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EFFECT OF SUNFLOWER CROP RESIDUE ON WEED SUPPRESSION IN DIRECT-SEEDED *AUS* RICE UNDER RICE – SUNFLOWER-RICE CROPPING PATTERN

L. Khatun[1], T. Chakrobarty[1], M.A. Zaman[1], M. Nasim[1] and S. Mondal[1, 2*]

[1] Bangladesh Rice Research Institute, Gazipur-1701. Bangladesh
[2]Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh
*Corresponding E-mail: satyen1981@gmail.com

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Abstract

In Bangladesh direct-seeded *Aus* rice is a conventional rice cultivation practice and weed infestation is a severe problem in direct-seeded rice production due to the existence of favorable environment during this period. So, by minimizing the use of herbicides and replace them with eco-friendly and environmentally sustainable herbicides based on natural plant products or allelochemicals, a factorial experiment based on randomized complete block design with three replications was performed at the research field of Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh from July 2018 to August 2019 to evaluate effect of sunflower crop residue on weeds growth and yield of direct seeded *Aus* rice in Transplanting Aman-Sunflower-Aus cropping pattern. Weed population and weed dry weight were significantly affected by crop residues treatment. Weed population was significantly lower in C_3 (Direct sowing of *Aus* after 7 days of Sunflower residue incorporation) treatment than the control C_1 (Direct sowing of *Aus* without Sunflower residue incorporation) treatment. The lowest weed dry weight (90.5 g m^{-2}) was also obtained from C_4 (Direct sowing of *Aus* after 14 days of Sunflower residue incorporation). The highest reduction of grain yield was obtained from without crop residue and no weeding treatments. The highest number of effective tillers m^{-2} (403.33), grain $panicle^{-1}$ (114.67), tillers $hill^{-1}$ (16.36), and grain yield (3.32 t ha^{-1}) were observed from the treatments where sunflower residue was incorporated and the plots that were weed free. Results of this study indicate that sunflower residues showed potentiality to inhibit weed growth and it has a significant effect on the yield and yield parameters of direct seeded rice. Again weeds played a significant role in the reduction of yield of direct seeded rice. Thus, sunflower residues might be substitute for weed management practice as well as obtaining higher yield of direct seeded rice.

Introduction

Bangladesh has three rice growing seasons: *Aus*, *Aman* and *Boro* which cover about 9.6, 48.82 and 41.58% of total rice area and these contribute to 7.63, 38.62 and 53.74% of the total rice production respectively (BBS, 2019). *Boro* is the most important and single largest crop in Bangladesh in respect of volume of production. Due to higher weed infestation problem, farmers don't like to cultivate *Aus* rice specially direct seeded *Aus* rice.

Seasonal variation was also observed in the yield losses caused by weeds, with estimated rice yield losses dueto weeds at 70-80%, 30-40% and 22-36% in Aus rice, Transplanted *Aman* rice and *Boro* rice, respectively (Mamun, 1990). Yield loss in direct seeded rice is about 40-100% (Mazid *et al*., 2001; Ahmed and Chauhan, 2014; Mondal *et al*., 2020). With a substantial yield loss due to weed in direct seeded *Aus* rice, manual weeding is becoming less effective because of labor crisis at critical times and

increased labor costs. Due to labor scarcity and lack of proper technologies, chemical weed control is becoming popular than hand weeding (Ahmed *et al*., 2011; Hasanuzzaman *et al*., 2008).

Chauhan *et al*. (2015) was found that even after the application of pre and post-emergence herbicides, it was not enough to achieve adequate weed control in direct seeded rice. To overcome the problems related to herbicides, use of allelopathic strategies is an alternative way in weed management for sustainable agriculture (Narwal, 1997).The application of the allelopathic properties of some crops (e.g. sunflower) has been suggested for weed management due to the possibility of reducing the application of expensive, pollutant synthetic herbicides (Belz, 2007; Kruse *et al*., 2000). As a tool for biological weed control in crop production, allelopathy may be natural technique (Cheema and Khaliq, 2000; Heidarzadeh *et al*., 2010). Even in alley cropping system direct seeded Aus rice is a good practice to uphold rice yield, minimizing weed infestation and soil health improvement through incorporation of pruning materials (Mondal *et al*., 2013). Considering the above point of view, the present study was conducted to determine the allelopathic and residual potential of sunflower towards weeds and yield performance of direct seeded rice.

