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Weed Science
ORIGINAL ARTICLE

Weed suppression and crop performance of rice (cv. BRRI dhan29) as influenced by application of different crop residues

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A B S T R A C T

Recent agriculture is productivity-oriented and relies principally on artificial inputs to tackle weeds and other pest problems. Exhaustive herbicide apply to control weeds over the last few decades is posing severe ecological and environmental threats to the globe. The presence of crop residues on the soil surface as mulch suppresses weeds through allelopathy and thus reduces a greater reliance on herbicides. Considering mentioned issue an experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2014 to June 2015 to evaluate the effect of time of application of different crop residues on weed management and crop performance of rice. The experiment consists of three time of crop residues application; i) crop residues application before transplanting, ii) crop residues application one week after transplanting, and iii) crop residues application two weeks after transplanting and five different crop residues treatments such as no weeding and no crop residues, sorghum residue, maize residue, mustard residue, and rice residue in dried condition including shoot and leaves together. The experiment was laid out in a split plot design with three replications. Four weed species belonging to three families infested the experimental plots. Weed population and weed dry weight were significantly affected by time of crop residues application and crop residues treatment. 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. Yield and yield contributing characters produced by application of crop residues before transplanting was the highest among the time of application. The highest reduction of grain yield was obtained in no weeding treatment while sorghum crop residue reduced the lowest grain yield. Similarly, most of the yields contributing characters were highest that are obtained from sorghum crop residues treatment. BRRI dhan29 under applied crop residues before transplanting treatment condition produced the highest grain and straw yields followed by applied crop residues one week after transplanting. Results of this study indicate that different crop residues showed potentiality to suppress weed growth. Therefore, crop residues might be used as an alternative tool for weed management.

INTRODUCTION

Rice is the vital food for more than two billion people in Asia including Bangladesh and four hundreds millions of people in Africa and Latin America (IRRI 2010).Bangladesh has three rice growing seasons among which *Boro* rice comprises about 47,60,055 hectares with a production of 1,87,78,154 M. tons (BBS 2013). Average yield of *Boro* rice is low compared with other rice producing countries like China, India, Indonesia etc and this is due to use of traditional local varieties, high weed

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infestation and poor crop management. Among these reasons high weed infestation are most serious problems for the lower productivity of *Boro* rice. 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). It has been estimated that 11.5% of the yield of major crops of the world is lost due to weeds. Weeds are very serious problem in transplanted rice (Walia et al. 2006). Aerobic soil conditions and dry-tillage practices, besides alternate wetting and drying conditions, are conducive for germination and growth of highly competitive weeds, which cause grain yield losses of 50–91 % (Elliot et al.1984; Fujisaka et al.1993). Hence, there is strong need to use modern science along with indigenous wisdom of farmers to enhance crop residues of rice production.

Crop residue mulch has the potential to control weed growth (Erenstien 2002; Sidhu et al. 2007), thereby suppressing the possible negative effect of increased weed intensity in reduced and no tillage systems. Mulch controls weed growth by shading or through allelopathic effects (Erenstien 2002), and it might reduce herbicide requirements and weed competition for nutrients and water. Increasing the amount of rice residue as mulch in wheat can increase the suppression of weeds. Many others have also reported significant and sometimes very large reductions in weed biomass with mulch (Rahman et al. 2005).Long-term straw application will build soil organic matter level and N reserves, and also increase the availability of macro- and micro-nutrients (Yadvinder et al. 2005). It was hypothesized that crop residues mulching can be applied as organic and sustainable weed management approach in rice crop. Keeping the above facts in view, the present study was conducted to investigate the weed suppressing ability of different crop residues and to determine the optimum time of application of crop residues for efficient weed management as well as performance of rice.

