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Effect of Sunflower Crop Residues on Weed Management in Transplanted Aman Rice

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ABSTRACT

Sunflower (*Helianthus annuus*) is one of the strongest allelopathic crops through incorporation of its residue in soil to control weed. An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from June to December 2017 to evaluate the effect of sunflower crop residues on weed management and performance of transplanted *aman* rice. The experiment consisted of four sunflower residues such as 0, 0.5, 1.0, 2.0 t ha^{-1} and four rice varieties i.e; BRRI dhan57, Binadhan-7, Binadhan-15 and Binadhan-16.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 weed inhibition was found in sunflower crop residues at 2 t ha^{-1} treatment which was 47.29, 52.03, 51.28, 71.41 and 70.44 percent for Shama *(Echinochloa crusgalli)*, Amrul (*Oxalis corniculata* L.), Panikachu (*Monochoria vaginalis*, Sabujnakful *(Cyperus difformis)* and Chesra *(Scirpus juncoides)*, respectively. The maximum weed growth was noticed with the cultivar BRRI dhan57 variety and the minimum was found in the cultivar Binadhan-16. The grain yield as well as the yield contributing characters produced by Binadhan-16 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 sunflower residues at 2.0 t ha^{-1} treatment. Binadhan-16 produced the highest grain and straw yields with sunflower residues 2.0 t ha^{-1}treatment. Results of this study indicate that sunflower residues showed potentiality to inhibit weed growth and it has a significant effect on the yield of transplanted *aman* rice. Therefore, sunflower residues might be used as an alternative way for weed management effective as well as obtaining higher yield of T. *aman* rice.

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Introduction

Rice (*Oryza sativa* L.) is the most important cereal grain in the diets of billions of people all over the world. In Asia, where 90% of rice is consumed, ensuring there is enough affordable rice for everyone. In Africa and Latin America, rice is becoming a more important staple food too (IRRI, 2015). In the 2018-19 financial year, about 11.8 million ha of land of Bangladesh was used for rice cultivation with annual production of 34.91 million tons (BBS, 2018). But now-days the yield of rice in Bangladesh is much lower than other rice growing countries of the world. The prevailing climatic and edaphic factors of Bangladesh are highly favorable for luxuriant growth of numerous species of weed, which offer a keen competition with rice crop. When weed control is neglected, there is a decrease in yield because of weeds even if other means of increasing production, including application of fertilizers are practiced due to weeds compete with crop plants for light, nutrients, water and space. In Bangladesh, manual hand weeding is still significantly practiced by farmers all over. Availability of Agricultural labor decrease progressively as workers migrates to cities or abroad to engage in more remunerative employment (Zhang *et al.,* 2014).As a result farmers face problem of labor shortage and increasing cost of production .Due to cost, difficulty of performance and limitation of labor at the proper time, hand weeding method isnot economical. Chemical weed control is becoming popular than hand weeding due to labor scarcity (Ahmed *et al*., 2011; Hasanuzzaman *et al*., 2008). But incessant uses of herbicide risks tend to

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develop of genetic resistance of weed. Furthermore, use of particular one herbicide does not control all kinds of weeds. Labrada (2002) stated that Butachlor used for weed control in transplant rice that efficiently control annual grasses but not able to control sedges and non-grass weed species. As a result resistant weed species compete with the crop and cause heavy yield losses (Singh *et al.,* 2004).It was also established that, even after the application of pre-and post-emergence herbicides, it was not enough to achieve adequate weed control in direct seeded rice (Chauhan *et al.,*2015).

Sunflower (*Helianthus annuus*) has allelopathic effect through incorporation of its residue in soil to control weed. Crop residues are defined as crop or its parts left in field for decomposition after it has been thrashed or harvested (Kumar and Goh, 2000). Earlier these were regarded merely as waste, but now because of their usefulness they are considered an important resource that can bring significant physical, chemical, and biological changes in the agricultural soil after amendment. 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). The incidence of growth inhibition of certain weeds and the induction of phytotoxic symptoms by plants and their residues is well documented for many crops, including all major grain crops such as rice, rye, barley, sorghum, wheat, mustard, marshpepper, hairy vetch, buckwheat and other crop residues (Uddin *et al.,* 2010; Won *et al.,* 2011; Uddin *et al.,* 2012; Uddin *et al.,* 2014; Ahmed *et al.,* 2018; Pramanik *et al.,* 2019; Sarker *et al.,* 2020). Crop residues can interfere with weed development and growth through alteration of soil physical, chemical, and biological characteristics. Allelopathy is inferred to be important in agro-ecosystems. Crop losses by weeds are partially caused by allelopathic effects of weeds (Rice, 1984), though it is very difficult to separate the allelopathic effects from competition for resources in fields. On the other hand, 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.To overcome weed infestation, presently researchers are giving more emphasis using different crop residues to suppress weed growth. Based on this information, the present study isundertaken to find out the consequence of sunflower crop residues on weed management and yield performance of transplanted *aman* rice.

