



Original Research

Weed suppression and crop performance of *T. aman* rice in response to combined application of lentil and grasspea crop residues

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from June to November 2018 to investigate the effect of application of lentil and grass pea crop residues on weed management and crop performance of *T. aman* rice. The experiment consisted of three variety i.e. BR11, BRRI dhan49 and Binadhan-7 and five treatments of crop residues such as no crop residues, lentil crop residue @ 2 t ha⁻¹, grass pea crop residue @ 2 t ha⁻¹, combination of lentil and grass pea @ 1 t ha⁻¹ of each and hand weeding. The experiment was laid out in a randomized complete block design with three replications. The maximum weed growth was noticed with the no crop residues treatment, the minimum was found in hand weeding. The highest percent weed inhibition of 83.95%, 80.87%, 82.21% and 81.49% was obtained from *Echinochloa crusgalli*, *Scirpus juncooides*, *Monochoria vaginalis* and *Marsilea quadrifolia* L. respectively caused by hand weeding. The grain yield as well as the yield contributing characters produced by BRRI dhan49 was the highest among the studied varieties. The highest production of grain yield was obtained by hand weeding, however, the second highest was obtained from a combination of lentil and grass pea @ 1 t ha⁻¹ of each was applied and the lowest production of grain yield was obtained in T₁ (no crop residues). BRRI dhan49 under combination of lentil and grass pea @ 1 t ha⁻¹ of each treatment produced the highest grain yield.

Introduction

Agrarian country Bangladesh enriched with plenty of water as well as suitable climatic condition for rice production. The annual production of rice is 35.30 million metric tons from 11.80 million acres of land (BBS, 2019). Food production in Bangladesh is at far with increase in population growth. Total *aman* production of financial year 2016-17 has been estimated 13.66 million metric tons compared to 13.02 million metric tons of financial year 2013-14 which is 4.64% higher (BBS,

2018). Sustainable weed management is a challenging task that causes substantial losses worldwide even more than the combined effect of insects, pests and diseases. In Bangladesh, weed infestation reduces the grain yield by 70-80% in *aus* rice, 30-40% for transplanted *aman* rice and 22-36% for modern *boro* rice varieties (Mamun, 1990; BRRI, 2008). Current agriculture is productivity-oriented and depends mostly on artificial inputs to deal with weeds and other pest problem (Sadeghi et al. 2010). Weeds are compromised in all yields as they vie for water, light, other supplements, harbor infections and creepy crawlies. High volumes of weed executioner utilization cause numerous adjustments in plant development like foliar chlorosis, hindrance of development, putrefaction and albinism (Subba et al. 2005). Many herbicides continue in the earth and initiate biomagnifications. So there is an increasing strength for originally produced products worldwide (Jamil et al. 2009). Herbicides planned from the plants will be biodegradable and they are more secure. Allelopathy holds possibilities for particular organic weed administrations. The procedure of allelopathy notices to concoction collaborations inside a wide range of plants. In this procedure the compound discharged or leachates exudates from stems, leaves or foundations of a plant can smother the advancement of a contiguous one (Scrivanti et al. 2011). Allelopathy is a lifelike phenomenon that takes place both in terrestrial and aquatic natural world (Kulmatiski, 2011) comprehended such interactions with both beneficiary and detrimental multiplicative inverse biochemical mode of action. Allelopathic crops exude diverse and numerous types of allelochemicals with potential to suppress weeds. It helps plants in strengthening their defence system against biotic and abiotic stress and also aids in regulating the nutrients transformations. Allelochemicals from several plants have been identified and their activities have also been established. Plant water extracts have been effective for weed control in several field crops (Cheema et al. 1997; Cheema et al. 2001; Cheema et al. 2002; Wazir et al. 2011). Other allelopathic weed management strategies for weed control in various crops may involve crop mulches (Cheema et al. 2000; Sarker et. al. 2020), soil incorporation of crop residues (Matloob et al. 2010), or the inclusion of crops with allelopathic potential in crop rotations (Einhellig and Rasmussen, 1989). Information regarding crop residues for suppression of weed is very limited in Bangladesh. However, in Bangladesh, so far, a little attempt has been done to exploit the allelopathy of plants for possible weed control purposes in the agriculture sector. In this study, an attempt has been made to examine the optimum dose and the influence of combined application of lentil and grass pea crop residues on weed dynamics, crop growth and yield performance of T. *Aman* rice.