MATERIALS AND METHODS

The experiment was conducted in Boro seasons at Agronomy Field Laboratory, Bangladesh University, Mymensingh during the period from December 2014 to June 2015.The variety BRRI dhan 29 was used as test material. The experimental treatment consists of time of crop residues application viz. i) crop residues application before transplanting (T_1), ii) crop residues application one week after transplanting (T_2), iii) crop residues application two weeks after transplanting (T_3) and crop residues viz. control (no weeding, no crop residues) (C_1), sorghum @ 2.0 t ha^{-1} (C_2), maize @ 2.0 t ha^{-1}(C_3), mustard @ 2.0 t ha^{-1} (C_4), rice @ 2.0 t ha^{-1} (C_5). The experiment was laid out in a split- plot design assigning time of crop residues application in main plot and different crop residues in split plot with three replications. Each plot size was 2m × 2m. The spacing between plots to plot was 0.5 m. The distance between blocks was maintained 1m. Land preparation for rice cultivation was done by 3-4 times plowing and cross-plowing followed by laddering. Fertilizers and Manure were applied at the following doses: Urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate @ 240, 100, 120, 110, 10 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 installments at 15, 30 and 45 days after transplanting (DAT). Transplanting was done in 18 January at the rate of three seedlings per hill with 25 cm × 15 cm spacing. Weed population, weed dry weight and % inhibition were measured to evaluate the performance of different crop residues. Besides, plant height was also measured at 25, 50 and 75 DAT to compare the performance of crop residues on plant growth. The crops were harvested on 6 May, 2015 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 l 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}. Data were statistically analyzed using the Analysis of Variance technique with the help of statistical computer package MSTAT-C. The mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Infested weed species in the experimental field

Four major weed species belonging to three families infested the experimental field. The weeds of the experimental plots were *Echinochloa crusgalli* (Shama), *Scirpus juncoides* (Chesra), *Monochoria vaginalis* (Panikachu) and *Cyperus difformis* (Sabujnakful). 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.* Other minor weed species are not mentioned here.

Time of application and different crop residues interaction influence on Shama *(Echinochloa crusgalli)*

The interaction on weed population, dry weight and growth inhibition of shama were significant .The highest weed population (28.33 m^{-2}) was found in T_1C_1 (crop residues application before transplanting x no crop residues), second highest weed population (19.67 m^{-2}) was found in T_1C_5 (crop residues application before transplanting x rice crop residues) and the lowest was found in T_1C_2 (crop residues application before transplanting x sorghum crop residues) treatment (Table 1). The highest weed dry weight (11.3g) was found in T_3C_1 (crop residues application at two weeks after transplanting x no crop residues) and the lowest weed dry weight was found in T_1C_2 (crop residues application before transplanting x sorghum crop residues). The growth inhibition of weed was the highest in T_1C_2 (crop residues application before transplanting x sorghum crop residues) (59.15 %) and the lowest inhibition (0.00 %) was observed in T_1C_1, T_2C_1 and T_3C_1 presented in Table 1.

Table 1. Combined effects time of application and crop residues on Shama (*Echinochloa crusgalli)* weed control

Treatment combination	Shama *(Echinochloa crusgalli)* Number	Dry weight (g)	% growth inhibition
T_1C_1	28.33 a	10.8	0.00
T_1C_2	12.00 g	4.40	59.15
T_1C_3	18.33 bc	6.90	36.29
T_1C_4	15.00 d-g	5.36	50.25
T_1C_5	19.67 b	6.00	44.23
T_2C_1	27.33 a	10.8	0.00
T_2C_2	16.00 c-f	4.90	54.48
T_2C_3	13.67 fg	7.60	29.21
T_2C_4	14.00 fg	5.97	44.55
T_2C_5	17.33 b-e	6.50	39.98
T_3C_1	25.33 a	11.3	0.00
T_3C_2	14.33 efg	5.86	48.16
T_3C_3	25.33 a	8.33	26.49
T_3C_4	15.33 c-f	7.03	37.31
T_3C_5	18.00 bcd	7.60	32.57
Level of significance	**	NS	NS
CV (%)	9.14	6.07	17.50

In a column, figures with the same letters do not differ significantly as per DMRT, ** =Significant at 1% level of probability, NS = Not significant, Here, T_1 = Crop residues application before transplanting, T_2 = Crop residues application one week after transplanting, T_3 = Crop residues application two week after transplanting, C_1 = Control (No weeding, no residues), C_2 =Sorghum residue, C_3 = Maize residue, C_4 = Mustard residue, C_5 = Rice residue.

