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ORIGINAL RESEARCH ARTICLE

Combined allelopathic effect of buckwheat and marsh pepper residues on weed management and crop performance of transplant *aman* rice

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ABSTRACT

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from June to December 2016 to evaluate the suppression of weed growth through combined application of buckwheat and marsh pepper residues in transplant *aman* rice. The experiment consisted of three cultivars i.e. BRRI dhan56, Binadhan-12 and Nizershail, and five different crop residues with their combination such as no residues, 2.0 t ha^{-1} buckwheat residues, 2.0 t ha^{-1} marsh pepper residues, combined 0.5 t ha^{-1} buckwheat and 1.0 t ha^{-1} marsh pepper residues, combined 1.0 t ha^{-1} buckwheat and 0.5 t ha^{-1} marsh pepper residues. The experiment was laid out in a randomized complete block design with three replications. Weed population and weed dry weight were significantly affected by cultivars and crop residues treatment. The maximum weed growth was noticed with no residues treatment and the minimum was found in combined 0.5 t ha^{-1} buckwheat and 1.0 t ha^{-1} marsh pepper residues. The grain yield as well as the yield contributing characters produced at BRRI dhan 56 was the highest among the studied varieties. The highest reduction of grain yield was obtained in no residues) treatment and the lowest was obtained when combined 0.5 t ha^{-1} buckwheat and 1.0 t ha^{-1} marsh pepper residues were applied. The highest numbers of effective tillers hill^{-1}, number of grains panicle^{-1}, 1000-grain weight, and grain and straw yields were observed in W_3 treatment. BRRI dhan56 under 0.5 t ha^{-1} buckwheat and 1.0 t ha^{-1} marsh pepper residues treatment produced the highest grain yield. Results of this study indicates that combination of 0.5 t ha^{-1} buckwheat and 1.0 t ha^{-1} marsh pepper residues showed potentiality to suppress weed growth. Therefore, crop residues could be used as an alternative tool for sustainable weed management.

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INTRODUCTION

Bangladesh is an agricultural country with plenty of water and suitable climatic condition for rice production. In respect of the area and production, Bangladesh ranks fourth among the rice producing countries of the world following China, India and Indonesia (FAO, 2009). About 75.61% of cropped area of Bangladesh is used for rice production, with annual production of 33.83 million tons from 11.41 million hectares of land (BBS, 2013). Food production in Bangladesh is at far with increase in population growth. The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years which will require about 27.26 million tons of rice for the year 2020 (BBS, 2011). On the other hand, agricultural land is decreasing day by day. Average yield of rice is low compared with other rice producing countries like

China, Korea, Japan, Indonesia etc. and this is due to traditional local varieties, high weed infestation and poor crop management. Among these reasons high weed infestation are most serious problems for low production of rice. Hence there is strong need to use modern science along with indigenous wisdom of farmers to use crop residues of rice production.

Weeds are one of the worst biological constrains to rice cultures. Weed competes with rice plants severely for space, nutrient, air, water and light. So, it is often said that "Crop production is a fight against weeds" (Mukhopadhyay and Ghosh, 1981). High competitive ability of weeds exerts a serious negative effect on crop production causing significant losses in crop yield. In Bangladesh, weed infestation reduces the grain yield by, 70-80% in *aus* rice (early summer), 30-40% for transplanted *aman* rice (late summer) and 22-36% for modern *boro* rice cultivars (winter rice) (Mamun, 1990; BRRI, 2008). Many investigators have reported great losses in the yield of rice due to weed infestation in different parts of the world (Nandal and Singh, 1994). Weeds are very serious problem in transplanted rice (Walia *et al*., 2006). Therefore, weed management have been a major challenge for crop producers from the start of agriculture. The weed species are suppressed differently by residual effect. The term allelopathy denotes the toxic effect of chemicals which are produced by one plant to another. Allelo-chemicals are released from crop plants through leaching, decomposition, root exudates of plants (Inderjit *et al*., 1999). Allelopathic substances are most commonly found in plants extracts and in plant residues in soil, in live plant exudates and as volatile gases liberated from leaves and rhizomes (Keely, 1987). To determine the most cost-effective weed control method and sustainable crop production is the main theme in agricultural production system all over the world. Currently, researches are giving more emphasis using different crop residues to suppress weed growth. Information regarding crop residues for suppression of weed is very limited in Bangladesh. By using phytotoxic crop residues, our resource-poor farmers will be benefited through reduction of weed control cost as well as maintain the good soil condition and no technical knowledge is needed to adopt 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 buckwheat and marsh pepper residues for weed management is limited in our country. However, in our 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 buckwheat and marsh pepper residues residual effects on weed suppressing ability and yield performance of transplant *aman* rice.

