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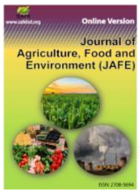

Original Article

Assessment of combined effect of *Eleocharis atropurpurea* and *Fimbristylis dichotoma* residues on the yield performance of T. *aman* rice

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A B S T R A C T

The current agricultural system is seeking a biological solution to lesson hazardous impacts from the use of chemicals to control weeds in rice production. Plant allelopathy is one of the ways where allelopathic plant inhibits its surrounding plants by releasing allelopathic substances. The present experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 2019 to study the allelopathic effects of the and residues of *Eleocharis atropurpurea* and *Fimbristylis dichotoma* on weed management and the yield performance of *aman* rice. The field experiment consisted of three rice varieties i.e BRRI dhan34, Nizershail and Kalozira and five treatments such as 0, 1.0, 2.0, 3.0 t ha^{-1} and farmer's practices. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The highest grain yield (4.44 t ha^{-1}) as well as the yield contributing character was recorded in Kalozira and the lowest grain yield (3.94 t ha^{-1}) was obtained in the BBRI dhan34. The highest number of effective tillers hill^{-1}, number of grains panicle^{-1}, 1000-grain weight, grain and straw yields were observed when the residue of *E. atropurpurea* and *F. dichotoma* was applied at 3 t ha^{-1}. Rice cultivar kalozira with the incorporation of *E. atropurpurea* and *F. dichotoma* residue at 3 t ha^{-1} produced the highest grain yield (5.08 t ha^{-1}) and straw yield (6.77 t ha^{-1}). Results of this study indicate that *E. atropurpurea* and *F. dichotoma* residue showed potentiality to inhibit weed growth and it has a significant effect on yield of *aman* rice.

Introduction

Rice (*Oryza sativa* L.) is the world's most important cereal crop and a primary food source for more than one third of world's population. A total of 49% calories consumed by the human population come from rice, wheat and maize where 23% are provided by rice, 17% by wheat and 9% by maize. Thus, almost one-fourth of the calories consumed by the entire world population come from rice (Subudhi *et al.*, 2006). Agro-based developing country like Bangladesh is striving hard for rapid development of its economy. Bangladesh is well known as a land of rice growers and rice eaters (Emi *et al.*, 2021). Rice is the most extensively cultivated crop in Bangladesh and the staple food for the people. Geographic and agronomic condition of Bangladesh are favorable for rice cultivation which occupies nearly 74.85% of the total net cropped area of the country with annual production is 34.71 million metric tons from 11.38 million hectors. Weed, an undesirable plant, creates severe problem in agriculture by interfering with natural resources and documented as one of the major and oldest constraints in maximizing rice production (Varanasi *et al.*, 2015). In weed-crop competition, high capability in taking of essential light, water, nutrients, and space by weeds makes them dominant to crops. Moreover, vigorous seed producing capacity and seed dormancy, ability to adapt in any conditions also makes the weeds a strong competitor of crops (Tanveer *et al.*, 2010; Harun *et al.*, 2014; Islam and Kato-Noguchi, 2014). In Bangladesh, a number of weeds grow in crop field, which compete with crop and reduce the crop yield. Control of weed, therefore, is essential to successful production of rice. Cultural, physical, biological and chemical methods are used to control of weeds in Bangladesh. Among them, farmers mostly used chemical method to control weed but it has negative effects both on human and environment. Therefore, researchers now searching some biological methods to control weed in rice cultivation. In these circumstances, plant allelopathy would a biological solution (Fay and Duke, 1977; Soltys *et al.*, 2013). The term allelopathy, originated from the Greek word ''allelon'' meaning each other and ''pathos'' meaning suffering and was coined plant physiologist, Hans Molisch, University of Vienna, Austria. The concept of allelopathy received new attention in 1974, after the publication of the first book in English on allelopathy by Elroy L. Rice. He defined allelopathy as the effect of one plan on other plants through the release of chemical compounds in the environment. This definition is largely accepted and includes both positive (growth promoting) and negative (growth inhibiting) effects (Quintana *et al.*, 2008; Weidenhamer and Callaway, 2010). Kohli *et al.* (1998) and Singh *et al.* (2001) opined that allelopathy refers to any direct or indirect effect of plants on other plants through the release of chemicals and plays an important role in many agro-ecosystems. Allelopathy is defined as a biochemical interaction between different plant species (Qasem, 1995; Nishida *et al.*, 2005; Batish *et al.*, 2007a, b).