Materials and Methods

The experiment was carried out at the research farm of Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh in medium high land during July 2018 to August 2019 (Aman-2018 to Aus 2019). The experimental field belongs to the Agro-Ecological Zone -28 (Madhupur Tract). Soil texture was clay loam. The experiment was executed in factorial randomized complete block design with three replications. The treatments were**:**

Factor A: Time of crop residue incorporation: C_1: Direct sowing of *Aus* without Sunflower residue incorporation, C_2: Direct sowing of *Aus* immediately after Sunflower residue incorporation, C_3: Direct sowing of *Aus* after 7 days of Sunflower residue incorporation and C_4: Direct sowing of *Aus* after 14 days of Sunflower residue incorporation and Factor B: Weeding: W_1: Weeding and W_2: No Weeding.

The experiment was conducted under T. *Aman* (var. BRRI dhan71)-Sunflower- DS (direct seeded) *Aus* (var. BRRI dhan83) cropping pattern to determine the effect of sunflower residue incorporation on weed scenario in direct seeded *Aus* rice and the system productivity of the following pattern. The seed of *Aman* rice was sown in the first week of July 2018 and twenty-five days old seedlings of Transplanting*Aman*rice var. BRRI dhan71 were transplanted on using 2-3 seedlings hill^{-1} at a spacing of 20 × 20 cm and harvested at last week of November 2018. Sunflower var.BARI Sunflower-2 were sown at a depth of 1 cm in December 2018. Seeds were planted with inter-row and interplant spacing of 50 and 25 cm, respectively. A basal dose of 180 urea, 160 triple super phosphates, 150muriate of potash and 150 kgha^{-1}was applied in each plot. Plots were irrigated as per necessary for sunflower. After 90 days of sowing, mature sunflower plants were decapitated. Remaining vegetative parts were uprooted, chopped into 3-5 cm to incorporate in the soil by ploughing in the recommended plot as per treatment.

Direct seeded *Aus* rice var. BRRI dan83 (growth duration 103 days) was selected. Seeds were sown continuously by maintaining 20 cm line to line distance according to the treatment at three dates (29 March 2019, 4 April 2019 and 11 April, 2019) and after sowing irrigation were ensured for germinating the seed. The recommended dose of chemical fertilizers was: 150 urea, 52 triple super phosphate and 75 kgha^{-1} muriate of potash.

Growth and yield attributes of rice

In case of T. *Aman* rice the crop cut area was 6 m^2 for grain yield measurement and 4 hills from three different place (4 hills × 3=12 hills) of the plot were taken for obtaining yield attributing characters of

rice. The data were recorded on grain weight (kg), straw weight (kg), moisture percentage (%), tiller number hill^{-1}, panicle number hill^{-1}, grain panicle^{-1}, unfilled spikelet panicle^{-1}, thousand grain weight (g). In *Aus* season data on weed parameters at 40 and 55 days after sowing the rice and alsorecorded on grain weight (kg), moisture percentage (%), tiller number hill^{-1}, effective tiller m^{-2} and filled spikelet panicle^{-1}. Biological yield was calculated by using following formula. Biological yield= Grain yield + straw yield.

Growth and yield attributes of sunflower

Plant height (cm), stem diameter (cm), capitulum diameter (cm), number of seeds per capitulum, thousand seed weight and total seed weight (kg) of the plot were recorded.

Weed density and dry matter production

Weed samples were collected from prefixed location of 1 m × 1m area in each plot. Collected weeds were separated into grass, sedge and broadleaf and were expressed in number m^{-2}.

After counting the weeds were firstly dried in shade for removing extra moisture and then oven dried at 70 °C for 48 h and weighed (g).

Statistical Analysis

All data were statisticallyanalyzed through STAR (Statistical Tools for Agricultural Research) statistical package and treatment means were compared by LSD test at 5% level of significance.

Results

Yield and yield component of *Aman* rice (BRRI dhan71)

There was no significant difference among the treatments in case of tiller, panicle number hill^{-1} filled spikelets and 1000- grain weight.