MATERIALS AND METHODS

Experimental design and treatments

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh during the period from June 2016 to December 2017. The experimental site is located at 24°75' N latitude and 90°50' E longitude at an elevation of 18m above the mean sea level. The experimental area is characterized by non-calcareous dark grey floodplain soil belonging to the Sonatola Soil Series under the Old Brahmaputra Floodplain, Agro-Ecological Zone 9 (UNDP and FAO, 1988). 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 experimental treatments consists of three varieties such as BRRI dhan56 (V_1), Binadhan-12 (V_2), Nizershail (V_3) and five crop residues application viz. no crop residues (W_0), 2.0 t ha^{-1} buckwheat residues (W_1), 2.0 t ha^{-1} marsh pepper residues (W_2), 0.5 t ha^{-1} buckwheat and 1.0 t ha^{-1} marshpepper residues (W_3) and 1.0 t ha^{-1} buckwheat and 0.5 t ha^{-1} marshpepper residues (W_4). The experiment was laid out in a randomized complete block design with three replications.

Cultivation practices of rice

Buckwheat and Marsh pepper were grown at the Agronomy Field Laboratory, Bangladesh Agricultural University and were harvested at the time of ripening stage to collect crop residues. After collection, the crop residues were dried under shade. The studied crop residues were cut into pieces by using sickle. The field was ploughed with tractor followed by laddering. The experimental plots were fertilized with urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate @ 90, 52, 60, 45, 4 kg ha^{-1}, respectively. The entire amounts 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). The prepared buckwheat and marsh pepper residues were applied at 7 days before transplanting of *T. aman* rice. After that crop residues were mixed well with the soil to the respective plots. Thirty eight days old seedlings were transplanted in the well prepared puddled field on 30 July 2016 @ 3 seedlings hill^{-1}maintaining 25 cm × 15 cm spacing. The crops were harvested at full maturity. Then the harvested crops of each plot was bundled separately, properly tagged and brought to threshing floor. The crops were then threshed and the fresh weights of grain and straw were recorded from an area of 1 m^2 in the middle of each plot. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of grain and straw plot^{-1} were recorded and converted to t ha^{-1}.

Statistical analysis of data

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 as laid out by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Infested weed species in the experimental field

Five weed species belonging to 4 families infested the experimental field. The weeds of the experimental plots were *Echinochloa crusgalli, Scirpus juncoides, Monochoria vaginalis, Cyperus difformis* and *Nymphea nouchali*. Bari *et al*. (1995) in the experimental at BAU reported that the three important weeds of rice fields were *Echinochloa crusgalli, Scirpus juncoides and Cyperus difformis.*

Variety and crop residues interaction influence on Shama *(Echinochloa crusgalli)*

The interaction between variety and crop residues was found to be significant for weed population, dry weight and percent inhibition. The highest weed population (6.67) was found in V_3W_0 (Nizershail × no residues) followed by V_2W_0 and the lowest (0.47) was found in V_1W_3 (BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment (Table 1). The highest weed dry weight (7.15 g) was found in V_3W_0 (Nizershail × no residues), and the lowest weed dry weight (0.83) was in V_1W_3 (BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and Marsh pepper residues at 1.0 t ha^{-1}) treatment (Table 4). Percent inhibition of weed was the highest in V_1W_3 (BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and Marsh pepper residues at 1.0 t ha^{-1}) treatment and the lowest one was observed in V_3W_0 (Nizershail × no residues) treatment (Table 1).