Materials and Methods

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from June to December 2017. The experiment consisted of four sunflower residues such as 0, 0.5, 1.0, 2.0 t ha^{-1} and four rice varieties i.e; BRRI dhan57, Binadhan-7, Binadhan-15 and Binadhan-16. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Thus total numbers of plots were 48. Each plot size was (2.5 m × 2.0 m). The field was ploughed with tractor drawn plough followed by laddering. The studied crop residues were collected three months before application in the field. The collected residues were cut as small as possible by using sickle and preserved in polythene bag. The prepared sunflower crop residues were applied at 7 days before transplanting *aman* rice at the time of final land preparation. The experimental plots were fertilized with N, P, K, S and Zn @ @ 66, 4, 29, 6 and 1 kg ha^{-1}, respectively. All the fertilizers applied at the time of final land preparation except N and N was applied at three split at 15, 30 and 45 days after transplanting (DAT). Thirty days old seedlings were transplanted in the well prepared puddle field on 7 August 2017 @ three seedlings hill^{-1} maintaining row and hill distance of 25 cm and 15 cm, respectively. Data on weed population were collected from each plot of the rice plants by using 0.25 m × 0.25 m quadrate as per method described by Cruz *et al.* (1986). The weeds within the quadrate were counted in number m^{-2} area. After attaining full maturity, BRRI dhan57 and Binadhan-16 were harvested on 10 November 2017. Binadhan-7 and Binadhan-15 was harvested on 27 November 2017. Data on grain and straw yields were collected from an area of l m^2 in each plot. The data on other crop characters were randomly sampled from the region outside 1 m^2 area (excluding the border hills) which was kept for taking yield and yield attributes of rice.

Table.1 Infested weed species found 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	Amrul	*Oxalis corniculata*L.	Oxalidaceae	Slender	Perennial
3	Panikachu	*Monochoria vaginalis*	Pontederiaceae	Broad leaved	Perennial
4	Sabujnakful	*Cyperus difformis*	Cyperaceae	Sedge	Annual
5	Chesra	*Scirpus juncoides*	Cyperaceae	Sedge	Annual

Data recorded for different parameters were compiled and tabulated in proper form and subjected to statistical analysis. The analysis of variance was done with the help of computer package MSTAT-C program. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT) as laid out by Gomez and Gomez (1984).

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. The weeds of the experimental plots were *Echinochloa crusgalli*, *Oxalis corniculata, Monochoria vaginalis*, *Cyperus difformis* and *Scirpus juncoides*. There were two perennial and three annual weed species in the experimental plot.

Interaction effect between variety and sunflower residues on Echinochloa crusgalli

The effect of interaction between variety and sunflower residues was found significant for shama (*Echinochloa crusgalli)* weed population, dry weight and percent inhibition. The highest weed population (13.67) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed population (4.67) was found in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). The highest weed dry weight (21.43 g) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed dry weight (9.23 g) was in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). Percent inhibition of weed was the highest in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) and the lowest one was observed in V_1C_1 (BRRI dhan57 × No crop residues) treatment (Table 2). Hossain *et al.* (2017) found that the highest percent inhibition of 71.17, 69.19, 80.88, 70.48 and 86.97 was in Shama *(Echinochlo acrusgalli*), Panishapla (*Nymphaea nouchali)*, Panichaise (*Scirpus juncoides)*, Panikachu (*Monochoria vaginalis)* and Susnishak *(Marsilea quadrifolia)*, respectively which was caused by the application of mustard crop residues @ 2 t ha^{-1}.