Table 1. Effect of weeding and crop residue of sunflower on yield component of *Aman* rice, BRRI dhan71

Crop residue of sunflower	Weeding (W_1)				No weeding (W_2)			
	Tiller no. hill^{-1}	Panicle no.hill^{-1}	Filled spikelets panicle^{-1} (no.	Thousand grain wt. (g)	Tiller no. hill^{-1}	Panicle no.hill^{-1}	Filled spikeletspanicle^{-1} (no.)	Thousand grain wt. (g)
C1	9.58	8.01	87.19	24.08	9.00	8.25	86.03	24.22
C2	10.33	9.58	83.82	24.04	10.55	9.75	87.09	23.87
C3	12.00	11.67	86.58	24.23	11.89	10.02	84.73	24.17
C4	13.01	12.23	87.18	24.05	12.33	11.11	86.37	24.25
$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	1.70	1.47	4.79	0.83	1.70	1.47	4.79	0.83

NS=Not significant

Grain yield and Biological Yield of BRRI dhan71

Grain yield and biological yield of BRRI dhan71 showed insignificant difference among the treatments. On an average BRRI dhan71 gave similar yield and biological yield in all the treatments (Fig.1).

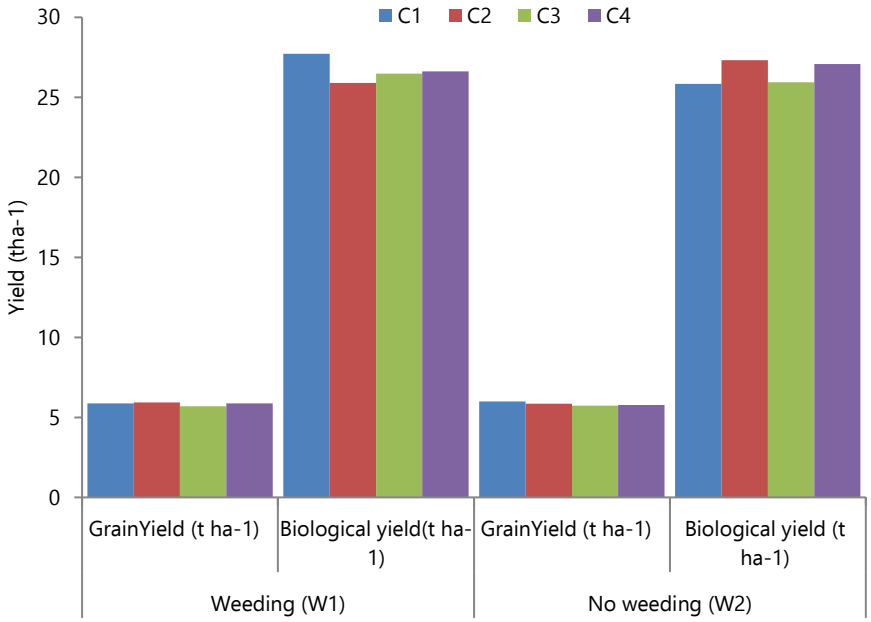

Fig. 1. Variation in grain yield and biological yield influenced by sunflower crop residue and weeding.

Yield and yield component of sunflower

There was no significant difference in case of plant height among the treatments. Stem diameter showed statistically significant difference among the treatments. The highest stem diameter (2.38 cm) was recorded in C_1W_2 followed by C_4W_1 (2.28 cm) treatment and the lowest value in C_4W_2 (1.33 cm) followed by C_3W_2 (1.51 cm) treatment (Table 2). Maximum capitulum diameter (22.67 cm) was found in C_1W_2 treatment followed by C_2W_1 (20.67 cm) and C_4W_1 (19.67 cm) and minimum capitulum diameter (8.00 cm) was recordedin C_4W_2 treatment (Table 2). Maximumnumber of seeds per capitulum (546.67) was found in C_4W_1 treatment followed by C_1W_2 (520.00), C_2W_1 (446.67) and C_2W_2 (446.6) where minimumnumber of seeds per capitulum (246.67) was in C_1W_2 followed by C_4W_2 (313.33) treatment (Table 2). Maximum value of thousand seeds weight(67.33 g) was found in C_4W_1 followed by C_3W_2 (65.66 g) and C_4W_2 (65.00 g) and minimum thousand seeds weight(67.33 g) was registered in C_3W_1 (62.33 g) followed by C_1W_2 (62.66 g) (Table 2). The maximumseed yield was found in C_1W_2 (2.43 tha^{-1}) treatment followed by C_4W_1 (2.32 tha^{-1}) and C_2W_1 (2.14 tha^{-1}) and lowest yield (1.46 tha^{-1}) was recorded in C_2W_2 treatment (Table 2).Maximum yield of sunflower (2.43 t ha^{-1}) was observed in C_1W_2 treatment followed by C_4W_1 (2.32 t ha^{-1}) and C_2W_1 (2.14 t ha^{-1}) treatments. Minimum yield (1.46) was in C_2W_2 followed by C_4W_2 (1.68 t ha^{-1}) treatment (Table 2).