Variety and crop residues interaction influence on Panikachu *(Monochoria vaginalis)*

The interaction between variety and crop residues was found to be significant of weed population, dry weight and percent inhibition. The highest weed population (17.33) was found in V_3W_0 (Nizershail × No residues) followed by V_1W_0 and the lowest was found in V_2W_2, V_2W_3, and V_2W_4 treatment (Table 2). The highest weed dry weight (9.19 g) was found in V_3W_0 (Nizershail × No residues), and the lowest weed dry weight (1.25) was in V_2W_2 (Binadhan-12 × Marsh pepper residues at 2.0 t ha^{-1}) treatment (Table 2). Percent inhibition of weed was the highest in V_2W_3 (Binadhan-12× Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment and the lowest one was observed in V_1W_0, V_2W_0, and V_3W_0 treatment (Table 2).

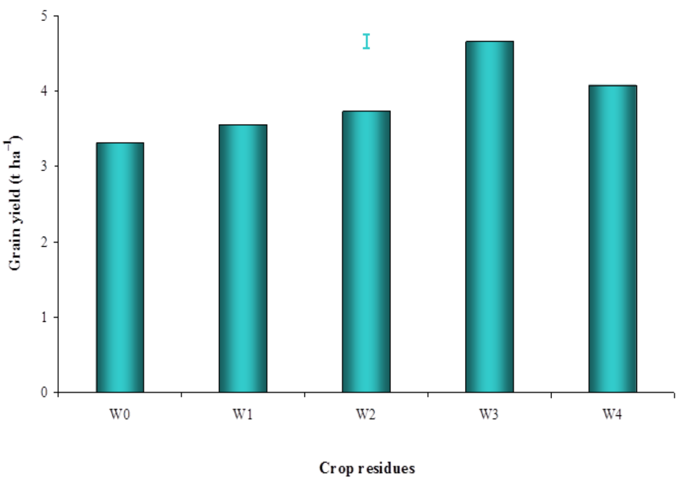

Figure 1. *Grain yield as influenced by variety (Bar represents standard error mean).*

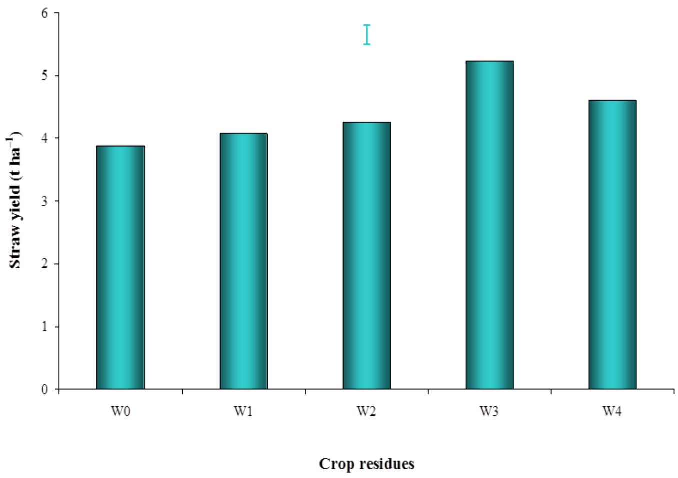

Figure 3. *Straw yield as influenced by variety (Bar represents standard error mean).*

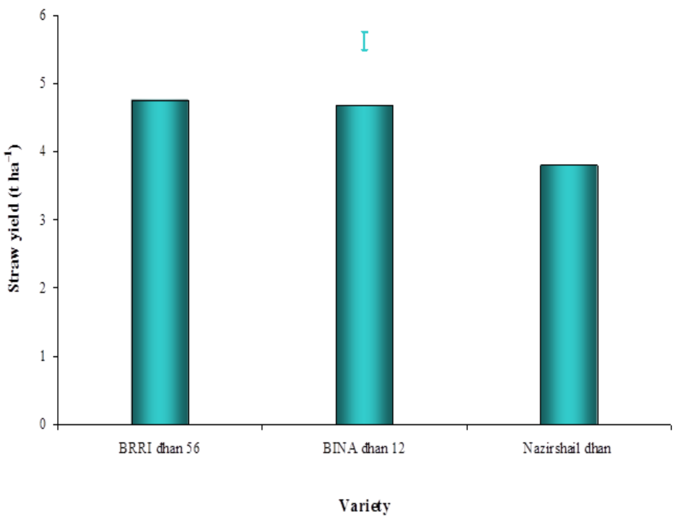

Figure 2. *Grain yield as influenced by buckwheat and marsh pepper residues (Bar represents standard error mean). W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1}, W_3= Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.*