Interaction effect between variety and sunflower residues on Oxalis corniculata

The effect of interaction between variety and sunflower residues was found significant for amrul (*Oxalis corniculata)* weed population, dry weight and percent inhibition. The highest weed population (6.67) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed population (1.33) was found in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). The highest weed dry weight (4.47 g) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed dry weight (1.67 g) was in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). Percent inhibition of weed was the highest in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) and the lowest one was observed in V_1C_1 (BRRI dhan57 × No crop residues) treatment (Table 2). Ferdousi *et al.* (2017) stated that 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.

Interaction effect between variety and sunflower residues on Monochoria vaginalis

The effect of interaction between variety and sunflower residues was found significant for panikachu (*Monochoria vaginalis*) weed population, dry weight and percent inhibition. The highest weed population (19.00) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed population (4.67) was found in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). The highest weed dry weight (31.60 g) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed dry weight (11.47 g) was in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). Percent inhibition of weed was the highest in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) and the lowest one was observed in V_1C_1 (BRRI dhan57 × No crop residues) treatment (Table 2).Afroz *et al.* (2018) also reported efficacy of weed control by crop residues.

Interaction effect between variety and sunflower residues on Cyperus difformis

The effect of interaction between variety and sunflower residues was found significant for sabujnakful (*Cyperus difformis***)** weed population, dry weight and percent inhibition. The highest weed population (8.33) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed population (2.00) was found in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). The highest weed dry weight (7.86 g) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed dry weight (1.40 g) was in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). Percent inhibition of weed was the highest in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) and the lowest one was observed in V_1C_1 (BRRI dhan57 × No crop residues) treatment (Table 2). Hossain *et al.* (2017) reported that the interaction between variety and mustard crop residues was found to be significant on weed population, dry weight and percent inhibition of *Monochoria vaginalis*. The highest weed population (20.0) was found in V_3T_1 (BRRI dhan49 × no crop residue) and the lowest was found in V_3T_5 (BRRI dhan49 × 2.0 t ha^{-1}) treatment.

Table 2. Interaction effects of variety and sunflower residues on weed density, dry weight and inhibition of different weeds

Variety x Residues	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	% Inhibition
Echinochloa crusgalli			
V1C1	13.67 a	21.43 a	0.00 f
V1C2	11.00 e	18.17 cd	15.24 e
V1C3	9.00 h	15.53 f	27.53 d
V1C4	7.33 k	11.43 i	46.66 a
V2C1	12.00 c	18.57 c	0.00 f
V2C2	9.33 g	15.23 f	17.96 e
V2C3	7.33 k	11.90 i	35.87 b
V2C4	5.67 n	9.73 k	47.58 a
V3C1	12.67 b	20.03 b	0.00 f
V3C2	10.33 f	16.70 e	16.60 e
V3C3	7.67 j	13.57 h	32.28 c
V3C4	6.00 m	10.63 j	46.88 a
V4C1	11.33 d	17.77 d	0.00 f
V4C2	8.33 i	14.57 g	17.97 e
V4C3	6.67 l	11.33 i	36.21 b
V4C4	4.67 o	9.23 k	48.05 a
Sx̄	0.02	0.19	1.16
Level of sig.	**	**	*
Oxalis corniculata			
V1C1	6.67 a	4.47 a	0.00 j
V1C2	5.33 e	3.90 d	12.69 i
V1C3	3.67 i	3.07 g	31.29 f
V1C4	2.00 m	2.50 j	44.03 c
V2C1	6.00 c	4.10 c	0.00 j
V2C2	4.33 g	3.37 f	17.81 h
V2C3	3.00 k	2.63 i	35.75 e
V2C4	1.33 o	1.80 m	56.07 a
V3C1	6.33 b	4.33 b	0.00 j
V3C2	4.67 f	3.63 e	16.20 h
V3C3	3.33 j	2.83 h	34.62 e
V3C4	1.67 n	2.13 l	50.82 b
V4C1	5.67 d	3.90 d	0.00 j
V4C2	4.00 h	3.13 g	19.62 g
V4C3	2.67 l	2.40 k	38.46 d
V4C4	1.33 o	1.67 n	57.18 a
Sx̄	0.04	0.03	0.58
Level of sig.	**	**	**
Monochoria vaginalis			
V1C1	19.00 a	31.60 a	0.00 g
V1C2	14.00 d	28.00 d	11.39 f
V1C3	11.00 f	25.03 h	20.79 e
V1C4	8.00 j	16.50 l	47.78 c
V2C1	16.33 c	28.80 c	0.00 g
V2C2	10.33 g	25.30 g	12.15 f
V2C3	9.33 i	22.63 j	21.42 e
V2C4	6.00 l	13.53 n	53.02 b
V3C1	17.00 b	29.43 b	0.00 g
V3C2	12.67 e	25.90 f	11.99 f
V3C3	9.67 hi	23.13 i	21.40 e
V3C4	7.33 k	15.23 m	48.25 c
V4C1	14.00 d	26.10 e	0.00 g
V4C2	10.00 gh	22.73 j	12.91 f
V4C3	7.33 k	19.90 k	23.76 d
V4C4	4.67 m	11.47 o	56.06 a
Sx̄	0.17	0.05	0.58
Level of sig.	**	**	**