Materials and Methods

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh from June to November 2018, located at 24°75' N latitude and 90°50' 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 variety (3): i) BRRI dhan49 ii) BR11 iii) Binadhan-7 and crop residues (5): i) No crop residues (control), ii) Lentil crop residues @ 2 t ha⁻¹ iii) Grass pea crop residues @ 2 t ha⁻¹ iv) Combination of lentil and grass pea @ 1 t ha⁻¹ of each and v) 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 24th June 2018. After the preparation of the experimental land, uprooted seedlings were immediately transferred to the main field on 28 July 2018 as per treatment specifications. The experiment was laid out in a randomized complete block design with three replications. Thus total numbers of plots were 45. Each plot size was (2.5 m × 2 m). Thirty eight days old seedlings were transplanted in the well prepared field where the rate of three seedlings hill⁻¹ maintaining row and hill distance were 25 cm and 15 cm, respectively. After collection of lentil and grass pea crop, 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. Lentil and grass pea crop residues were applied at 7 days before transplanting of rice at the time of final land preparation as per experimental specification. After that crop residues were mixed well to the respective plots with a spade to facilitate their decomposition.

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

$$\text{Inhibition (\%)} = \frac{\text{Dry weight of weed at control} - \text{Dry weight of weed from treatment}}{\text{Dry weight of weed at control}} \times 100$$

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 at 5 % probability level.

Results and Discussion

Infested weed species in the experimental field

Four 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. Ahmed et al. (2018) also reported some major weeds infestation in wheat field and their effective suppression by the application of sorghum crop residues.

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	<i>Echinochloa crusgalli</i>	Poaceae	Grass	Annual
2	Chechra	<i>Scirpus juncooides</i>	Cyperaceae	Sedge	Perennial
3	Pani kachu	<i>Monochoria vaginalis</i>	Pontederiaceae	Broad leaf	Perennial
4	Shusni shak	<i>Marsilea quadrifolia</i> L.	Marsileaaceae	Broad leaf	Annual

Effect of variety on number and percent inhibition on different weeds

The highest number of weeds was found in V₃ and the lowest number was found in V₁ variety (Table 2). On the other hand percent inhibition was significantly affected by variety for all weed species. *Echinochloa crusgalli*, *Marsilea quadrifolia* L were showed 48.43, 48.81 highest percent inhibition for V₁ and *Monochoria vaginalis*, *Scirpus juncooides* were found 48.07, 49.18 in V₃ variety (Table 2). This results support Pramanik et al. 2019 who showed that the percent inhibition of weed is significantly influenced by variety of transplanted *Aman* rice and residual effect of marshpepper.

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

Weed name	Weed per quadrate (25×25) cm ²				% Inhibition			
	Shama	Shusnishak	Panikachu	Chesra	Shama	Shusnishak	Panikachu	Chesra
Variety								
V ₁	2.66b	1.86	4.53	3.26	48.43a	48.81a	47.26b	47.25c
V ₂	3.46b	2.60	4.66	2.86	47.87ab	48.08a	48.03a	48.37b
V ₃	4.40a	2.60	4.2	3.60	47.44b	46.49b	48.07a	49.18a
LSD _{0.05}	0.89	0.94	0.79	1.19	0.71	0.75	0.63	0.60
Level of significance	**	NS	NS	NS	**	**	*	**

Here, 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, V₁= BRRI dhan49, V₂= BR11, V₃= Binadhan-7

Effect of crop residues on number and percent inhibition on different weeds

Numbers of weed populations were significantly affected by the treatments for all weed species except *Scirpus juncooides*. Weeds can be suppressed by physical hindrance or by posing chemical (allelopathy) secreted by mulching of crop residues (Khaliq et al. 2015; Reddy, 2001). The lowest weed population was found in T₅ treatment (Hand weeding) and the highest was found by T₁ treatment (Table 3). The highest percent inhibition was also found in T₅ treatment which is followed by T₄ treatment where combination of lentil and grass pea crop residues applied at 1 t ha⁻¹ each. Numerically 63.57, 64.22, 65.56 and 65.96 percent inhibition were found in *Echinochloa crusgalli*, *Masilea quadrifolia* L., *Monochoria vaginalis*, *Scirpus juncooides* respectively for T₄ treatment (Table 3).

Table 3. Effect of crop residues on number and percent inhibition on different weeds.