Table 2. Effect of weeding and crop residue of sunflower on yield and yield componentof sunflower

Crop residue of sunflower	Weeding (W1)						No weeding (W2)					
	Plant height (cm)	Stem diameter (cm)	Capitulum diameter (cm)	No.of seeds per capitulum	1000-seed wt.(g)	Seed yield (tha^{-1})	Plant height (cm)	Stem diameter (cm)	Capitulum diameter (cm)	No. of seeds per capitulum	1000-seed wt. (g)	Seed yield (tha^{-1})
C_1	105.00	1.78	13.33	246.67	63.00	1.75	116	2.38	22.67	520.00	62.66	2.43
C_2	113.00	1.85	20.67	466.67	64.33	2.14	113	2.11	14.33	446.6	63.66	1.46
C_3	119.33	2.03	15.00	396.00	62.33	1.75	116	1.51	10.33	396.67	65.66	1.97
C_4	103.33	2.28	19.67	546.67	67.33	2.32	127	1.33	8.00 b	313.33	65.00	1.68

$LSD_{(0.05)}$	NS	0.56	6.18	167.23	NS	0.51	NS	0.56	6.18	167.23	NS	0.51
CV (%)	9.12	6.12	10.45	9.45	3.73	9.26	9.12	6.12	10.45	9.45	3.73	9.26

NS=Not significant

Weed scenario

The experimental field was infested with the naturally occurring weed community including grass, broad leaved and sedge weeds. The weed composition of the plots is presented in Table 4. The most dominant weed species (on the basis of density) encountered in the weedy plots at 40DAS. Number of grasses differed significantly among the treatments. The highest number of grasses (45.33 and 65.00 m^{-2}) was observed in the treatments where no sunflower residue was incorporated (C_1W_1 and C_1W_2 respectively) and lowest number of grasses (13.67 and 23.33 m^{-2}) was recorded in the treatment where *Aus* rice was sown 7 days after the incorporation of sunflower residue (C_3W_1 and C_3W_2 respectively) (Table 3). The highest number of sedges m^{-2} was registered in C_2W_1 (254), C_4W_1 (250) and C_4W_2 (398) which were statistically different from other treatments and the lowest number of sedges m^{-2} in C_1W_1 (215) treatment followed by C_3W_1 (226) and C_3W_2 (230) treatments (Table 3). The highest number of broadleaved weed m^{-2} was found in C_1W_2 (20.67) treatment followed by C_1W_1 (20.33) and the lowest in C_3W_1 (10.00) (Table 3).There is no significant difference of dry weight and fresh weight of weeds among the treatments.The effect of crop residue on fresh weight and dry weight of weeds in Rice-Sunflower-Rice cropping pattern was statistically significant. Incorporation of sunflower residue significantly reduced fresh weight and dry weight of weeds. The highest value (660.01 g m^{-2}) of fresh weight of weeds was registered in C_1 treatment and the lowest (535.03 g m^{-2}) value was in C_4 treatments. The highest value (205.02 g m^{-2}) of dry weight was recorded in C_1 treatment which was statistically different from others and the lowest value (125.33 g m^{-2}) was in C_4 treatment (Fig. 2).