Here, V_1 = BRRI dhan57, V_2 = Binadhan-7, V_3 = Binadhan-15, V_4 = Binadhan-16, C_1 = No crops residues (control), C_2 = sunflower crop residues at 0.5 t ha^{-1}, C_3 = sunflower crop residues at 1.0 t ha^{-1}, C_4 = sunflower crop residues at 2.0 t ha$^{-1,}$ * =Significant at 5% level of probability, ** =Significant at 1% level of probability

Table 2. Interaction effects of variety and sunflower residues on weed density, dry weight and inhibition of different weeds (continued)

Variety x Residues	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	% Inhibition
Cyperus difformis			
V1C1	8.33 a	7.86 a	0.00 h
V1C2	6.67 d	6.50 c	17.38 g
V1C3	4.67 g	4.23 f	46.18 e
V1C4	2.67 k	2.50 i	68.22 b
V2C1	7.33 c	6.53 c	0.00 h
V2C2	5.67 f	4.96 e	23.97 f
V2C3	3.67 i	3.20 h	51.00 cd
V2C4	1.67 n	1.86 j	71.4 b
V3C1	7.67 b	7.03 b	0.00 h
V3C2	6.33 e	5.80 d	17.52 g
V3C3	4.33 h	3.66 g	47.84 de
V3C4	2.33 l	2.06 j	70.59 b
V4C1	6.33 e	5.70 d	0.00 h
V4C2	4.67 g	4.33 f	23.95 f
V4C3	3.33 j	2.66 i	53.22 c
V4C4	2.00 m	1.40 k	75.43 a
Sx̄	0.04	0.08	1.21
Level of sig.	**	**	*
Scirpus juncoides			
V1C1	9.67 a	6.23 a	0.00 i
V1C2	7.67 e	4.36 e	29.94 h
V1C3	5.67 i	3.46 g	44.39 f
V1C4	2.67 m	2.20 j	64.69 c
V2C1	9.00 c	5.30 c	0.00 i
V2C2	7.00 g	3.46 g	34.56 g
V2C3	4.67 k	2.70 i	49.07 e
V2C4	2.00 o	1.46 l	72.33 ab
V3C1	9.33 b	5.80 b	0.00 i
V3C2	7.33 f	3.93 f	32.16 gh
V3C3	5.33 j	3.13 h	45.97 f
V3C4	2.33 n	1.70 k	70.67 b
V4C1	8.33 d	4.63 d	0.00 i
V4C2	6.67 h	3.06 h	33.72 g
V4C3	4.33 l	2.23 j	51.76 d
V4C4	1.67 p	1.20 m	74.07 a
Sx̄	0.04	0.04	0.92
Level of sig.	**	**	**

Table 3. Interaction effects of variety and sunflower residues on yield and yield contributing characters of *T. aman* rice