Weed name	Weed per quadrat (25×25) cm ²				% Inhibition			
	Shama	Shusnishak	Panikachu	Chesra	Shama	Shusnishak	Panikachu	Chesra
Treatments								
T ₁	4.66a	3.22a	6.33a	4.33	0.00e	0.000e	0.000e	0.000e
T ₂	3.66ab	2.44abc	5.00b	3.33	41.63d	44.36d	41.34d	41.79d
T ₃	4.11ab	2.66ab	5.11b	3.66	52.13c	51.19c	51.18c	53.68c
T ₄	3.11bc	2.00bc	3.55c	2.77	63.57b	64.22b	65.56b	65.96b
T ₅	2.00c	1.44c	2.33d	2.11	83.95a	81.49a	82.21a	80.87a
LSD _{0.05}	1.16	1.22	1.02	1.54	0.92	0.97	0.81	0.79
Level of sig.	**	*	**	NS	**	**	**	**

Here, 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, T₁=No crop residues, T₂= Lentil crop residues @ 2.0 t ha⁻¹, T₃= Grass pea crop residues @ 2.0 t ha⁻¹, T₄=Combination of lentil and grass pea @ 1 t ha⁻¹ of each, T₅= Hand weeding.

Combined effect of variety and crop residues on number and percent inhibition on different weeds

The highest percent inhibition for *Echinochloa crusgalli*, *Masilea quadrifolia* L., *Monochoria vaginalis* was also found in the V₁T₅ combination. For *Scirpus juncooides* V₃T₅ shows the highest combined effect of variety and crop residues on percent inhibition (Table 4).

Effect of variety on yield and yield contributing characters of rice

Varietal effect on yield and yield contributing characters of rice showed a significant effect. The highest number of total tillers and effective tillers hill⁻¹, panicle length, higher number of grain panicle⁻¹ was found in V₁ (BRRI dhan49) variety (Table 5). The highest grain yield (4.62 t.ha⁻¹) was

obtained in V_1 followed by V_3 (4.37 t ha^{-1}) (Figure 1). The highest straw yield was found in V_2 (Figure 3) but the lowest number of grain yield was found in V_2 (3.8) (Figure 1). It was reported that variety significantly differed in respect of grain yield and BR11 showed highest yield of 4.09 t ha^{-1} (Hossain et al. 2017).

Table 4. Combined effect of variety and crop residues on number and percent inhibition on different weeds.

Weed name	Weed per quadrat (25×25) cm ²				% Inhibition			
	Shama	Shusnishak	Panikachu	Chesra	Shama	Shusnishak	Panikachu	Chesra
Treatments								
V_1T_1	4.00	2.33	6.00	4.00	0.000g	0.000i	0.000g	0.000h
V_1T_2	2.33	2.00	5.00	3.33	42.27e	43.35g	40.10f	40.98g
V_1T_3	3.00	2.00	5.66	3.66	52.03d	51.14f	50.68e	52.71f
V_1T_4	2.66	1.66	4.00	3.00	62.48c	66.16c	62.28d	62.54e
V_1T_5	1.33	1.33	2.00	2.33	85.40a	83.42a	83.23a	80.02b
V_2T_1	4.33	4.00	6.66	4.33	0.000g	0.000i	0.000g	0.000h
V_2T_2	3.66	2.66	5.00	3.00	40.24f	42.97gh	41.12f	41.47g
V_2T_3	4.00	3.00	5.66	3.33	52.21d	51.12f	51.11e	54.02f
V_2T_4	3.33	2.00	3.33	2.33	63.90c	64.37d	66.51c	65.90d
V_2T_5	2.00	1.33	2.66	1.33	83.02b	81.95a	81.43b	80.46ab
V_3T_1	5.66	3.33	6.33	4.66	0.000g	0.000i	0.000g	0.000h
V_3T_2	5.00	2.66	5.00	3.66	40.90ef	41.43h	41.44f	42.01g
V_3T_3	5.33	3.00	4.00	4.00	50.67d	49.99f	50.58e	53.59f
V_3T_4	3.33	2.33	3.33	3.00	63.16c	60.96e	66.89c	68.68c
V_3T_5	2.66	1.66	2.33	2.66	82.50b	80.07b	81.43b	81.61a
LSD _{0.05}	2.01	2.11	1.76	2.67	1.60	1.68	1.40	1.35
Level of significance	NS	NS	NS	NS	**	**	**	**

Here, in a column, figures with the same letter do not differ significantly as per DMRT. ** = Significant at 1% level of probability, NS = Not significant, V_1 =BRRI dhan49, V_2 =BR11, V_3 = Binadhan-7, T_1 =No crop residues, T_2 = Lentil crop residues @ 2.0 t ha^{-1} , T_3 = Grass pea crop residues @ 2.0 t ha^{-1} , T_4 = Combination of lentil and grass pea @ 1 t ha^{-1} of each, T_5 = Hand weeding.