Table 3. Effect of sunflower crop residue on the growth, plant population and dry matte production of weeds

Crop Residue	Weeding (W_1)					No weeding (W_2)				
	No. of grass m^{-2}	No. of sedge m^{-2}	No. of broadleaf m^{-2}	fresh wt. of weed (g m^{-2})	Dry wt. of weed (g m^{-2})	No. of grass m^{-2}	No. of sedge m^{-2}	No. of broad Leaf (m^{-2})	fresh wt. of weed (g m^{-2})	Dry wt. of weed (g m^{-2})
C_1	45.33	215.00	20.33	590.02	180.01	65.00	273	20.67	730.12	230.03
C_2	31.67	254.00	13.67	570.23	170.06	41.00	319	14. 67	710.20	190.05
C_3	13. 67	226.00	10.00	440.32	100.05	23.33	230	14.00	630.11	180.15
C_4	24.33	250 .00	11.33	400.04	90.50	36.67	398	16.00	670.02	160.21
$LSD_{(0.05)}$	3.78	14.48	3.10	54.80	23.80	3.78	14.48	3.10	54.80	23.80
CV (%)	6.15	3.50	11.72	10.56	11.78	6.15	3.50	11.72	10.56	11.78

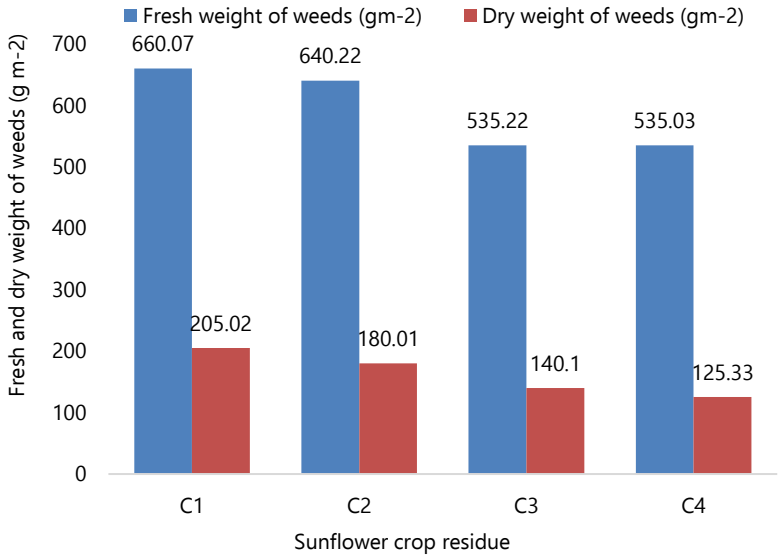

Fig. 2. Effect of sunflower crop residue on fesh and dry weight of weeds in Rice-Sunflower-Rice cropping pattern.

Yield and Yield parameters of *Aus* rice in Rice-Sunflower-Rice cropping pattern

Sunflower residue incorporation at different time in combination with the weeding treatments was no significant effect on plant height at harvest. (Table 4). Data presented in Table 1 revealed that there were no significant effects on effective tiller m^{-2} among the treatments combination. There was no significant difference among the treatments in case of number of tillers $hill^{-1}$(Table 4). Grains per panicle showed insignificant different among the treatments. Maximum number of Filled $spikeletspanicle^{-1}$(114.67) was observed in C_2W_1 followed by C_3W_1 (113.67) treatment and minimum number of filled grains $panicle^{-1}$(114.67) was found in C_1W_2 (75.33) treatment (Table 4).There was no significant difference among various treatments combination (Table 4).

Table 4. Yield and yield parameters of *Aus* rice (var. BRRI dhan83) in Rice-Sunflower-Rice cropping Pattern

Crop residue of sunflower	Weeding (W_1)					No weeding (W_2)				
	plant height (cm)	Effective tiller m^{-2} (no.)	Tillers $hill^{-1}$ (no.)	Filled spikelets $panicle^{-1}$ (no.)	Grain yield (tha^{-1})	Plant height (cm)	Effective tillers m^{-2} (no.)	Tillers $hill^{-1}$ (no.)	Filled spikelets $panicle^{-1}$ (no.)	Grain yield (tha^{-1})
C1	99.00	385.00	13.67	105.00	2.75	97.67	262.33	4.67	75.33	1.72
C2	103.67	403.33	16.33	114.67	3.21	98.33	269.67	5.67	93.67	2.39
C3	104.00	394.00	15.67	113.67	3.32	98.67	316.33	6.00	86.67	2.26
C4	102.67	267.83	13.33	102.33	3.00	99.33	265.33	4.33	88.33	1.99
$LSD_{(0.05)}$	NS	73.79	2.03	6.78	0.21	NS	73.79	2.03	6.78	0.21
CV (%)	5.05	9.16	8.33	7.95	9.53	5.05	9.16	8.33	7.95	9.53