Materials and methods

The present research work was carried out at the Agronomy Field Laboratory Bangladesh Agricultural University, Mymensingh during the period from June to December, 2019 to investigate the effect of Eleocharis Atropurpurea and Fimbristylis Dichotoma residues on the yield of T. aman rice. The materials used and methods followed in this present study have been discussed. The experimental field was located at 24°25´ N latitude and 90°50´ E longitude at an elevation of 18 m above the sea level belonging to non-calcareous dark grey flood plain soil under the Sonatala series of the Old Brahmaputra Flood plain which falls under Agro-ecological region of the Old Brahmaputra Flood plain (AEZ-9) (FAO and UNDP, 1988). The experimental treatment consisted of two factors. They are as follows, Factor A: Residues of *E. Atropurpurea* and *F. Dichotoma;* No crop residues (R_1), 1.0 tha^{-1} (R_2), 2.0tha^{-1} (R_3), 3.0tha-1(R_4), Farmars practices (R_5). Factor B: Rice Variety (3): BRRI dhan34 (V_1), Nizershail (V_2), Kalozira (V_3). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The total number of plot was 45. Each plot size was 2.5 m x 2.0 m. A piece of land was selected for raising seedlings. The land was puddled well with country plough followed by leveling with a ladder. The sprouted seeds were sown in three different nursery beds on 7 July 2019 Proper care was taken to raise the healthy seedlings in the nursery bed. Weeds were removed and irrigation was given in the nursery bed as and when necessary. The field was prepared on 30 July 2019. The field was ploughed with a tractor drawn plough follow land preparation. Weeds and stubbles were removed and cleaned from individual followed by laddering. The layout of the field was made after final plots. The experimental plots for BRRI dhan34, Nizershail and Kalozira were fertilized, with urea, triple super phosphate, muriate of potash and gypsum @130, 55, 82, 10 kg ha^{-1}, respectively. Except urea the whole amount of others fertilizer was applied before final land preparation. Urea was top dressed in two installments at 20 and 40 days after transplanting (DAT). The residues of *E. atropurpurea* and *F. dichotoma* residues were applied at 7 days before transplanting of rice at the time of final land preparation. After that residues were mixed well to the respective plots by a spade. The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on 15 August, 2019 and they were immediately transferred to the main field. Healthy and similar sized seedlings were selected for transplanting. Seedlings were transplanted in the well prepared puddled field on 15 August, 2019 at the rate of three seedlings hill^{-1} maintaining row and hill distance of 25 cm and 15 cm, respectively. Data on yield and yield contributing characters were recorded from five randomly selected sample plants from each plot on the following parameters should be done for maximum yield: Plant height (cm), Number of total tillers hill$^{-1,}$ Number of effective tillers hill$^{-1,}$ Number of non-effective tiller hill$^{-1,}$ Panicle length (cm), Number of grains panicle$^{-1,}$ Number of sterile spikelets panicle$^{-1,}$ 1000- grain weight (g), Grain yield (t ha^{-1}), Straw yield (t ha^{-1}), Biological yield (t ha^{-1}), Harvest index (%). The crops were harvested at full maturity. Maturity of crops was determined when 90% of the grains became golden yellow in color. BRRI dhan34 were harvested on 27-11-2019, nizershail were harvested on 29-11-2019 and kalozira were harvested on 30-11-2019, respectively. Then the harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. The crop was then threshed and the fresh weights of grain and straw were recorded from an area of 1 m^2 in the middle of each plot. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of grain and straw yield were recorded and converted to t ha^{-1}. Harvest index is the relationship between grain yield and biological yield

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

The data were compiled and tabulated in proper form and subjected to 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 (DMRT) as laid out by Gomez and Gomez (1984).

