*Original Research Article*

Allelopathic Effects of *Cyperus difformis* and *Eleocharis atropurpurea* along with Manures and Fertilizers on the Weed Growth in T. *Aman* Rice

ABSTRACT

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| --- |
| At present, the rice cultivation system is in search of a biological alternative to lessen the harmful effects of chemical herbicides, as it relies heavily on them for managing weeds. This is where allelopathy plays a role, offering a potential alternative to traditional weed control methods in rice farming through the use of residues from allelopathic plants. An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, from July 2019 to December 2019 to study the suppression of weed growth through *Cyperus difformis and* *Eleocharis atropurpurea* residues along with Manures and fertilizers in transplant *aman* rice. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Four weed species belonging to four different families infested the experimental plots. Weed population and weed dry weight were significantly affected by treatment. Highest weed population and and dry weight was found in T1 (control) for all weed variety while the minimum was found in T6 (Residues 3 t ha-1 + Vermicompost 2.5 t ha-1 + Fertilizers). The findings of this study demonstrate that combining plant residues with manures and fertilizers has the potential to suppress weed growth and improve the yield of transplanted Aman rice. Therefore, integrating plant residues with manures and fertilizers could serve as a sustainable and environmentally friendly approach for weed control and yield improvement in upcoming crop production seasons. |

*Keywords: Allelopathy; Rice, Manures; Fertilizers; Weed.*

1. INTRODUCTION

Rice is the most important food, eaten by more than half of the world’s population. 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). Geographic and agronomic conditions of Bangladesh are favorable for rice cultivation.

The average yield of rice in Bangladesh is almost less than 50% of the world average rice grain yield. About 75.61% of cropped area of Bangladesh is used for rice production. In the 2019-20 Financial Year, about 28.21 million acres of land of Bangladesh is used for rice cultivation with annual production of 36.60 million tons (BBS, 2020). *Aman* rice covers 13.74 million acres of land with a production of 14.20 million metric tons (BBS, 2020).

The factors which are responsible for reducing rice production, weeds are one of them which greatly affect the growth and production of rice yield. Weeds cause substantial decline in rice production. In our country, weed infestation reduces the grain yield by 70-80% in *aus* rice, 30-40% for transplanted *aman* rice and 22-36% for modern *boro* rice varieties (BRRI, 2008). It competes with rice plant for light, nutrient, space. As a result, grain yield of rice becomes affected due to weed. The prevailing climatic and edaphic conditions are very much favorable for luxuriant growth of numerous species of weeds that strongly compete with rice plant. Highly competitive ability of weeds exerts a serious negative effect on crop production causing significant losses in crop yield (Asha *et al*., 2025; Mia *et al*., 2023a).

Yield losses due to weed infestation and nutrition deficiency are greater than the combined losses of insect pests and diseases (Islam *et al*., 2024a)). The traditional method of weed control is hand weeding which is very much laborious and time consuming. Mechanical weeding and herbicides are the alternatives to hand weeding. Herbicides are effective in controlling weeds alone or in combination with hand weeding but it is harmful for the nature (Halder *et al*., 2024a; Ahmed *et al*., 2005). Herbicides in combination with hand weeding would help to obtain higher crop yield but its efforts high cost of production (Islam *et al*., 2024b; Sathyamoorthy *et al*., 2004).

In all rice ecosystems, herbicides have become one of the most important components in weed control. The reason for increased use of herbicides is the availability of cheaper herbicides, indicating that the cost of weed control by herbicides in wet-seeded rice is less than one-fifth of the cost of a single hand weeding (Hossain *et al*., 2024). But the repeated use of herbicides in rice to control weed has already led to the evolution of resistance in some weed species to several herbicides in several countries (Khatun *et al*., 2024). The conventional synthetic herbicides are becoming less and less effective against the resistant weed biotypes. Herbicide-resistant weeds pose the greatest threat to farmers when there are few or no other alternatives to control them (Asaduzzaman *et al*., 2023; Heap, 2014).

To overcome weed infestation presently, researchers are giving more emphasis using different plant residues to suppress weed growth. With rising human health and ecological concerns about the adverse effects of indiscriminate use of farm chemicals research on alternative weed management methods is underway worldwide (Mia *et al*., 2024b; Afroz *et al*., 2018). Exploitation of allelopathic potential of different crop/plant species for weed management under field conditions is one such approach (Popy *et al*., 2017).

Little researches have been conducted to find out the allelopathic potentiality of different plant species from Cyperaceae family, i.e., *C. esculentus* and *C.* *rotundus* (Johnson *et al*. 2007; Anwar *et al*., 2014). *Cyperus difformis* has been reported to evolve resistance to propanil and acetolactate synthase-inhibiting herbicides in rice fields of California (Valverde *et al*. 2014). *Eleocharis atropurpurea,* as noted one of major weeds of paddy rice, is widely distributed in Asia and Africa, as well as in other parts of the tropics. *E. atropurpurea* grows mainly in the moist soils but can also grow in aerated soils, acidic soils of volcanoes (Farhat *et al*., 2023) and in high saline soil (Siddika *et al*., 2024).