Variety x sunflower residues	Plant height (cm)	Effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	WTG (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1C_1	127.51	5.93 g	19.89	96.76 d	18.97	2.48 i	2.61 j	48.72
V_1C_2	132.34	6.20 fg	20.95	103.1 c	19.80	2.97 h	3.16 i	48.45
V_1C_3	135.93	6.53 def	21.21	109.8 b	20.77	3.07 gh	3.35 ghi	47.81
V_1C_4	137.47	6.66 def	22.01	141.7 a	21.70	3.30 efg	3.65 ef	47.41
V_2C_1	85.34	6.20 fg	20.76	72.40 g	21.00	3.09 gh	3.26 hi	48.66
V_2C_2	91.16	7.06 cd	21.12	77.44 g	22.57	3.39 ef	3.76 ef	47.41
V_2C_3	92.75	7.73 b	21.73	86.54 f	23.77	3.95 c	4.13 d	48.82
V_2C_4	98.22	8.46 a	22.85	88.85 ef	24.97	4.42 b	4.61 b	48.89
V_3C_1	92.58	6.53 def	21.37	84.46 f	20.67	3.06 gh	3.21 hi	48.72
V_3C_2	103.45	6.80 cde	21.82	87.94 ef	22.00	3.18 fgh	3.40 gh	48.32
V_3C_3	104.10	7.26 bc	22.91	92.52 de	22.87	3.49 de	3.66 ef	48.74
V_3C_4	106.55	8.33 a	23.73	108.6 b	24.63	4.17 c	4.36 c	48.82
V_4C_1	86.78	6.26 efg	23.57	66.83 h	22.30	3.26 efg	3.54f g	47.94
V_4C_2	94.51	6.40 efg	24.42	72.15 g	23.37	3.67 d	3.85 e	48.80
V_4C_3	97.40	7.26 bc	24.94	85.47 f	24.03	3.96 c	4.13 d	48.94
V_4C_4	98.35	8.26 a	25.55	93.32 de	25.30	4.70 a	4.85 a	49.16
Sx̄	2.25	0.178	0.862	1.81	0.742	0.080	0.071	0.619
Level of sig.	NS	**	NS	**	NS	**	**	NS

Here, V_1 = BRRI dhan57, V_2 = Binadhan-7, V_3 = Binadhan-15, V_4 = Binadhan-16, C_1 = No crops residues (control), C_2 = sunflower crop residues at 0.5 t ha^{-1}, C_3 = sunflower crop residues at 1.0 t ha^{-1}, C_4 = sunflower crop residues at 2.0 t ha$^{-1,}$ ** =Significant at 1% level of probability, NS = Not significant

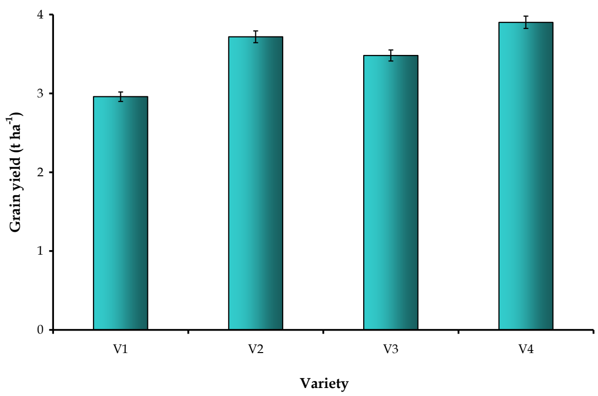

Figure 1. Grain yield as influenced by variety (Bar represents standard error mean). Here, V_1 = BRRI dhan57, V_2 = Binadhan-7, V_3 = Binadhan-15, V_4 = Binadhan-16

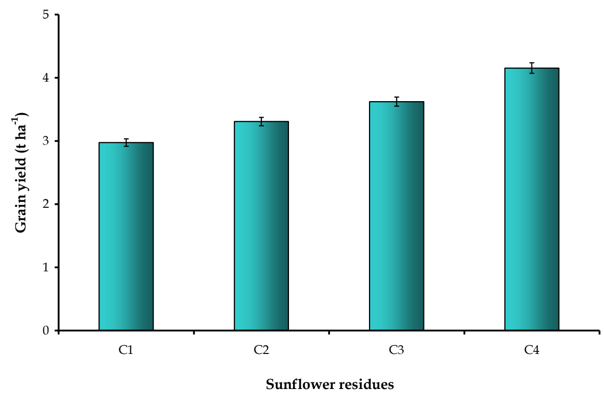

Figure 2. Grain yield as influenced by sunflower residues treatment (Bar represents standard error mean). Here, C_1 = No crops residues (control), C_2 = sunflower crop residues at 0.5 t ha^{-1}, C_3 = sunflower crop residues at 1.0 t ha^{-1}, C_4 = sunflower crop residues at 2.0 t ha^{-1}