Results and Discussion

Yield and yield contributing characters at harvest

The plant height varied significantly among the varieties. The tallest plant (152.64cm) was observed in Kalozira and the shortest plant was observed in BRRI dhan34 (146.28 cm) (Figure 1). Plant height is a varietal character and it is the genetic constituent of the cultivar, therefore, plant height was different among the three varieties. The results are consistent with the findings of Bisne *et al.* (2006) who observed plant height differed significantly among the varieties. Number of effective tillers hill^{-1} was significantly influenced by variety. The highest number of effective tillers hill^{-1} (13.70) was found in Kalozira and the lowest number of effective tillers hill^{-1} was found in BRRI dhan34 (Figure 1). Panicle length was not significant by different varieties. Numerically the longest panicle length (25.56 cm) was recorded in variety Kalozira and the shortest panicle (24.05 cm) was recorded in BRRI dhan34 (Figure 1). Number of panicle was significantly influenced by different varieties. The highest number of grains (152.44) was observed in Kalozira and the lowest one (137.40) was found in BRRI dhan34 (Figure 1). Weight of 1000-grain was significantly affected by different varieties of rice The highest thousand grain weight (19.82) was found in Kalozira and the lowest one was found

(17.61g) in BRRI dhan34 (Figure 1). The studied variety differed significantly in respect of grain yield. The highest grain yield (4.44t ha^{-1}) was obtained in Kalozira (Figure 1). The increased yield might be due to the lowest number of sterile spikelet panicle^{-1}. The lowest grain yield (3.94t ha^{-1}) was obtained in BRRI dhan34. Straw yield was significantly influenced by three varieties. The highest straw yield (5.61 t ha^{-1}) was found in Kalozira and the lowest straw yield (5.12 t ha^{-1}) was found in BRII dhan34 (Figure 1). Biological yield was significantly affected by variety. The highest biological yield (10.05t ha^{-1}) was found in Kalozira and the lowest biological yield (9.07t ha^{-1}) was found in BRRI dhan34 variety (Figure 1). Harvest index was significantly affected by variety. The highest harvest index (44.42%) was found in Kalozira rice variety and the lowest harvest index (43.49%) was found in nizershail (Figure 1).