Time of application and different crop residues interaction influence on Chesra *(Scirpus juncoides)*

Combined effect of time of application and crop residues was significant for inhibition. The interaction on weed population, dry weight and growth inhibition of Chesra were significant. The highest weed population (28.33 m^{-2}) was found in T_1C_1 (crop residues application before transplanting x no crop residues) and the lowest was found in T_3C_4 (crop residues application at two weeks after transplanting x mustard crop residues) treatment (Table 2).The highest weed dry weight (15.70g) was found in T_1C_1(crop residues application before transplanting x no crop residues) which is statistically similar to T_2C_1 (crop residues application at one week after transplanting x no crop residues) treatment (Table 2) and the lowest weed dry weight was found in T_3C_2 (crop residues application at two weeks after transplanting x sorghum crop residues). The percent growth inhibition of Chesra weed was the highest (57.75%) in T_1C_2 (crop residues application before transplanting x sorghum crop residues) and the lowest inhibition (0.00 %) was observed in T_1C_1, T_2C_1 and T_3C_1 presented in (Table 2).

Table 2. Combined effects time of application and crop residues on Chesra *(Scirpus juncoides)* weed control

Treatment combination	Chesra*(Scirpus juncoides)*		
	Number	Dry weight (g)	% growth inhibition
T_1C_1	44.00 a	15.70 a	0.00 i
T_1C_2	33.00 bc	6.63 gh	57.75 a
T_1C_3	26.67 cde	10.20 bc	35.03 f
T_1C_4	29.67 cd	8.23 ef	47.56 c
T_1C_5	25.00 de	8.80 de	43.95 d
T_2C_1	38.00 ab	14.83 a	0.00 i
T_2C_2	44.00 a	6.70 gh	54.83 b
T_2C_3	33.00 bc	10.73 b	27.64 g
T_2C_4	26.67 cde	8.70 de	41.35 e
T_2C_5	29.67 cd	9.50 cd	35.96 f
T_3C_1	25.00 de	9.46 cd	0.00 i
T_3C_2	41.00 a	4.90 i	48.24 c
T_3C_3	28.00 cde	7.30 fg	22.89 h
T_3C_4	22.33 e	6.13 h	35.21 f
T_3C_5	33.00 bc	6.66 gh	29.58 g
Level of significance	**	**	**
CV (%)	11.64	6.85	3.69

Details for the symbol are same as Table 1

Time of application and different crop residues interaction influence on Panikachu (*Monochoria vaginalis*)

The highest weed population (2.33 m^{-2}) was found in T_1C_2 (crop residues application before transplanting x sorghum crop residues) and the lowest was found in T_1C_1, which was statistically identical to T_1C_5, T_2C_2, T_3C_1, T_3C_2 and T_3C_3 (Table 3). The highest weed dry weight (0.41g) was found in T_1C_1 (crop residues application before transplanting x no crop residues) (Table 3) and the lowest weed dry weight was found in T_3C_2 (crop residues application at two weeks after transplanting x sorghum crop residues). Apparently, the percent growth inhibition of panikachu weed was the highest (64.50%) in T_1C_2 (crop residues application before transplanting x sorghum crop residues) and the lowest inhibition (0.00 %) was observed in T_1C_1, T_2C_1 and T_3C_1 presented in (Table 3).