The reports on the allelopathy of *Cyperus difformis and* *Eleocharis atropurpurea* were scarcely found out in field conditions in Bangladesh. Only petri-dish experiments have been checked using their extract by Islam and Kato (2016) and Zaman and Kato (2018) and found both species had allelopathic potentiality against test species. *C. difformis and* *E. atropurpurea* shows allelopathy in lab condition and no field assessment yet to be checked.

Today environmental pollution is the burning issue to the people especially to researchers, scientists and they are very much concerned about its bad effect. Several factors are responsible for polluting the environment, herbicides and chemical fertilizers have a great contribution too (Salam *et al*., 2022). Now, it is the time to protect the soil environment by using allelochemicals instead of herbicides, organic fertilizers by reducing the use of chemical fertilizers. Combined use of manures and fertilizers with weed residues increases soil fertility and reduces the cost of chemical fertilization and weeding (Halder *et al*., 2024b).

Information regarding *C. difformis and* *E. atropurpurea* residues for weed management is highly scarce our country. Very few research works have been conducted to find out suitable weed control and nutrient management system in our country. The present study was, therefore, undertaken to develop an integrated weed control, nutrient management practice and yield performance.

2. material and methods

**2.1 Experimental location and site**

The experiment was carried out in the Agronomy field of Bangladesh Agricultural University (BAU), Mymensingh from July 2019 to December 2019. This region is under the Old Brahmaputra Floodplain, AEZ-9 and is defined by non-calcareous dark gray floodplain soil (Old Brahmaputra Alluvial Soil Tract). It is positioned at 24°75' N latitude and 90°50' E longitude with an average elevation of 18 meters above sea level.

**2.2 Experimental soil and weather**

The soil of the experimental field was more or less neutral in reaction with pH value 6.8, low in organic matter and fertility level. The land type was medium high with silty loam in texture. The physical and chemical characteristics of the soil of the experimental field have been presented in Table 1. The climate of the locality is tropical in nature and is characterized by high temperature and heavy rainfall during Kharif season (April to September) and scanty of rainfall associated with moderately low temperature during Rabi season (October to March). The climatic condition i.e. monthly average air temperature (0C), air pressure (mbs), wind speed (kmph), relative humidity (%), rainfall (mm) and sunshine (hour day-1) during the period of experiment have been presented in Table 2.

**Table 1. Soil properties of the experimental field**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Soil Properties** |  |
| **Physical** |  | **Chemical (0-15 cm depth)** |  |
| Particle size analysis  | 2.57 | Soil pH | 6.5 |
| Bulk density (g/ce) | 1.42 | Organic matter (%) | 1.30 |
| Porosity (%) | 44.7 | Total nitrogen (%) | 0.10 |
| Sand (%) (0.0-0.02 mm) | 21.75 | Available phosphorus (ppm) | 27 |
| Silt (1%) (0.02-0.002 mm) | 66.60 | Exchangeable potassium (me%) | 0.12 |
| Clay (%) (<0.002 mm) | 11.65 | Available Sulphur (ppm) | 22.7 |
| Soil textural class  | Silt loam  |  |  |
| Colour | Dark grey |  |  |
| Consistency  | Grounder  |  |  |

Source: Soil Science department, Bangladesh Agricultural University, Bangladesh

**Table 2. Distribution of monthly average air temperature relative humidity, rainfall and sunshine hours of the experiment site during the period from July to December 2019**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Month** | **\*\* Air temperature****(0C)** | **\*\* Relative humidity****(%)** | **\*\*Rainfall****(cm)** | **\*\* Sunshine (hrs)** |
| **Maximum** | **Minimum** | **Average** |
| July | 32.5 | 26.7 | 29.6 | 84.5 | 582.9 | 120.9 |
| August | 33.3 | 27.3  | 30.2 | 81.6 | 116.5 | 198.4 |
| September | 32.4 | 26.3 | 29.3 | 84.6 | 203.0 | 147 |
| October | 31.2 | 23.3  | 27.3 | 87.3 | 200.9 | 164.3 |
| November | 30.2 |  19.5 | 24.7  | 83.4 | 2.0 | 216 |
| December | 24.5 | 13.4 | 19.2 | 82.7 | 1.6 | 161.2 |