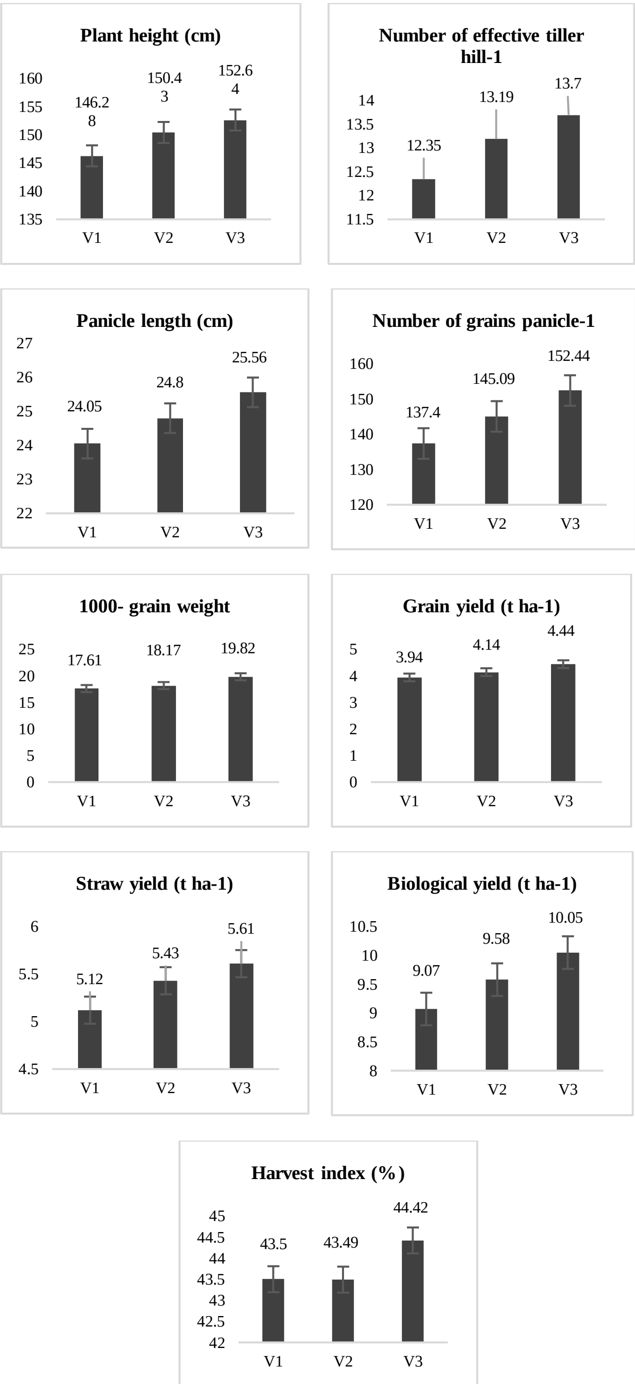

Figure 1: Yield and yield contributing characters at harvest.

Effect of *E. atropurpurea* (Retz.) and *F. dichotoma* residues

Plant height was significantly affected by *E. atropurpurea* (Retz.) and *F. dichotoma* residues. The tallest plant (160.12 cm) was found in R_4 (3.0 t ha^{-1}) treatment and the shortest plant (132.29cm) was found in R_1 (no crop residue) treatment (Figure 2). The results revealed that application of 3.0-ton *E. atropurpurea* and *F. dichotoma* residues ha^{-1} produced the highest plant height. This might be due to the availability of more nutrients from a weed free environment. Number of effective tillers hill^{-1} was significantly influenced by *E. atropurpurea* and *F. dichotoma* residues. The highest number of effective tillers hill^{-1} (14.81) was produced by R_4 (3.0 t ha^{-1}) treatment. The lowest number of effective tillers hill^{-1} (11.42e) was produced by R_1 (no residue) treatment (Figure 2). Panicle length was significantly influenced by *E. atropurpurea* and *F. dichotoma* residues. The longest panicle (25.91 cm) was observed in R_4 (3.0 t ha^{-1}) treatment and the shortest one (23.60cm) was observed in R_1 (no residue) treatment (Figure 2). Number of panicle was significantly influenced by *E. atropurpurea* and *F. dichotoma* residues. The highest number of grains panicle^{-1} (166.48) was produced by R_4 (3.0 t ha^{-1}) treatment while the lowest number of grains panicle^{-1} (120.99) was found R_1 (no residue) treatment. It indicated that weed free condition encouraged the number of grains panicle^{-1} and negative effect of weeds on plant growth resulted in decreased number of grains panicle^{-1} (Figure 2). Weight of 1000-grain was significantly affected by *E. atropurpurea* and *F. dicotoma* residues. The highest 1000-grain weight (19.65g) was recorded in R_4 (3.0 t ha^{-1}) treatment and the lowest 1000-grain weight (17.23g) was observed in R_1 (no residue) treatment (Figure 2). Grain yield was significantly influenced by *E. atropurpurea* and *F. dichotoma* residues. The highest grain yield (4.89 t ha^{-1}) was produced by R_4 (3.0 t ha-$^{-1}$) treatment and the lowest grain yield (3.38 t ha^{-1}) was produced by R_1 (no residue) treatment (Figure 2). Incorporation of 3.0-ton *E. atropurpurea* and *F. dichotona* residue ha^{-1} decrease weed emergence in the rice field and produced maximum grain yield also. It might be due to application of residues added organic matter to the soil and enhance grain yield. On the other hand, control plot (no residue) showed maximum weed population and highest dry weight of weed. The weeds compete with the crop for nutrient, water, air, sunlight and space and so grain yield decreased. Uddin and Pyon (2010) also reported the similar results, where crop residues influenced in crop performance. Straw yield was significantly influenced by *E. atropurpurea* and *F. dichotoma* residues. The highest straw yield (6.47t ha^{-1}) was observed in 3.0-ton *E. atropurpurea* and *F. dichotoma* residue ha^{-1} treatment, and the lowest straw yield (4.00t ha^{-1}) was observed in R_1 (no residue) treatment (Figure 2). *E. atropurpurea* and *F. dichotoma* residues had significant influence on biological yield. The highest biological yield (11.37 t ha^{-1}) was obtained in R_4 (3.0 t ha^{-1}) treatment and the lowest biological yield (7.39 t ha^{-1}) was obtained in R_1 (no residue) treatment (Figure 2). Variations in biological yield among the weed control treatment were dependent upon the severity of weed infestation and climatic condition. Higher weed infestation not only reduced grain yield and finally influenced straw yield as well as biological yield. Harvest index was significantly influenced by *E. atropurpurea* and *F. dichotoma* residues. The highest harvest index (45.81 %) was observed in R_1 (no residue) treatment, and the lowest harvest index (42.34%) was observed in R_5 (farmers practice) treatment (Figure 2).