NS=Not significant

Effect of crop residue on filled $spikeletspanicle^{-1}$and grain yield ($t\ ha^{-1}$)of *Aus* Rice

Crop residue incorporation of sunflower had significant effect on filled spikelets $panicle^{-1}$ and grain yield ($t\ ha^{-1}$) of *Aus* rice. The highest filled $spikeletspanicle^{-1}$ (104.17) was observed in the treatment where *Aus* rice was sown immediately after the incorporation of sunflower residue (C_2) which was

statistically identical with the treatment where *Aus* rice was sown seven days after the incorporation of sunflower residue (C_3) and lowest value (90.17) was noted where no residue was incorporated (Fig. 2). Grain yield of rice was significantly influenced by crop residue incorporation of sunflower at different time. The highest grain yield (2.80 t ha^{-1}) was found in (C_2) which was statistically similar with the treatment C_3 (1.79 t ha^{-1}). The lowest grain yield (2.23 t ha^{-1}) was noted in the treatment (C_1) where no residue was incorporated (Fig. 3).Effective tillers m^{-2}, tillers $hill^{-1}$, filled spikelets $panicle^{-1}$ and yield (t ha^{-1}) of *Aus* were significantly affected by weed management practices. The highest value of effective tillers m^{-2} (362.54), tillers $hill^{-1}$ (14.75), filled spikelets $panicle^{-1}$ (108.92) and yield (3.07 t ha^{-1}) of *Aus* was found in weeding plot and lowest was in no weeding plot (Fig. 4).

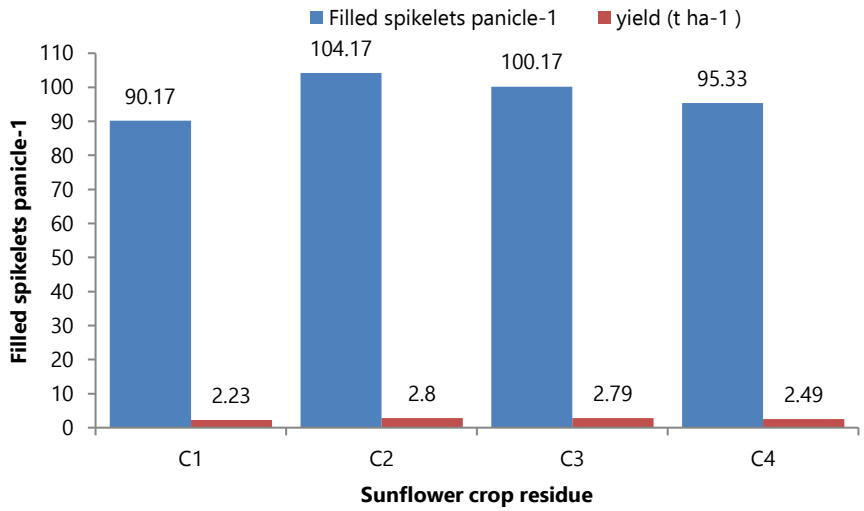

Fig. 3. Effect of crop residue on filled spikelets $panicle^{-1}$ and yield of *Aus* rice in Rice-Sunflower-Rice cropping pattern.