*\*\* Monthly average*

*Source: Weather Yard, Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh.*

**2.3 Experimental treatments and design**

The experimental treatment consisted of two factors. They are as follows: Factor A: Rice varieties: V1=Binadhan-13 and V2=BRRI dhan34.Factor B: Combination of manures and fertilizers with the residues of *Cyperus difformis* and *Eleocharis atropurpurea*: T1=Control, T2=Residues 3 t ha-1 + Cowdung 5 t ha-1, T3=Residues 3 t ha-1 + Cowdung 2.5 t ha-1 + Fertilizers (N = 55 kg ha-1, P= 30 kg ha-1, K = 25 kg ha-1, S = 15 kg ha-1),T4=Residues 3 t ha-1 + Vermicompost 5 t ha-1,T5=Residues 3 t ha-1 + Vermicompost 2.5 t ha-1 + Fertilizers (N = 55 kg ha-1, P = 30 kg ha-1, K = 25 kg ha-1, S = 15 kg ha-1),T6= Residues 3 t ha-1 + Trichocompost 10 t ha-1,T7= Residues 3 t ha-1 + Trichocompost 5 t ha-1 + Fertilizers (N = 55 kg ha-1, P = 30 kg ha-1, K = 25 kg ha-1, S = 15 kg ha-1).

The experiment was set up using three replications using a Randomized Complete Block Design. There were 42 plots in all. The unit plot measured 2 m by 2.5 m.

**2.4 Crop Husbandry**

**2.4.1 Collection and preparation of crop residues**

This study used residues from *Eleocharis atropurpurea* and *Cyperus difformis*. *Eleocharis atropurpurea* and *Cyperus difformis* plants were gathered at their peak vegetative stage from the Bangladesh Agricultural University's Agronomy Field and then allowed to dry in the shaded threshing floor. Finally, the residues were chopped into little bits with a sickle.

**2.4.2 Preparation of seedling nursery bed and seed sowing**

On July 1, 2019, the sprouting seeds were evenly distributed in a nursery bed that had been prepared thoroughly by a tractor. The nursery bed's robust seedlings were raised with the right attention. As needed, weeds were pulled from the nursery bed.

**2.4.3 Preparation of the experimental land**

The land was opened and thoroughly prepared with tractor followed by laddering. Weeds and stubbles were removed from the field during land preparation. Finally, the land was ready for transplantation and the field layout was done on the next day.

**2.4.4 Application of residues, manures and fertilizers**

The *Cyperus difformis* and *Eleocharis atropurpurea* residues along with manures were applied at 7 days before transplanting of *aman* rice at the time of final land preparation in accordance with experimental specification. After that crop residues were mixed well to the respective plots. According to treatment, urea, triple super phosphate, muriate of potash, and gypsum were used to fertilize the experimental plots. At the time of the last land preparation, the full amounts of gypsum, muriate of potash, and triple super phosphate were applied. Three doses of urea were administered at 15, 30, and 45 days after transplantation (DAT).

**2.4.5 Transplanting of seedlings**

Thirty-day-old seedlings were moved on July 30, 2019, at a pace of three seedlings per hill, with a spacing of 25 cm by 15 cm, on the prepared puddled field.

**2.5 Data Collection Parameters**

Five randomly chosen sample plants from each plot had their yield and yield-contributing characteristics documented based on the following criteria: plant height,  number of total tillers hill-1, number of effective tillers hill-1, number of non-effective tillers hill-1, grain yield (t ha-1), straw yield (t ha-1), biological yield (t ha-1), panicle length (cm), number of grains panicle-1, 1000-grain weight (g) and harvest index (%).

**2.6 Statistical analysis**

For statistical analysis, the recorded data were collated and tabulated. With the use of the computer program MSTAT, analysis of variance was completed. Duncan's Multiple Range Test was used to determine the mean differences between the treatments (Gomez and Gomez, 1984).

3. results and discussion

**3.1 Infested weed species in the experimental field**

Four weed species belonging to 4 different 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 3. The weeds of the experimental plots were Shama (*Echinochloa crusgalli L.*)*,* Shusni shak (*Marsilea quadrifolia L.),* Panikachu *(Monochoria vaginalis L.),* Sabuj nakful *(Cyperus difformis L.)* 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.*

**Table 3. Infested weed species found growing in the experimental plots in rice**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Local name** | **Scientific name** | **Family** | **Morphological type** | **Life cycle** |
| 1 | Shama | *Echinochloa crusgalli* L. | Poaceae | Grass | Annual |
| 2 | Shusni Shak | *Marsilea quadrifolia* L. | Marsileaceae | Broad leaved | Annual |
| 3 | Panikachu | *Monochoria vaginalis* L. | Pontederiacee | Broad leaved | Perennial |
| 4 | Sabuj nakful | *Cyperus difformis* L. | Cyperaceae | Sedge | Annual |

**3.2 Weed population and dry weight**

**3.2.1 *Echinochloa crusgalli* (shama)**

**3.2.1.1 Effect of variety**

Weed population and dry weight of shama were not significantly affected by variety. The weed population was highest at 25 DAT and was same (1.80) for both variety and lowest (1.14) was found in BRRI dhan34 at 50 DAT (Table 4). The highest weed dry weight (2.05 g) was obtained in BRRI dhan34 at 25 DAT and the lowest weed dry weight (1.64 g) was in Binadhan-13 at 50 DAT.