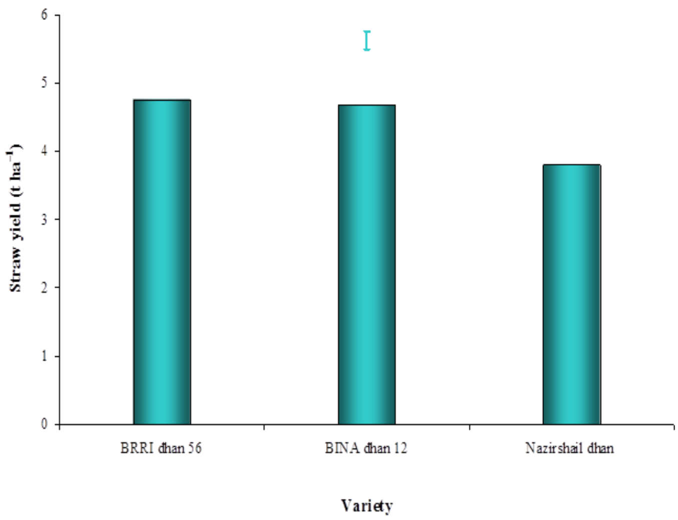

Figure 4. *Straw yield as influenced by buckwheat and marsh pepper residues treatment (Bar represents standard error mean).W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1} , W_3= Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.*

Variety and crop residues interaction influence on Pani shapla (*Nymphea nouchali)*

The interaction between variety and crop residues was found to be significant of weed population, dry weight and percent inhibition (Table 3). The highest weed population (33.33) was found in V_3W_0 (Nizershail × No residues) followed by V_2W_0 and the lowest (6.67) was found in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment (Table 3). The highest weed dry weight (6.67 g) was found in V_3W_0 (Nizershail × No residues), and the lowest weed dry weight (0.69) was in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment. Percent inhibition of weed was the highest in V_1W_3 (BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment and the lowest one was observed in V_1W_0, V_2W_0, and V_3W_0 treatment (Table 3).

Variety and crop residues interaction influence on sabuj nakphul *(Cyperus difformis)*

The interaction between variety and crop residues was found to be significant of weed population, dry weight and percent inhibition (Table 4). The highest weed population (22.67) was found in V_3W_0 (Nizershail × No residues) followed by V_1W_0 and the lowest (1.33) was found in V_2W_3 treatment (Table 4). The highest weed dry weight (9.13 g) was found in V_3W_0 (Nizershail × No residues), and the lowest weed dry weight (1.25) was in V_2W_2 (Binadhan-12 × Marsh pepper residues at 2.0 t ha^{-1}) treatment (Table 4). Percent inhibition of weed was the highest in V_2W_3 (Binadhan-12× Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment and the lowest was observed in V_1W_0, V_2W_0, and V_3W_0 treatment (Table 4).

Variety and crop residues interaction influence on Chechra *(Scirpus juncoides)*

The interaction between variety and crop residues was found to be significant of weed population, dry weight and percent inhibition (Table 5). The highest weed population (38.67) was found in V_3W_0 (Nizershail × no residues) followed by V_2W_0 and the lowest (6.67) was found in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment (Table 5). The highest weed dry weight (6.60 g) was found in V_3W_0 (Nizershail × No residues), and the lowest weed dry weight (0.57) was in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment (Table 5). Percent inhibition of weed was the highest in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment and the lowest was observed in V_3W_0, V_1W_0 and V_2W_0 treatment (Table 5).

Variety and crop residues interaction influence on yield contributing characters and yield

The effect of interaction between variety and crop residues was not significant for plant height (Table 6). Numerically, the tallest plant was obtained from Nizershail in buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1} and Binadhan-12 produced the shortest plant in no residues treatment. Significant variation was found in number of effective tillers hill^{-1} due to interaction between variety and crop residues (Table 6). The highest number of effective tillers hill^{-1} was produced by BRRI dhan56 in buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1} treatment, while the lowest number of effective tillers hill^{-1} was found from Nizershail in no residues treatment. Panicle length was not significantly influenced by variety and crop residues. However the longest panicle was observed in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) and the shortest one was found in V_3W_0 (Nizershail × no residues) treatment (Table 6).There was non-significant relationship among interaction of variety and crop residues in case of weight of 1000 grains . But apparently, the highest weight of 1000 grains was recorded in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment.