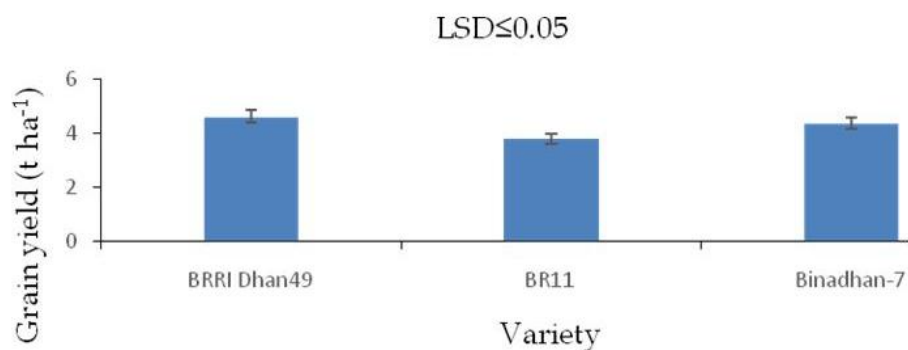


Figure 1. Grain yield as influenced by variety (Bar represents standard error of means).

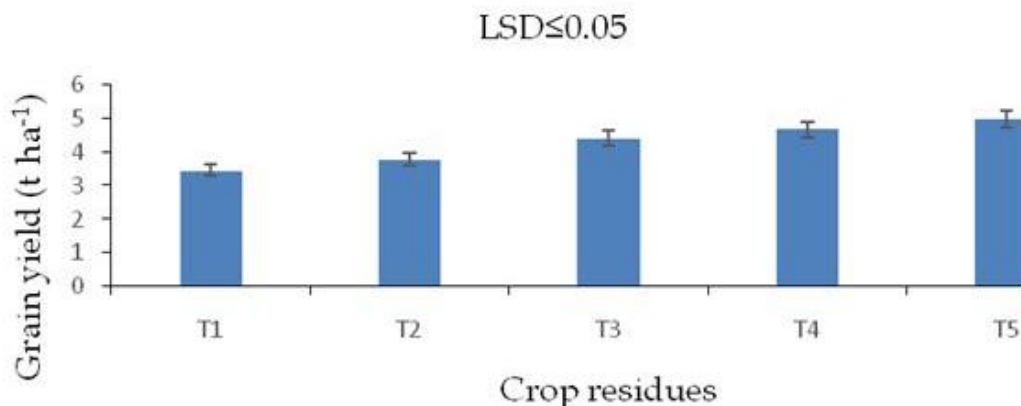


Figure 2. Grain yield as influenced by crop residues (Bar represents standard error of means). Here, T₁= No crop residues, T₂ = Lentil crop residues 2.0 t ha⁻¹, T₃ = Grass pea crop residues 2.0 t ha⁻¹, T₄ = Combination of lentil and grass pea @ 1 t ha⁻¹ of each, T₅ = Hand weeding.

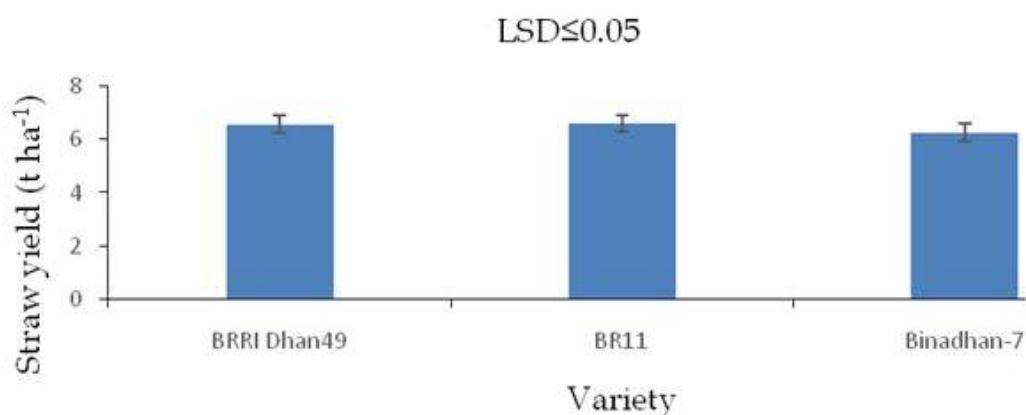


Figure 3. Straw yield as influenced by variety (Bar represents standard error of means).