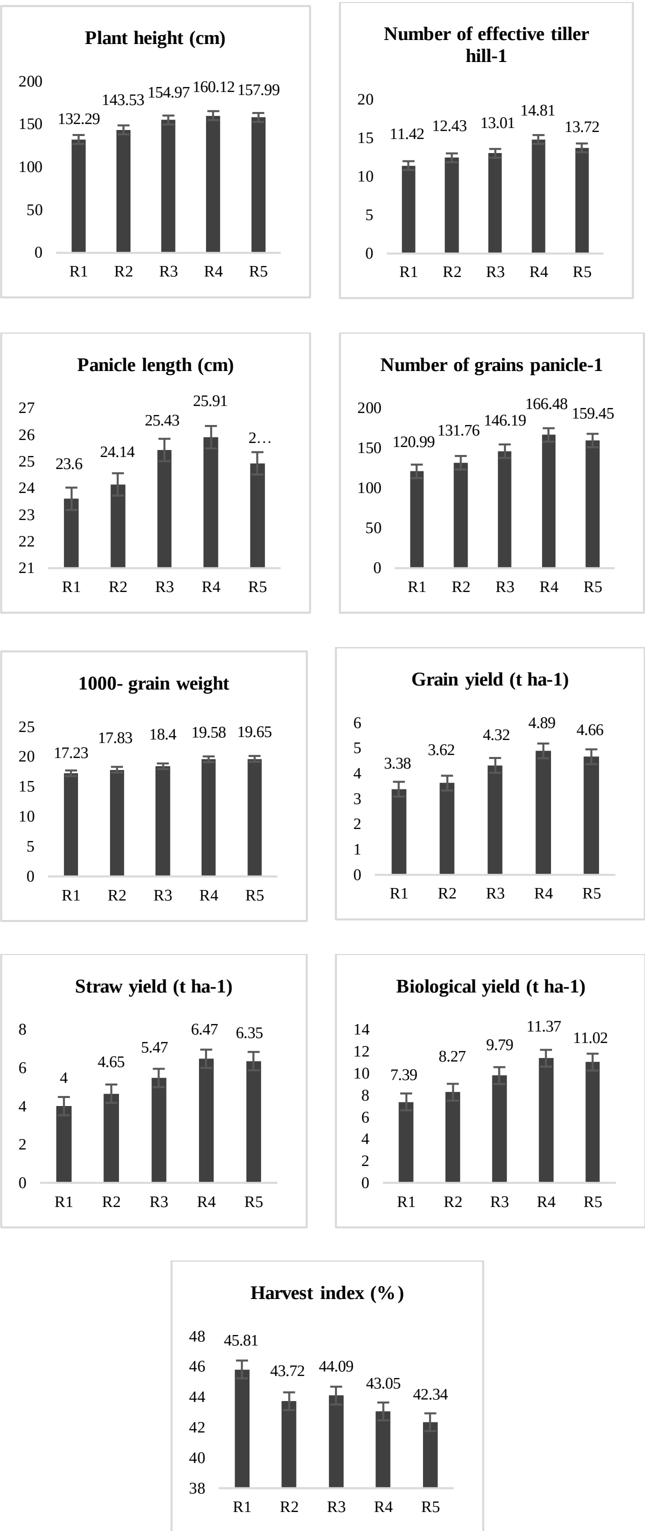

Figure 2: Effect of *E. atropurpurea* (Retz.) and *F. dichotoma* residues.