The studied different varieties significantly affected the grain yield. The highest grain yield (4.19 t ha^{-1}) was obtained in BRRI dhan56 (Figure 1) followed by Binadhan-12 (4.09 t ha^{-1}). The lowest grain yield (3.31 t ha^{-1}) was obtained in Nizershail (Figure 1). This difference was observed due to different varietal characteristics of rice plant. BRRI (2005) also reported variation in grain yield among the varieties. Grain yield was significantly influenced by buckwheat and marsh pepper residues. The highest grain yield (4.66 t ha^{-1}) was produced by Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1} treatment, followed by Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1} treatment (4.08 t ha^{-1}) and lowest one (3.31 t ha^{-1}) was produced by W_0(no residue) treatment (Figure 2). Uddin and Pyon (2010) also reported the similar results, where crop residues influenced in crop performance.

Straw yield was significantly influenced by three varieties. The highest straw yield (4.75 t ha^{-1}) was found in BRRI dhan56 followed by Binadhan-12 (4.66 t ha^{-1}) and the lowest straw yield (3.80 t ha^{-1}) was found in Nizershail (Figure 3). Straw yield was significantly influenced by buckwheat and marsh pepper residues. The highest straw yield (5.23) was observed in Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1} treatment and the lowest straw yield (3.88) was observed in W_0(no residues) treatment (Figure 4). Biological yield was significantly influenced by the interaction between variety and crop residues. The highest biological yield was produced by V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1})treatment and the lowest biological yield was produced by V_3W_0 (Nizershail × no residues) treatment (Table 6). Harvest index was significantly influenced by the interaction between variety and crop residues. The highest harvest index was observed in V_1W_3(BRRI dhan56 × Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment and the lowest harvest index was observed in V_3W_0 (Nizershail × No residues) treatment (Table 6).

Table 1. Combined effects of variety and buckwheat and marsh pepper residues on number, dry weight and percent inhibition of weed shama in *T. aman* rice.

Variety × Crop residues	Number of weed quadrate^{-1} (25×25) cm^2	Dry weight (g) of weed quadrate^{-1} (25×25) cm^2	% Inhibition of weed
V_1W_0	4.00 c	3.33 d	0.00 i
V_1W_1	1.33 e	1.98 gh	40.46 g
V_1W_2	1.00 ef	1.28 j	60.57 d
V_1W_3	0.47 g	0.83 k	74.88 a
V_1W_4	0.72 fg	1.06 jk	67.98 c
V_2W_0	5.33 b	4.12 c	0.00 i
V_2W_1	2.67 d	2.53 ef	38.50 g
V_2W_2	1.15 ef	1.68 hi	59.14 e
V_2W_3	0.72 fg	1.17 jk	70.52 b
V_2W_4	0.92 ef	1.36 ij	66.83 c
V_3W_0	6.67 a	7.15 a	0.00 i
V_3W_1	2.67 d	4.66 b	34.72 h
V_3W_2	1.33 e	3.16 d	55.70 f
V_3W_3	0.83 fg	2.28 fg	68.06 c
V_3W_4	1.02 ef	2.63 e	63.16 d
$LSD_{0.05}$	0.140	0.114	0.702
Level of sig.	**	**	**

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. Here, V_1= BRRI dhan56, V_2= Binadhan-12, V_3= Nizershail; W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1}, W_3= Buckwheat residues at 0.5 t ha^{-1} and Marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.

Table 2. Combined effects of variety and buckwheat and marsh pepper residues on number, dry weight and percent inhibition of weed panikachu in *T. aman* rice.