Table 3. Combined effects time of application and crop residues on Panikachu (*Monochoria vaginalis*) weed control

Treatment combination	Panikachu (*Monochoria vaginalis*)		
	Number	Dry weight (g)	% growth inhibition
T_1C_1	1.00 c	0.41	0.00
T_1C_2	2.33 a	0.14	64.50
T_1C_3	1.67 b	0.25	37.70
T_1C_4	2.00 ab	0.19	54.10
T_1C_5	1.00 c	0.22	45.08
T_2C_1	1.67 b	0.37	0.00
T_2C_2	1.00 c	0.15	59.63
T_2C_3	2.33 a	0.24	35.08
T_2C_4	1.67 b	0.19	49.86
T_2C_5	2.00 ab	0.22	41.07
T_3C_1	1.00 c	0.25	0.00
T_3C_2	1.00 c	0.11	54.67
T_3C_3	1.00 c	0.17	30.67
T_3C_4	1.67 b	0.14	45.33
T_3C_5	1.67 b	0.16	37.33
Level of significance	**	NS	NS
CV (%)	13.75	16.38	12.50

Details for the symbol are same as Table 1

Time of application and different crop residues interaction influence on Sabujnakful *(Cyperus difformis)*

The highest weed population (32.67 m^{-2}) was found in T_1C_1 (crop residues application before transplanting x no crop residues) and the lowest weed population (11.33 m^{-2}) was found in T_1C_4(Table 4).The highest weed dry weight (11.07g) was found in T_3C_1(crop residues application at two weeks after transplanting x no crop residues) and the lowest weed dry weight (4.40g) was found in T_1C_2 (crop residues application before transplanting x sorghum crop residues) (Table 4). The percent growth inhibition of Sabujnakful weed was the highest (59.53%) in T_1C_2 (crop residues application before transplanting x sorghum crop residues) and the lowest inhibition (0.00 %) was observed in T_1C_1, T_2C_1 and T_3C_1 presented in (Table 4). In case interaction effect, it was non-significant for crop residues and its application time.

Table 4. Combine effects time of application and crop residues on sabujnakful *(Cyperus difformis)* weed control

Treatment combination	Sabujnakful*(Cyperus difformis)*		
	Number	Dry weight (g)	% growth inhibition
T_1C_1	32.67 a	10.93	0.00
T_1C_2	16.33 e	4.40	59.53
T_1C_3	14.00 efg	6.47	40.14
T_1C_4	11.33 g	5.40	50.19
T_1C_5	26.33 bc	5.80	46.50
T_2C_1	26.67 bc	10.43	0.00
T_2C_2	32.00 a	4.63	55.36
T_2C_3	22.00 d	6.77	34.75
T_2C_4	13.00 fg	5.73	44.95
T_2C_5	13.67 efg	6.30	39.15
T_3C_1	25.67 bc	11.07	0.00
T_3C_2	24.67 cd	5.57	49.59
T_3C_3	28.33 b	8.10	26.66
T_3C_4	15.67 ef	6.47	41.44
T_3C_5	14.33 efg	7.17	35.00
Level of significance	**	NS	NS
CV (%)	8.21	7.47	10.39

Details for the symbol are same as Table 1

Time of application and different crop residues interaction influence on plant height

Combined effect of application time and crop residues showed non-significant effect on plant height .The highest plant height (34.63, 61.58 and 78.27 cm) was found in T_1C_2 (crop residues application before transplanting x sorghum crop residues) at all days of sampling and the lowest plant height (28.25, 41.50 and 58.07 cm) was found in T_3C_1 (crop residues application at two weeks after transplanting x no crop residues) at all sampling dates.