Effect of interaction between variety and *E. atropurpurea* and *F. dichotoma* residues

The effect of interaction between variety and *E. atropurpurea* and *F. dichotoma* residues was not significant for plant height. Numerically, the tallest plant (160.12 cm) was obtained from Kalozira variety in R_4 (3.0-ton *E. atropurpurea* and *F. dichotoma* residues ha^{-1}) treatment and BRRI dhan34 produced the shortest plant height (132.29) in R_1 (no residue) treatment (Table 1). The effect of interaction between variety and *E. atropurpurea* and *F. dichotoma* residues was not significant for effective tillers $hill^{-1}$. The highest number of effective tillers $hill^{-1}$ (15.35) was produced by Kalozira in R_4 (3.0 t ha^{-1}) treatment, while the lowest number of effective tillers $hill^{-1}$ (10.38k) was found from V_1R_1 (BRRI dhan34× no residue) treatment combination (Table 1). The effect of interaction between variety and *E. atropurpurea* and *F. dichotoma* residues was not significant for panicle length but numerically the longest panicle (26.34 cm) was observed in V_3R_4 (Kalozira× 3.0 t ha^{-1}) treatment and the shortest (22.59 cm) one was found in V_1R_1 (BRRI dhan34 × no residue) treatment (Table 1). Number of grains $panicle^{-1}$ was significantly influenced by the interaction between varieties and residues. The highest number of grains (170.1) was produced by V_3R_4 (Kalozira × 3.0 t ha-1) treatment and the lowest number of grains $panicle^{-1}$ (111.71) was produced by V_1R_1 (BRRI dhan34 × no residue) treatment (Table 1). Weight of 1000-grain was not significantly affected by the interaction between variety and residues. Apparently, the highest 1000-grains weight (20.70 g) was recorded in V_3R_4 (Kalozira × 3.0 t ha^{-1}) treatment and the lowest one (16.38g) was found in V_1R_1 (BRRI dhan34 × no residue) treatment (Table 1). Grain yield was significantly influenced by the interaction between varieties and residues. The highest number of grain yield (5.08t ha^{-1}) was produced by V_3R_4 (Kalozira × 3.0 t ha^{-1}) treatment and the lowest number of grain yield (3.19 t ha^{-1}) was produced by V_1R_1 (BRRI dhan34 × no residue) treatment (Table 1). The lowest grain yield ha^{-1} in the control plot might be due to the poor performance of yield contributing characters like number of tillers $hill^{-1}$ and grain $panicle^{-1}$, Because severe weed infestation occurred in the plots due to competition for moisture, nutrients between weed and rice plants. Similar results were also observed by Gogoi *et al.* (2000), Islam *et al.* (2001). Straw yield was significantly influenced by the interaction between variety and residues. The highest straw yield (6.77 t ha^{-1}) was produced by V_3R_4 (Kalozira × 3.0 t ha^{-1}) treatment and the lowest straw yield (3.91 t ha^{-1}) was produced by V_1R_1 (BRRI dhan34 × no residue) treatment (Table 1). Biological yield was significantly influenced by the interaction between variety and residues. The highest biological yield (11.85 t ha^{-1}) was produced by V_3R_4 (Kalozira× 3.0 t ha^{-1}) treatment and the lowest biological yield (7.10 t ha^{-1}) was produced by V_1R_1 (BRRI dhan34 × no residue) treatment (Table 1). Harvest index was significantly influenced by the interaction between variety and residues. The highest harvest index (47.07%) was observed in V_3T_1 (Kalozira × no residue) treatment and the lowest harvest index (41.55%) was observed in V_2T_5 (nizershail × farmers practice) treatment (Table 1).

Table 1. Interaction effect of variety and treatment on yield and yield contributing characters at harvest.