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

Variety	Plant height (cm)	Total tillers hill ⁻¹ (no.)	Effective tillers hill ⁻¹ (no.)	Panicle length (cm)	Grains panicle ⁻¹ (no.)	1000-grain weight (g)	Biological yield (t ha ⁻¹)	Harvest index (%)
V ₁	105.67b	10.67a	9.55a	21.92a	94.41a	22.56a	10.68a	48.22
V ₂	118.81a	9.14b	8.10b	20.97b	85.41b	21.86b	9.56c	48.59
V ₃	102.78c	10.53a	9.29a	21.12b	84.98b	21.75b	9.91b	48.50
LSD _{0.05}	1.89	0.27	0.29	0.73	7.98	0.63	0.08	0.54
Level of sig.	**	**	**	*	*	*	**	**

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. V₁ = BRRI dhan49, V₂ = BR11, V₃ = Binadhan-7, ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = not significant.

Effect of crop residues on yield and yield contributing characters of rice

Crop residues had also significant effect on yield and yield contributing characters. The highest grain yield (4.99 tha⁻¹) was produced by T₅ treatment, followed by T₄ (4.68 tha⁻¹) and the lowest

one (3.46 t ha^{-1}) was produced by T_1 (no residue) treatment due to the production of higher number of effective tillers hill^{-1} and higher number of grain panicle $^{-1}$ (Table 6 and Figure 2). Uddin and Pyon (2010) also reported the similar results, where crop residues influenced in crop performance. The highest straw yield (7.15) was found by T_5 followed by T_4 treatment (6.79) (Figure 4).

Table 6. Effect of crop residues on yield and yield contributing characters of *T. aman* rice.

Crop residues	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle $^{-1}$ (no.)	1000-grain weight (g)	Biological yield (t ha^{-1})	Harvest index (%)
T_1	110.33a	8.95d	7.84d	20.64	81.68c	21.96ab	8.24e	47.93c
T_2	110.29a	9.80c	8.63c	21.92	83.55bc	22.22ab	9.01d	48.75ab
T_3	109.29a	9.96c	8.94c	21.54	84.48bc	21.48b	10.26c	49.35a
T_4	106.80b	10.49b	9.49b	21.03	92.25ab	22.01ab	11.08b	47.76c
T_5	108.73ab	11.35a	10.01a	21.55	99.37a	22.62a	11.66a	48.40bc
LSD _{0.05}	2.44	0.35	0.37	0.94	10.31	0.81	0.10	0.70
Level of sig.	**	**	**	NS	**	*	**	**

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 = not significant. T_1 = No crop residues, T_2 = Lentil crop residues 2.0 t ha^{-1} , T_3 = Grass pea crop residues 2.0 t ha^{-1} , T_4 = Combination of lentil and grass pea @ 1 t ha^{-1} of each, T_5 = Hand weeding.

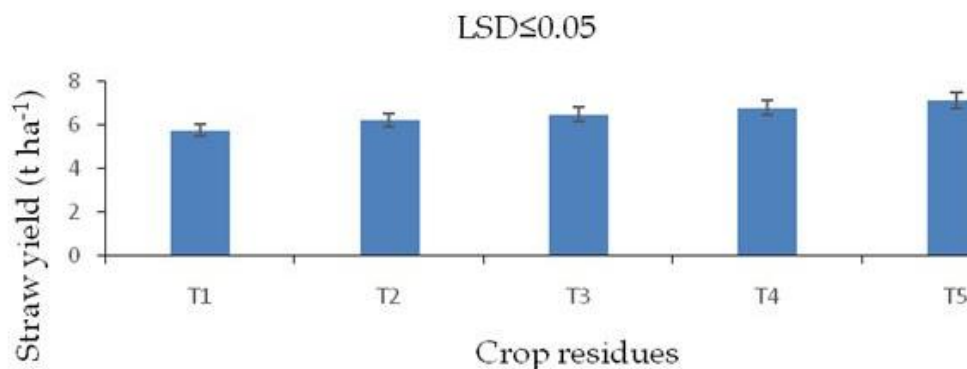


Figure 4. Straw yield as influenced by crop residues (Bar represents standard error of means). Here, T_1 = No crop residues, T_2 = Lentil crop residues 2.0 t ha^{-1} , T_3 = Grass pea crop residues 2.0 t ha^{-1} , T_4 = Combination of lentil and grass pea @ 1 t ha^{-1} of each, T_5 = Hand weeding.