Table 5. Combined effects of time of application and crop residues on plant height at different days after transplanting (DAT)

Treatment combination	Plant height (cm)		
	25 DAT	50 DAT	75 DAT
T_1C_1	30.50	49.50	73.90
T_1C_2	34.63	61.58	78.27
T_1C_3	31.17	49.75	75.68
T_1C_4	31.50	53.75	77.11
T_1C_5	31.83	50.58	75.78
T_2C_1	28.33	44.33	61.50
T_2C_2	33.82	60.92	73.07
T_2C_3	28.80	48.08	63.46
T_2C_4	32.75	52.50	68.28
T_2C_5	32.65	50.25	67.02
T_3C_1	28.25	41.50	58.07
T_3C_2	33.00	58.25	72.95
T_3C_3	29.50	48.03	60.38
T_3C_4	31.98	52.25	67.25
T_3C_5	32.20	49.75	66.96
Level of significance	NS	NS	NS
CV (%)	7.57	4.04	4.69

Details for the symbol are same as Table 1

Time of application and different crop residues interaction influence on yield attributes and yield

Combine effect of time of application and crop residues showed significant variation in case ofeffective tillers hill^{-1} (Table 6). The highest number of effective tillers hill^{-1} (7.97) was obtained from T_1C_2 (crop residues application before transplanting and sorghum residues application) treatment, while the lowest number of effective tillers hill^{-1} (6.10) was obtained from T_3C_3 (crop residues application at two weeks after transplanting and maize crop residues application) treatment (6). Panicle length was non-significant for both times of application and crop residues. The highest panicle length (22.33 cm) was observed in T_1C_2 (crop residues application before transplanting and sorghum residues application) treatment, while the shortest panicle length (20.04 cm) was observed in T_3C_1 (crop residues application at two weeks after transplanting and no crop residues application) treatment (Table 6). Interaction effect of time of application and crop residues showed non-significant variation in case of grains panicle^{-1}. The highest grains panicle^{-1} (115.0) was produced in T_1C_2 (crop residues application before transplanting and sorghum residues application) treatment, while the lowest grains panicle^{-1} (99.45) was produced in T_3C_1 (crop residues application at two weeks after transplanting and no crop residues application) treatment (Table 6). Interaction effect was also non-significant for 1000-grain weight. The highest weight of 1000 grains (22.77g) was recorded in T_3C_2 (crop residues application at two weeks after transplanting and sorghum crop residues application) treatment (Table 6).Combined effect of time of application and crop residues showed non-significant variation in grain yield. However highest grain yield (4.53 t ha^{-1}) was observed in sorghum residues application when applied before transplanting while the lowest grain yield (1.02 t ha^{-1}) was observed in T_2C_1 (crop residues application at one week after transplanting and no crop residues application) treatment (Figure 1). The lowest grain yield (1.02 t ha^{-1}) in the no weed management practices might be due to the poor performance of yield characters like highest number of effective tillers hill^{-1}and highest number of grains/spikelet panicle^{-1}. Because severe weed infestation occurred in the plots due to competition for nutrient, water, air, sunlight and space between weed and rice plants. Similar results were also observed by Gogoi et al. (2001); Attalla and Kholosy (2002). Interaction effect of time of application and crop residues showed significant variation in straw yield. The highest straw yield (4.93 t ha^{-1}) was observed in sorghum residues application when applied before transplanting and the lowest straw yield (1.27 t ha^{-1}) was produced by T_3C_1 (crop residues application at two weeks after transplanting and no crop residues application) treatment (Figure 2).

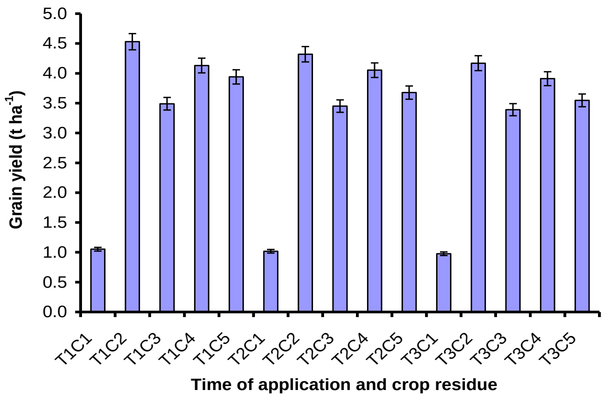

Figure 1. Effect of interaction between the time of application and different crop residues on grain yield