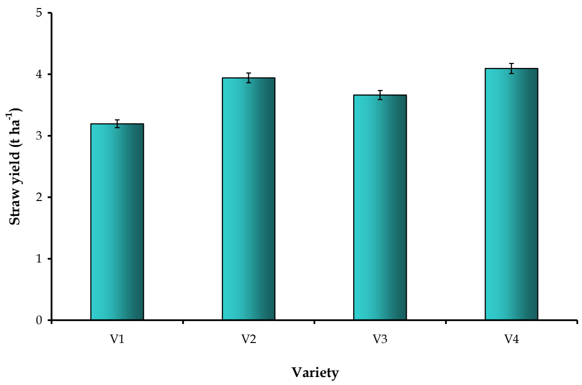

Figure 3. Straw yield as influenced by variety (Bar represents standard error mean). Here, V_1 = BRRI dhan57, V_2 = Binadhan-7, V_3 = Binadhan-15, V_4 = Binadhan-16

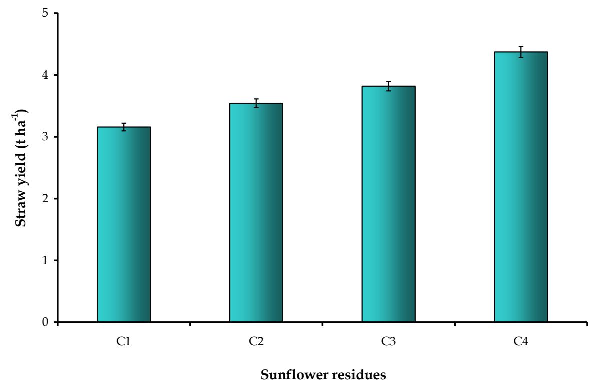

Figure 4. Grain yield as influenced by sunflower residues treatment (Bar represents standard error mean). Here, C_1 = No crops residues (control), C_2 = sunflower crop residues at 0.5 t ha^{-1}, C_3 = sunflower crop residues at 1.0 t ha^{-1}, C_4 = sunflower crop residues at 2.0 t ha^{-1}

Interaction effect between variety and sunflower residues on Scirpus juncoides

The effect of interaction between variety and sunflower residues was found significant for chesra (*Scirpus juncoides*) weed population, dry weight and percent inhibition. The highest weed population (9.67) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed population (1.67) was found in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). The highest weed dry weight (6.23 g) was found in V_1C_1 (BRRI dhan57 × No crop residues) and the lowest weed dry weight (1.20 g) was in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) treatment (Table 2). Percent inhibition of weed was the highest in V_4C_4 (Binadhan-16 ×2.0 t ha^{-1} of sunflower crop residues) and the lowest one was observed in V_1C_1 (BRRI dhan57 × No crop residues) treatment (Table 2).Halim *et al.* (2017) found significant weed control efficacy by crop residues. They reported that the maximum weed growth was noticed with the application of crop residues two weeks after transplanting and the minimum was found with application of crop residues before transplanting treatment.

Effect of variety and sunflower residues on yield contributing characters and yield

The effect of interaction between variety and crop residues was not significant for plant height. Numerically, the tallest plant was obtained from BRRI dhan57 in C_4 treatment and Binadhan-7 produced the shortest plant in C_1 treatment (Table 3). Significant variation was found in number of effective tillers hill^{-1} due to interaction between variety and crop residues. The highest number of effective tillers hill^{-1} (8.26) was produced by Binadhan-7 in C_4 treatment, while the lowest number of effective tillers hill^{-1}(5.93) was found from BRRI dhan57 in C_1 treatment (Table 3). Panicle length was not significantly influenced by variety and crop residues. Numerically the longest panicle was observed in V_4C_4 treatment and the shortest one was found in V_1C_1 treatment (Table 3). Number of grains panicle^{-1} was significantly influenced by the interaction between varieties and crop residues. The highest number of grains panicle^{-1}(141.7) was produced by V_1C_4 treatment and the lowest number of grains panicle^{-1}(66.83) was produced by V_4C_1 treatment (Table 3). Weight of 1000 grains was not significantly affected by the interaction between variety and crop residues (Table 3). The highest numbers of tillers hill^{-1}, numbers of grains panicle^{-1}, 1000-grain weight, grain yield and straw yield were observed where wheat crop residues were incorporated @ 2.0 t ha^{-1} (Ferdousi *et al.* 2017).