Variety × Crop residues	Number of weed quadrate^{-1} (25×25) cm^2	Dry weight (g) of weed quadrate^{-1} (25×25) cm^2	% Inhibition of weed
V_1W_0	14.67 b	4.83 b	0.00 h
V_1W_1	13.33 c	2.33 f	51.71f
V_1W_2	12.00 d	2.06 f	57.15 e
V_1W_3	6.67 h	1.28 g	73.41 b
V_1W_4	8.00 g	0.53 g	68.24 c
V_2W_0	12.00 d	3.31 d	0.00 h
V_2W_1	9.33 f	1.46 g	55.68 e
V_2W_2	5.33 i	1.25 g	62.25 d
V_2W_3	5.33 i	0.79 h	76.21 a
V_2W_4	5.33 i	1.27 g	61.69 d
V_3W_0	17.33 a	9.19 a	0.00 h
V_3W_1	13.33 c	5.12 b	44.27g
V_3W_2	12.00 d	4.13 c	55.03 e
V_3W_3	8.670 fg	2.70 e	70.62 c
V_3W_4	10.67 e	3.53 d	60.55 d
$LSD_{0.05}$	0.325	0.117	0.953
Level of sig.	**	**	**

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. Here,V_1= BRRI dhan56, V_2= Binadhan-12, V_3= Nizershail; W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1} , W_3= Buckwheat residues at 0.5 t ha^{-1} and Marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.

Table 3. Combined effects of variety and buckwheat and marsh pepper residues on number, dry weight and percent inhibition of weed pani shapla in *T. aman* rice.

Variety × Crop residues	Number of weed quadrate^{-1} (25×25) cm^2	Dry weight (g) of weed quadrate^{-1} (25×25) cm^2	% Inhibition of weed
V_1W_0	14.67 cd	3.11 d	0.00 j
V_1W_1	10.67 e	0.57 hi	49.35 h
V_1W_2	9.33 ef	1.20 j	61.35 e
V_1W_3	6.67 g	0.69 k	77.68 a
V_1W_4	9.3 ef	1.01 jk	67.29 c
V_2W_0	18.67 b	4.57 b	0.00 j
V_2W_1	14.67 cd	2.35 ef	48.62 h
V_2W_2	10.67 e	1.91 gh	58.09 f
V_2W_3	7.670 fg	1.24 ij	72.89 b
V_2W_4	10.67 e	1.61 h	64.65 d
V_3W_0	33.33 a	6.67 a	0.00 j
V_3W_1	16.00 c	3.61 c	45.82 i
V_3W_2	13.33 d	2.96 d	55.51 g
V_3W_3	9.330 ef	2.08 fg	68.76 c
V_3W_4	10.67 e	2.55 e	61.76 e
$LSD_{0.05}$	0.645	0.118	0.844
Level of sig.	**	**	**

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. Here, V_1= BRRI dhan56, V_2= Binadhan-12, V_3= Nizershail; W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1}, W_3= Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.

Table 4. Combined effects of variety and buckwheat and marshpepper residues on number, dry weight and percent inhibition of weed sabuj nakphul in *T. aman* rice.

Variety × Crop residues	Number of weed quadrate^{-1} (25×25) cm^2	Dry weight (g) of weed quadrate^{-1} (25×25) cm^2	% Inhibition of weed
V_1W_0	20.00 b	9.11 a	0.00 i
V_1W_1	8.00 f	5.73 b	37.08 h
V_1W_2	5.33 g	3.86 c	57.55 e
V_1W_3	2.67 h	2.53 e	72.19 ab
V_1W_4	5.33 g	2.83 de	68.89 cd
V_2W_0	10.67 d	3.13 d	0.00 i
V_2W_1	6.67 fg	1.75 f	44.09 g
V_2W_2	5.33 g	1.25 fg	60.09 e
V_2W_3	1.33 h	0.80 g	74.45 a
V_2W_4	2.67 h	0.93 g	70.19 bc
V_3W_0	22.67 a	9.13 a	0.00 i
V_3W_1	14.67 c	5.86 b	35.76 h
V_3W_2	9.33 e	4.31 c	52.81 f
V_3W_3	6.67 fg	2.75 de	69.88 bc
V_3W_4	6.67 g	3.06 de	66.42 d
$LSD_{0.05}$	0.445	0.184	1.03
Level of sig.	**	**	**

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. Here, V_1= BRRI dhan56, V_2= Binadhan-12, V_3= Nizershail; W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1}, W_3= Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.