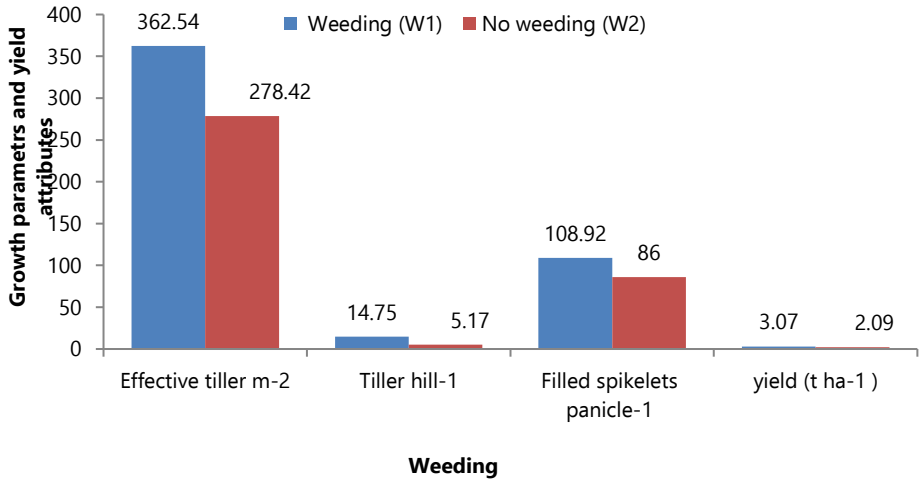

Fig. 4. Effect of weeding on effective tillers m^{-2}, tillers $hill^{-1}$, filled spikelets $panicle^{-1}$ and yield of *Aus* in Rice-Sunflower-Rice cropping pattern.

Rice equivalent yield (REY) of the cropping patterns

There was no significant difference in REY among the treatments. The highest REY was registered in C_4W_1 (19.31 t ha^{-1}) followed by C_2W_1 (18.78 t ha^{-1}) and C_1W_2 (18.65 t ha^{-1}) treatments and the lowest in C_2W_2 (14.83 t ha^{-1}) treatment (Table 5).

Table 5. Rice equivalent yield(t ha^{-1}) of Rice-Sunflower-Rice cropping pattern

Crop residue of sunflower	Weeding (W_1)	No weeding (W_2)
C_1	16.51	18.65
C_2	18.78	14.83
C_3	16.88	16.86
C_4	19.31	15.32
$LSD_{(0.05)}$	NS	NS
CV (%)	12.05	12.05

Discussion

Among the sunflower residue treatments, the significantly higher number of weeds (grass and broadleaf) was recorded in the plots (45.33 and 20.33 m^{-2} respectively) which were not treated with sunflower residue incorporation and the lowest value of weeds (grass and broadleaf) in C_3W_1 (10.00 m^{-2}) and C_3W_2 (14.00 m^{-2}) treatment where *Aus* seeds were directly sown after seven days of sunflower residue incorporation. There was significant reduction of weed number in sunflower residue incorporated plot. This might be due to inhibition of weed growth by allelopathic effect of sunflower residue. Sunflower rhizosphere soil reduces the seedling growth (population, plant height) and yield attributes (seed and biomass) of P. hysterophorus and Trianthemaportulacastrum weeds in pot experiments. The effect of such soil was due to the presence of allelochemicals (p-hydroxybenzoic acid, vanillic acid, caffic acid, ferulic acid) released by sunflower roots in soil (Rawat *et al*., 2011). Sarker*et al*. (2020) also found the highest weed population (9.67 m^{-2}) with no sunflower crop residues and the lowest weed population (1.67 m^{-2}) was found in the treatments where 2.0 t ha^{-1} of sunflower crop residues was used in transplanted Aman rice and also reported that application of sunflower residues reduce weed. Allelopathic effects of sunflower on other crops and weeds are well established in the literature **(**Mahmood *et al*., 2013).

Again the effect of crop residue on fresh weight and dry weight of weeds was significant. The highest value of fresh weight (660.01 g m^{-2}) was found in C_1 (Direct sowing of T. Aus without Sunflower residue incorporation) and dry weight (205.02 g m^{-2}) was found in C_1 treatment and lowest value of fresh weight (535.03 g m^{-2}) and dry weight (125.33 g m^{-2}) was in C_4 (Direct sowing of T. Aus after 14 days of Sunflower residue incorporation) treatment followed by C_3 (Direct sowing of T. Aus after 7 days of Sunflower residue incorporation) treatment. Similar trend in weed dry weight was observed by Sahoo *et al*. (2020). They reported that significantly lower weed dry weight was recorded in the sunflower residue incorporation plot (69.7 g m^{-2}) which was lesser than sunflower residue removal (71.1 g m^{-2}) and control (73.6 g m^{-2}) at 40 days after sowing/transplanting.

Maximum plant height (104.0 cm) of *Aus* rice was found in C_3W_1 treatment followed by C_2W_1 (103.67 cm) andC_4W_1 (102.67 cm) while shortest (99.0 cm) was found in C_1W_1 treatment (control) followed by C_1W_2 (97.67 cm),C_2W_2 (98.33 cm),C_3W_2 (98.67 cm) and C_4W_2 (99.33 cm).