The studied different varieties significantly affected the grain yield. The highest grain yield (3.90 t ha^{-1}) was obtained in Binadhan-16 (Fig. 1). The increased yield might be due to the lowest number of sterile spikelet panicle^{-1}. The lowest grain yield (2.95 t ha^{-1}) was obtained in BRRI dhan57 (Fig. 2). This difference was observed due to different varietal characteristics of rice. BRRI (2005) also reported variation in grain yield among the varieties.Grain yield was significantly influenced by sunflower residues. The highest grain yield (4.15 t ha^{-1}) was produced by sunflower residues at 2.0 t ha^{-1}treatment and lowest one (2.97 t ha^{-1}) was produced by no residue treatment (Fig. 2). Uddin and Pyon (2010) also reported crop residues influenced in crop performance. Straw yield was significantly influenced by four varieties. The highest straw yield (4.09 t ha^{-1}) was found in Binadhan-16 and the lowest straw yield (3.19 t ha^{-1}) was found in BRRI dhan57 (Fig. 3). Straw yield was significantly influenced by sunflower residues. The highest straw yield (4.37) was observed in sunflower residues 2.0 t ha^{-1}treatment and the lowest straw yield (3.15) was observed in no residues treatment (Fig. 4). Similar findings were reported by Afroz *et al.* (2018) who found significant weed control efficacy by crop residues. Harvest index was not significantly influenced by the interaction between variety and crop residues. The highest harvest index was observed in V_1C_4 treatment and the lowest harvest index was observed in V_4C_4 treatment (Table 3).

Conclusion

Weed population, weed dry weight and percent inhibitions were significantly affected by variety, sunflower residues and their interaction. It was found that the variety Binadhan-16 with sunflower residues at 2.0 t ha^{-1} treatment exhibited the superior performance. Results of the present study reveal that application of sunflower residues reduce weed and it has positive effect on yield and yield attributes. Therefore, sunflower residues could be a prospective weed control tool for crop production in modern agricultural science.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Afroz, F., Uddin, M.R., Hasan, A.K., Sarker, U.K., Hoque, M.M.I. Islam, M.A. 2018: Combined allelopathic effect of buckwheat and marsh pepper residues on weed management and crop performance of transplant *aman* rice. Archives of Agriculture and Environmental Science,3: 289-296. https://doi.org/10.26832/24566632.2018.0303012

Ahmed, F., Uddin, M.R., Hossain, M.D., Sarker, U.K., Sarkar, D. Chadny, D.N.2018: Effect of aqueous extract of sorghum crop residues on weed management and crop performance of wheat. Bangladesh Agronomy Journal, 21(2): 87-95. https://doi.org/10.3329/baj.v21i2.44497

Ahmed, S., Islam, M.R., Alam, M.M., Haque, M.M. Karim, A.J.M.S. 2011: Rice production and profitability as influenced by integrated crop and resources management. Eco-Friendly Agriculture, 11: 720-725.

BBS (Bangladesh Bureau of Statistics). 2018: Statistical Year Book of Bangladesh, Bureau of Statistics, Statistical Division, Ministry of planning, Goverment People's Republic Bangladesh, Dhaka. pp 42-46.

Belz, R.G. 2004: Evaluation of allelopathic traits in *Triticum* L. spp and *Secale cereal* L. PhD Thesis, University of Hohenheim, Stuttgart, Germany.

BRRI (Bangladesh Rice Research Institute) 2005: Adhunik Dhaner Chash. Bangladesh Rice Research Institute, Joydevpur, Gazipur, Bangladesh. pp. 12, 20-21, 23.

Chauhan, B.S., Ahmed, S., Awan, T.H., Jabran, K. Manalil, S. 2015: Integrated weed management approach to improve weed control efficiencies for sustainable rice production in dry-seeded systems. Crop Protection, 71: 19-24. https://doi.org/10.1016/j.cropro.2015.01.012.

Cruz, E.D., Moody, K. Ramos, M.B.D. 1986. Reducing variability sampling weeds in upland rice (*Oryza sativa*) Philippines Journal of Weed Science, 13: 56-59.

Ferdousi, S., Uddin, M.R., Begum, M., Sarker, U.K., Hossain, M.N. Hoque, M.M.I. 2017: Herbicidal activities of wheat residues in transplant *aman* rice. Progressive Agriculture, 28: 253-261. https://doi.org/10.3329/pa.v28i4.36364

Gomez, K.A. Gomez, A.A. 1984: Duncan's, Muitiple Range Test. Statistical Procedures for Agricultural Research 2ndEdition. AWiley Inter-Science publication, John Wiley and Sons, New York. pp. 202-215.