T_1 = Crop residues application before transplanting, T_2 =Crop residues application one week after transplanting, T_3 = Crop residues application two weeks after transplanting, C_1 = Control (No weeding, no residue), C_2 =Sorghum residue, C_3 = Maize residue, C_4 = Mustard residue, C_5 = Rice residue

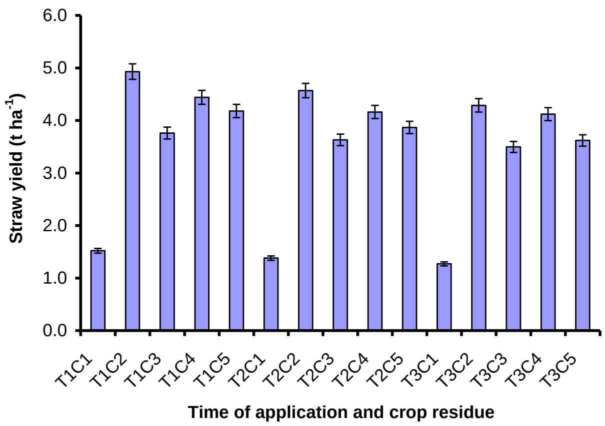

Figure 2. Effect of interaction between the time of application and different crop residues on straw yield. Other details are same as Figure 1.

Table 6. Combined effects of time of application and crop residues on yield contributing characters of rice

Treatments combination	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	1000 grain weight (gm)	Harvest index (%)
T_1C_1	73.51	7.33	6.77	20.36	105.3	21.29	40.94
T_1C_2	79.38	9.87	7.97	22.33	115.0	21.38	47.92
T_1C_3	74.92	7.80	7.40	21.40	107.9	21.50	48.17
T_1C_4	76.49	8.20	7.73	22.08	112.5	21.77	48.20
T_1C_5	74.93	8.00	7.47	21.73	110.1	21.49	48.52
T_2C_1	72.63	6.70	6.20	20.09	101.9	21.73	42.54
T_2C_2	79.98	8.96	7.20	21.90	112.7	21.37	48.57
T_2C_3	76.18	7.66	6.67	21.35	105.9	21.83	48.74
T_2C_4	78.66	8.10	7.07	21.70	110.4	21.81	49.35
T_2C_5	78.34	7.86	7.03	21.65	107.4	21.30	48.73
T_3C_1	73.01	6.53	6.13	20.04	99.45	22.03	43.65
T_3C_2	77.30	8.43	6.83	21.45	109.7	22.77	49.33
T_3C_3	75.80	7.50	6.10	20.84	104.0	21.81	49.17
T_3C_4	76.25	7.93	6.93	21.31	106.3	22.47	48.69
T_3C_5	76.78	7.80	6.67	21.25	105.2	22.44	49.48
Level of significance	NS	NS	NS	NS	NS	NS	NS
CV (%)	3.08	7.59	5.63	2.30	3.18	3.95	3.82

Details for the symbol are same as Table 1

Interaction effect of time of application and crop residues showed non- significant variation in harvest index. The highest harvest index (49.48%) was observed in T_3C_5 (crop residues application at two weeks after transplanting and rice crop residues application) and the lowest harvest index (40.94%) was produced by T_1C_1 (crop residues application before transplanting and no crop residues application) treatment (Table 6).

CONCLUSION

Crop residues had significant effect on yield and yield contributing characters. Application of sorghum crop residues produced maximum grain yield followed by mustard crop residues treatment while the lowest grain yield was produced by no crop residues treatment. From the above results it was found that application of crop residues before transplanting and application of sorghum crop residues treatment exhibited the superior effect for most of the studied traits. Result of the present study revealed that different crop residues showed significant effects for suppressing weed growth. Therefore, different crop residues could be a potential source of efficient weed management tool for production of rice.

CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this paper.

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