The highest number of effective tiller m^{-2} (403.33) was registered in C_2W_1 treatment followed by C_3W_1 (394.00) and C_1W_1 (385.00) treatments. The lowest number of effective tiller m^{-2} (262.33) in C_1W_2 treatment followed by C_4W_2 (265.33) treatments. Islam *et al.*, (2018) reported the lowest number of effective tiller $hill^{-1}$ due to the severe crop weed competition in the weedy treatment whereas, the highest number was found in weed free treatment because of no crop-weed competition in T. Aman rice. The highest number of panicles m^{-2} (305.00) was recorded from weed free plots by manual weeding in transplanted rice (Tanu *et al*. 2020). Maximum number of tiller $hill^{-1}$ (16.36) was found in

weed free treatment (C_2W_1) followed by C_3W_1 (15.67). The highest number of tiller hill^{-1} may be due to the reduction of inter species competition between crop and weed thus facilitated efficient utilization of resources viz., sunlight, nutrient and moisture to produce effective tillers. The lowest tiller hill^{-1} (4.33) was in weed containing treatment (C_4W_2) followed by C_1W_2 (4.67) treatment.

Again the highest number of filled spikelets panicle^{-1} (114.67) was observed in C_2W_1 followed by C_3W_1 (113.67) treatment and minimum number of filled spikelets panicle^{-1} (75.33) was found in C_1W_2 treatment. The reason for higher plant height, more number of Effective tiller m^{-2} and filled spikelets panicle^{-1} in the weed free treatments might be due to the fact that there was lower weed-crop competition in terms of dry matter production of weeds as well as good source sink relationship which allowed the crop to absorb the required amount of nutrient, water and sunlight for its growth, production of panicles m^{-2} and grains panicle^{-1}. The highest number of grains panicle^{-1} (120.78) was recorded in weed-free treatment and Weedy check treatment gave the lowest no. of grains panicle^{-1} (78.85) in transplanted rice by Tanu *et al.* **(**2020**).** These results are also the substantiating with the results of Acharya and Bhattacharya (2013**).**

The highest yield (3.32 t ha^{-1}) was observed in C_3W_1 treatment followed by C_2W_1 (3.21 t ha^{-1}) treatment and lowest yield was recorded in C_1W_2 (1.72 t ha^{-1}) treatment followed by C_4W_2 (1.99 t ha^{-1}) treatment. From the yield data it was observed that in all cases maximum yield was observed in weed free condition and the lowest was in weed containing treatments.

Crop residue incorporation of sunflower had significant effect on filled spikelets panicle^{-1} and yield (t ha^{-1}) of *Aus* rice. The highest filled spikelets panicle^{-1} (104.17) and yield (2.80 t ha^{-1}) of *Aus* rice was observed in C_2 (direct sowing of T. Aus immediately after Sunflower residue incorporation) treatment and lowest was in C_1 (Direct sowing of T. Aus without Sunflower residue incorporation) treatment. Sarker *et al*. (2020) also found maximum number of grains panicle^{-1} (141.7) by using sunflower crop residues at 2.0 t ha^{-1} in transplanted *Aman* rice and the lowest number of grains panicle^{-1} (66.83) was produced by no crops residues treatment. 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).

Effective tiller m^{-2}, tiller hill^{-1}, filled spikelets panicle^{-1} and yield (t ha^{-1}) of *Aus* were significantly affected by weed management practices. The highest value of effective tiller m^{-2} (362.54), tiller hill^{-1} (14.75), filled spikelets panicle^{-1} (108.92) and yield (3.07 t ha^{-1}) of *Aus* was found in weeding plot and lowest was in no weeding plot. Bhurer *et al.* (2013) reported that weed control treatments significantly increased the number of paniclesm^{-2}, panicle weight, filled grains/panicle and thousand grain weight.

Conclusion

Results of the present study reveal that application of sunflower residue reduces weed infestation and it has positive effect on yield and yield attributes of rice. Therefore, sunflower residues could be a prospective weed control tool for crop production in modern agricultural science. So, further study is neededon this regard for several yearsto draw a better conclusion on yield performance of different crops, weed status and soil health.

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