Halim, M.A., Uddin, M.R., Salam, M.A., Sarker, U.K. Haque, M.A. 2017:Weed suppression and crop performance of rice (cv. BRRI dhan29) as influenced by application of different crop residues. Fundamental and Applied Agriculture, 2(1): 207-211.

Hasanuzzaman, M., Islam, O. Bapari, S. 2008: Efficacy of different herbicides over manual weeding in controlling weeds in transplanted rice. Australian Journal of Crop Science, 2(1):18-24.

Hossain, M.N., Uddin, M.R., Salam, M.A., Sarker, U.K., Ferdousi, S. Uddin, M.J. 2017: Allelopathic potential of mustard crop residues on weed management and performance of transplant *aman* rice. Journal of Bangladesh Agricultural University, 15: 133–139. https://doi.org/10.3329/jbau.v15i2.35054

IRRI (International Rice Research Institute) 2015: Rice Yield by Country and Geographical Region. World Rice Statistic. International Rice Research Institute, Los Banos, Laguna Philippines. pp. 1-8.

Khanh,T.D., Chung, M.I., Xuan, T.D. Tawata, S. 2005: The exploitation of crop allelopathy in sustainable agricultural production. Journal of Agronomy and Crop Science, 191: 172-184. https://doi.org/10.1111/j.1439-037X.2005.00172.x

Kumar, K. and Goh, K.M. 2000: Crop residues and management practices: effects on soil quality, soil nitrogen dynamics, crop yield and nitrogen recovery. Advances in Agronomy, 68: 197–319. https://doi.org/10.1016/S0065-2113(08)60846-9

Labrada, R. 2002: The need for improved weed management in rice. Proceedings of the 20thSession of the International Rice Commission, Bangkok, Thailand, 23-26 July 2002, 181-189.

Pramanik, S.K., Uddin, M.R., Sarker, U.K., Sarkar, D., Ahmed F. Alam, M.J. 2019: Allelopathic potential of marshpepper residues for weed management and yield of transplant *Aman* rice. Progressive Agriculture, 30(4): 379-386. https://doi.org/10.3329/pa.v30i4.46897

Putnam, A.R. Duke, W.B. 1974: Biological suppression of weeds: Evidence for allelopathy in accessions of cucumber. Science. 185: 370-372. https://doi.org/10.1126/science.185.4148.370

Rice, E.L. 1984: Allelopathy: Physiological Ecology. Orlando, FL: Academic Press.

Sarker, U.K., M.R. Uddin Faruk, G.M.2020: Weed suppressing ability and performance of common crop residues for sustainable weed management. Journal of research in Weed Science 3(3):310-327.

Singh, V.P., Singh, G. Singh, M. 2004: Effect of Almix and Butachlor alone and in combinations on transplanted rice and associated weeds. Indian Journal of Weed Science, 36: 190-192.

Uddin, M.R. Pyon, J.Y. 2010: Herbicidal Activity of Rotation Crop Residues on Weeds and Selectivity to Crops. Journal of Agricultural Science, 37: 1-6.

Uddin, M.R., Li, X., Won, O.J., Park, S.U. Pyon, J.Y. 2012: Herbicidal activity of phenolic compounds from hairy root cultures of *Fagopyrum tataricum* Gaertn. Weed Research, 52(1): 25-33. https://doi.org/10.1111/j.1365-3180.2011.00894.x

Uddin, M.R., Park, S.U., Dayan, F.E. Pyon, J.Y. 2014: Herbicidal activity of formulated sorgoleone, a natural product of sorghum root exudate. Pest Management Science, 70:252-257. https://doi.org/10.1002/ps.3550

Uddin,M.R., Won, O.J. Pyon,J.Y. 2010: Herbicidal effects and crop selectivity of sorgoleone, a sorghum root exudate under greenhouse and field conditions. Korean Journal of Weed Science, 30(4): 412-420. https://doi.org/10.5660/KJWS.2010.30.4.412

Won, O.J., Uddin, M.R. Pyon, J.Y. 2011:Herbicidal activities and crop injury of hairy vetch residues. Korean Journal of Weed Science, 31(2): 175-182. https://doi.org/10.5660/KJWS.2011.31.2.175

Zhang, X.,Rashid, S.,Ahmad, K. Ahmed, A. 2014: Escalation of real wages in Bangladesh: is it the beginning of structural transformation? World Development, 64: 273-285. https://doi.org/10.1016/j.worlddev.2014.06.015