-1}, W_4= hand weeding.

***Effect of marshpepper crop residues on yield and yield contributing characters of rice*:** Marshpepper crop residues had also significant effect on yield and yield contributing characters. The highest grain yield (5.09 tha^{-1}) was produced by W_4 treatment, followed by W_3 (4.98 tha^{-1}) and lowest one (3.49 tha^{-1}) was produced by W_0 (no residue) treatment due to the production of higher number of effective tillers hill^{-1}, higher number of grain panicle^{-1}, higher number of filled grain panicle^{-1} (Table 6 and Figure 2)**.**

Uddin and Pyon (2010) also reported the similar results, where crop residues influenced in crop performance.

***Combined effects of variety and marshpepper crop residues on yield and yield contributing characters of rice*:** Yield and yield contributing characters like straw yield and grain yield were significantly affected by the interaction between variety and crop residues. V_3W_4 combination showed the maximum result and the lowest result was produced by V_2W_0 combination (Table 7).

Table 6. Effect of marshpepper residues on yield and yield contributing characters of rice.

Crop residues treatment	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	Panicle length (cm)	No. of filled grains panicle^{-1}	1000 grain weight (gm)	Straw yield (t ha^{-1})	Harvest index (%)
W_0	85.16c	6.422d	4.38d	20.82	112.5c	21.60b	4.48d	44.07b
W_1	100.1b	8.800c	6.49c	21.19	117.3bc	21.75ab	5.82c	45.05ab
W_2	100.8ab	9.678b	7.26b	21.30	118.1b	21.87a	5.99b	45.81a
W_3	101.1ab	9.867ab	7.39ab	21.35	121.3ab	21.95a	6.17a	44.66b
W_4	102.a	10.19a	7.60a	21.52	125.6a	22.06ab	6.28a	44.77b
Level of significance	**	**	**	NS	**	NS	**	**
CV (%)	2.30	5.03	3.88	2.83	4.30	2.35	2.73	2.26

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT; W_0 = No residues, W_1 = marshpepper crop residues at 1.0 t ha^{-1}, W_2 = marshpepper crop residues at 2.0 t ha^{-1}, W_3 = marshpepper crop residues at 3.0 t ha^{-1}, W_4 = Hand weeding, NS= Non significant, ** =Significant at 1% level of probability, * =Significant at 5% level of probability.

Table 7. Combined effect of variety and treatment on yield and yield contributing characters of rice.

Variety x Residues	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	Panicle length (cm)	No. of filled grains panicle^{-1}	1000 grain weight (gm)	Grain yield t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1W_0	93.80	6.33f	4.33f	20.11c	113.3	21.62	3.56g	4.53g	44.94bc
V_1W_1	109.3	8.63d	7.00d	21.16abc	115.3	21.82	5.00c	5.80de	46.29b
V_1W_2	110.7	9.66c	7.50c	21.60ab	117.0	21.98	5.06c	6.00d	48.46a
V_1W_3	110.3	10.00bc	7.50c	22.09a	118.0	22.02	5.10c	6.30c	44.74bc
V_1W_4	113.5	10.67b	8.00b	22.18a	122.4	22.20	5.33a	6.53abc	44.94bc
V_2W_0	75.77	5.26g	3.13g	21.20abc	101.3	20.19	3.13h	4.13h	43.12c
V_2W_1	93.30	6.10f	4.13f	21.24abc	111.3	20.21	4.20e	5.26f	44.37bc
V_2W_2	93.57	7.36e	5.27e	21.17abc	113.7	20..31	4.30de	5.43f	44.18c
V_2W_3	94.33	7.50e	5.47e	20.72bc	121.9	20.41	4.43d	5.53ef	44.48bc
V_2W_4	94.57	7.56e	5.57e	20.82bc	122.5	20.51	4.46d	5.53f	44.67bc
V_3W_0	85.90	7.66e	5.67e	21.15abc	122.7	22.98	3.76f	4.76g	44.14c
V_3W_1	97.73	11.67a	8.33b	21.18abc	125.2	23.21	5.13bc	6.40bc	44.50bc
V_3W_2	98.25	12.00a	9.00a	21.29ab	123.6	23..31	5.30ab	6.53abc	44.79bc
V_3W_3	98.59	12.10a	9.20a	21.25abc	124.0	23.41	5.40a	6.66ab	44.75bc
V_3W_4	99.41	12.33a	9.23a	21.57ab	131.8	23.48	5.46a	6.76a	44.69bc
Level of sig.	NS	**	**	*	NS	NS	**	**	*
CV (%)	2.30	5.03	3.88	2.83	4.30	2.35	2.10	2.73	2.26

In a column, figures with 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 = Not significant; V_1 = BR 11, V_2 = BRRI dhan 33, V_3 = BRRI dhan 49; W_0 = No residudes, W_1 = marshpepper crop residues at 1.0 t ha^{-1}, W_2 = marshpepper crop residues at 2.0 t ha^{-1}, W_3 = marshpepper crop residues at 3.0 t ha^{-1}, W_4 = Hand weeding.

The highest grain yield was produced by hand weeding, followed by aqueous extract of sorghum crop residues @ 1:20 ratio (Ahmed *et al.*, 2018).

Conclusion

To encapsulate, the incorporation of marshpepper crop residues significantly suppresses the weed population. The variety BRRI dhan49 with W_4 (hand weeding) treatment exhibited the superior effect followed by W_3. Results of the present study reveal that application of marshpepper residues before transplanting exhibited it may reduce weed and it has positive effect on yield for most of the studied traits. This will reduce the reliance on synthetic herbicides which otherwise may cause environmental and health-related problems, as well as the evolution of herbicide-resistant weeds in the near future. It is undeniable that application of marshpepper crop residues might be a successful weed management tool in this contemporary era.

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