Table 5. Combined effects of variety and buckwheat and marsh pepper residues on number, dry weight and percent inhibition of weed chechra in *T. aman* rice.

Variety × Crop residues	Number of weed quadrate^{-1} (25×25) cm^2	Dry weight (g) of weed quadrate^{-1} (25×25) cm^2	% Inhibition of weed
V_1W_0	21.33 d	6.27 a	0.00 h
V_1W_1	20.00 de	3.23 de	48.36 de
V_1W_2	18.67 e	2.59 g	58.56 bc
V_1W_3	6.67 h	0.57 i	74.79 a
V_1W_4	8.00 h	2.27 g	63.62 b
V_2W_0	28.00 b	6.31 a	0.00 h
V_2W_1	25.33 c	3.50 d	44.28 ef
V_2W_2	24.00 c	3.27 d	48.00 def
V_2W_3	8.00 h	1.93 h	69.32 a
V_2W_4	10.67 g	2.91 ef	53.63 cd
V_3W_0	38.67 a	6.60 a	0.00 h
V_3W_1	28.00 b	4.16 b	36.87 g
V_3W_2	25.33 c	3.83 c	41.92 fg
V_3W_3	14.67 f	2.59 fg	60.81 b
V_3W_4	25.33 c	3.45 d	47.73 def
$LSD_{0.05}$	0.690	0.110	1.94
Level of sig.	**	**	**

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. Here, V_1= BRRI dhan56, V_2= Binadhan-12, V_3= Nizershail; W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1}, W_3= Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.

Table 6. Combined effect of variety and treatment on yield and yield contributing characters of rice.

Variety ×Treatment	Plant height (cm)	No. of effective tillers hill^{-1}	Panicle length (cm)	1000 grain weight (g)	Biological yield (t ha^{-1})	Harvest index (%)
V_1W_0	117.73	6.53 de	23.32	21.83	7.87	46.18
V_1W_1	117.93	6.60 de	24.05	23.23	8.33	46.83
V_1W_2	120.67	7.87 b	24.46	24.40	8.69	46.97
V_1W_3	127.33	9.13 a	24.53	24.53	10.66	47.20
V_1W_4	123.07	8.93 a	24.53	24.43	9.25	47.04
V_2W_0	95.27	5.97 fg	23.16	21.60	7.63	46.07
V_2W_1	97.80	6.33 ef	23.91	22.30	8.10	46.49
V_2W_2	97.87	6.73 cde	23.91	23.30	8.40	46.84
V_2W_3	109.40	9.07 a	24.46	23.43	10.51	47.10
V_2W_4	98.60	7.20 c	24.40	23.37	9.19	46.97
V_3W_0	143.67	5.67 g	21.68	20.77	6.12	45.78
V_3W_1	148.07	6.23 ef	22.06	21.40	6.47	46.39
V_3W_2	149.00	6.53 de	22.14	22.17	6.86	46.32
V_3W_3	151.40	8.33 b	23.14	22.37	8.50	47.04
V_3W_4	149.60	6.87 cd	22.92	22.23	7.63	46.82
$LSD_{0.05}$	3.05	0.164	0.499	0.603	0.171	0.413
Level of sig.	NS	**	NS	NS	NS	NS
CV (%)	4.29	3.95	3.67	4.59	3.58	0.53

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; Here, V_1= BRRI dhan56, V_2= Binadhan-12, V_3= Nizershail; W_0= No residues, W_1= Buckwheat residues at 2.0 t ha^{-1}, W_2= Marsh pepper residues at 2.0 t ha^{-1}, W_3= Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}, W_4= Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}.

Conclusion

From the above results and discussion it was found that the variety BRRI dhan56 and W_3 (Buckwheat residues at 0.5 t ha^{-1} and marsh pepper residues at 1.0 t ha^{-1}) treatment exhibited the superior effect followed by Binadhan-12 and W_4(Buckwheat residues at 1.0 t ha^{-1} and marsh pepper residues at 0.5 t ha^{-1}) treatment for most of the studied traits. Results of present study reveal that combined effect of buckwheat and marsh pepper residues showed herbicidal activity for suppressing weed growth. Therefore, buckwheat and marsh pepper residues could be a potential source of weed management tool for sustainable crop production.

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