Combined effects of variety and 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_1T_5 combination showed the maximum result (grain and straw yield) followed by V_1T_4 and the lowest result was produced by

V₂T₁ combination. (Table 7). It was reported that BRRI dhan56 under buckwheat crop residues 5 t/ha and marsh pepper residues at 1 t/ha produced the highest grain yield (Afroz et al. 2018).

Table 7. Combined effect of variety and crop residues on yield and yield contributing characters of *T. aman* rice.

Treatment	Plant height (cm)	Total tillers hill ⁻¹	Effective tillers hill ⁻¹	Panicle length (cm)	Grains panicle ⁻¹	1000-grain weight (g)	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index(%)
V ₁ T ₁	105.70 cd	9.11 hij	8.43 f	21.85	86.07	22.61 ab	4.33 h	4.56 h	8.90 j	48.68 b-f
V ₁ T ₂	107.34 c	9.77 efg	8.66 ef	22.40	87.82	21.89 bc	4.58 g	5.03 fg	9.62 i	47.64 fgh
V ₁ T ₃	105.43 cd	10.17 def	9.34 cd	21.99	89.59	22.43 ab	5.22 d	5.55 de	10.77 e	48.50 b-g
V ₁ T ₄	107.23 c	11.22 bc	10.37 ab	21.04	96.69	22.36 ab	5.65 b	6.17 b	11.82 b	47.81d-h
V ₁ T ₅	102.66 de	13.07 a	10.97 a	22.32	111.92	23.51 a	5.96 a	6.33 a	12.29 a	48.48 c-g
V ₂ T ₁	122.09 a	8.66 j	7.33 h	20.62	81.69	20.71 cd	3.65 k	4.13 j	7.78 m	46.96 h
V ₂ T ₂	120.31 a	9.33 ghi	8.06 fg	21.59	81.53	22.24 ab	4.19 i	4.37 i	8.56 k	48.93 a-e
V ₂ T ₃	118.47 a	9.05 ij	7.73 gh	20.38	85.55	21.60 bcd	4.94 f	4.95 g	9.90 h	49.93a
V ₂ T ₄	112.97 b	8.99 ij	8.33 fg	21.41	85.96	22.04 bc	5.05 ef	5.44 e	10.49 f	48.17 d-g
V ₂ T ₅	120.19 a	9.66 fgh	9.08 de	20.87	92.33	22.71 ab	5.43 c	5.66 cd	11.09 d	48.97 a-d
V ₃ T ₁	103.19 cde	9.07 hij	7.77 gh	19.46	77.29	22.55 ab	3.87 j	4.16 j	8.03 l	48.15 d-h
V ₃ T ₂	103.21cde	10.29 de	9.18 cde	21.78	81.33	22.53 ab	4.40 h	4.45 hi	8.85 j	49.69 ab
V ₃ T ₃	103.97 cde	10.66 cd	9.74 bc	22.25	78.31	20.41 d	5.02 f	5.10 f	10.13 g	49.62 abc
V ₃ T ₄	100.20 e	11.27 b	9.77 bc	20.66	94.11	21.62 bcd	5.17 de	5.76 c	10.93 de	47.30 gh
V ₃ T ₅	103.32 cde	11.33 b	10.00 b	21.47	93.88	21.65 bcd	5.53 bc	6.06 b	11.59 c	47.74 e-h
LSD _{0.05}	4.23	0.59	0.64	1.64	17.87	1.40	0.14	0.14	0.17	1.21
Level of sig.	*	**	**	NS	NS	*	**	**	**	**

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Conclusion

To recapitulate, the incorporation of crop residues significantly suppresses the weed population. The variety BRRI dhan49 with T₄ (combination of lentil and grass pea @ 1 t ha⁻¹ of each) performed better than separate application of each residues. Results of the present study divulge that combined application of lentil and grass pea residues had a synergistic effect. The strong weed suppressing ability of these two combined natural products offers interesting possibilities for effective bio approaches to weed management.

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Conflicts of Interest

The authors have declared no conflicts of interest.

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