Treatment	Plant height (cm)	Number of total tiller $hill^{-1}$	Number of effective tiller $hill^{-1}$	Number of non-effective tiller $hill^{-1}$	Panicle length (cm)	Number of grains $panicle^{-1}$	Number of sterile spikelets $panicle^{-1}$	1000-grain weight	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
V1R1	128.26g	11.35h	10.38k	0.97	22.59l	111.71h	15.3	16.38i	3.19h	3.91k	7.10n	44.88bcd
V1R2	138.46e	12.43g	11.63j	0.8	23.23k	120.83gh	15.25	16.92gh	3.36g	4.57i	7.94k	42.40gH
V1R3	151.71c	13.08f	12.04i	1.04	24.74fgh	138.60def	16.24	17.05gh	3.99e	5.20g	9.19h	43.3ef
V1R4	157.39b	15.18bc	14.24c	0.93	25.46cde	162.4ab	12.14	18.66de	4.74b	6.02d	10.76e	44.09dE
$V15_5$	155.58b	13.85de	13.47e	0.38	24.24hi	153.39bc	15.97	19.06cd	4.43d	5.93d	10.36f	42.76fg
V2R1	133.35f	12.64fg	11.93i	0.71	23.64jk	120.97gh	14.62	16.86h	3.33g	3.99jk	7.32m	45.49b
V_2R_2	144.92d	13.26ef	12.69h	0.57	24.06ij	132.76ef	14.95	17.35g	3.57f	4.63i	8.21j	43.5ef
V_2R_3	156.19b	13.96d	13.14f	0.82	25.46cde	145.55cd	15.66	18.02f	4.40d	5.45f	9.85g	44.64bcd
V_2R_4	160.64a	15.62b	14.85b	0.77	25.93abc	166.8a	11.34	19.38c	4.85b	6.64b	11.49c	42.20gh
V_2R_5	157.04b	14.90c	13.32e	1.57	24.91efg	159.3ab	16.05	19.28c	4.58c	6.45c	11.03d	41.55h
V_3R_1	135.25f	12.92fg	11.95i	0.96	24.59ghi	130.3fg	14.62	18.46e	3.64f	4.09j	7.74l	47.07a
V_3R_2	147.22d	13.90d	12.97g	0.93	25.15 dg	141.69de	14.95	19.21c	3.92e	4.75h	8.68i	45.20bc
V_3R_3	157.01b	14.81c	13.85d	0.95	26.09ab	154.43bc	15.66	20.12b	4.57c	5.75e	10.32f	44.26cde
V_3R_4	162.33a	16.46a	15.35a	1.11	26.34a	170.1a	11.34	20.70a	5.08a	6.77a	11.85a	42.85fg
V_3T_5	161.36a	15.13bc	14.37c	0.75	25.62bcd	165.6a	16.05	20.61a	4.98a	6.68ab	11.67b	42.72fg
LSD(0.05)	2.55	0.62	0.16	0.66	0.55	10.82	4.49	0.43	0.13	0.12	0.17	0.97
Level of significant	**	**	**	NS	**	**	NS	**	**	**	**	**
CV%	1.02	2.66	0.74	14.50	1.34	4.46	18.32	1.40	1.90	1.35	1.09	1.33

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.

Summary and Conclusion

Variety had significant effect on yield and yield contributing characters like number of total tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, number of grains $panicle^{-1}$, number of sterile spikelets panicle and grain yield. Kalozira had the highest grain yield because of its higher number effective tillers $hill^{-1}$, higher number of grains $panicle^{-1}$ and grain yield. On the other hand, BRRI dhan34 variety produced the lowest grain yield due to the higher number of sterile spikelets $panicle^{-1}$. Residues had also significant effect on yield and yield contributing characters. The highest grain yield was found in 3.0 t ha^{-1} treatment due to the production of higher number of effective tillers $hill^{-1}$, higher number of grain $panicle^{-1}$ and lower number of sterile spikelets $panicle^{-1}$. The lowest grain yield was produced in $R_{\cdot 1}$ treatment due to lower number of effective tillers $hill^{-1}$, lower number of grain $panicle^{-1}$ and higher number of sterile spikelets $panicle^{-1}$. Yield and yield contributing characters like effective tillers $hill^{-1}$, grains $panicle^{-1}$ and grain yield were significantly affected by the interaction between variety and residues. Kalozira under 3.0 t ha^{-1} treatment condition produced the highest grain and straw yield followed by the same variety. The lowest grain yield resulted from BRRI dhan34 variety under R_1 treatment.

From the above results it was found that the variety Kalozira and R_4 (*E. atropurpurea* and *F. dichotoma* residue at 3 t ha^{-1}) treatment exhibited the superior effect. Therefore, *E. atropurpurea* and *F. dichotoma* residue could be a potential source of weed management tool for sustainable crop production

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