**Table 4. Effect of variety on weed population and dry weight of shama (*Echinochloa crusgalli*)**

|  |  |
| --- | --- |
| **Variety** | ***Echinochloa crusgalli*** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1 | 1.80 | 1.23 | 1.86 | 1.64 |
| V2 | 1.80 | 1.14 | 2.05 | 1.67 |
| LSD (0.05) | 0.39 | 0.51 | 0.38 | 0.77 |
| Level of significance | NS | NS | NS | NS |
| CV (%) | 14.03 | 27.73 | 13.78 | 23.15 |

*In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.NS = Not significant**, V1 =Binadhan-13, V2 = BRRI dhan34, 1 quadrate = 0.25 m × 0.25 m.*

**3.2.1.2 Effect of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

Weed population and dry weight of shama were significantly affected by combination of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea*. The highest weed population (4.66) was found in T1 (control) at 25 DAT and the lowest population (0.83) was found in T4 at 25 DAT, T3, T4, T5 and T7 treatment at 50 DAT (Table 5). The highest weed dry weight (4.97 g) was found in T1 (control) at 25 DAT treatment and the lowest weed dry weight (0.89 g) was in T5 at 25 DAT(Table 5). Similar findings were reported by Uddin and Pyon (2011) who found significant weed control efficacy by different crop residues.

**Table 5. Effect of combination** **of manures and fertilizers with the residues of *C. difformis* *and* *E. atropurpurea*** **on weed population and dry weight of shama (*Echinochloa crusgalli*)**

|  |  |
| --- | --- |
| **Crop residues** | ***Echinochloa crusgalli*** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| T1 | 4.66a | 2.83a | 4.97a | 3.48a |
| T2 | 1.66b | 1.16b | 1.58bc | 1.66b |
| T3 | 1.50bc | 0.83b | 1.83b | 1.26b |
| T4 | 1.50bc | 0.83b | 1.59bc | 1.21b |
| T5 | 0.83c | 0.83b | 0.89c | 1.08b |
| T6 | 1.33bc | 1.00b | 1.45bc | 1.50b |
| T7 | 1.16bc | 0.83b | 1.39bc | 1.41b |
| LSD (0.05) | 0.73 | 0.95 | 0.71 | 1.44 |
| Level of significance | \*\* | \*\* | \*\* | \*\* |
| CV (%) | 14.03 | 27.73 | 13.78 | 23.15 |

*In a column, figures with the same letter do not differ significantly as per DMRT. \*\* = Significant at 1% level of probability, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.1.3 Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

The interaction between variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea* was found nonsignificant at 25 DAT and to be significant at 50 DAT of weed population and dry weight. The highest weed population (5.00) was found inV1T1 (Binadhan-13 × control) and the lowest (0.66) was found in V2T5 (BRRI dhan34 × residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1)) at 25 DAT and V1T3 (Binadhan-13 × residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1)), V1T4 (Binadhan-13 × residues 3 t ha-1+vermicompost 5 t ha-1) , V1T7 (Binadhan-13 × residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), V2T5 (BRRI dhan34 × residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1) at 50 DAT treatment (Table 6). The highest weed dry weight (4.98 g) was found in V1T1 (Binadhan-13 × control), and the lowest weed dry weight (0.87 g) was in V1T5 (Binadhan-13 × residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers (N=55 kg ha-1, P=30 kg ha-1, K=25 kg ha-1, S=15 kg ha-1)) (Table 6).

**Table 6. Combined effect of interaction of variety and** **manures and fertilizers with residues of *C. difformis* *and* *E.******atropurpurea*** **on weed population and dry weight of shama (*Echinochloa crusgalli*)**

|  |  |
| --- | --- |
| **Interaction** | ***Echinochloa crusgalli*** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1T1 | 5.00 | 3.33a | 4.98 | 3.81a |
| V1T2 | 1.66 | 1.33bc | 1.78 | 1.82abc |
| V1T3 | 1.33 | 0.66c | 1.50 | 1.04c |
| V1T4 | 1.33 | 0.66c | 1.18 | 0.94c |
| V1T5 | 1.00 | 1.00bc | 0.87 | 1.08c |
| V1T6 | 1.33 | 1.00bc | 1.60 | 1.46bc |
| V1T7 | 1.00 | 0.66c | 1.15 | 1.36bc |
| V2T1 | 4.33 | 2.33ab | 4.96 | 3.15ab |
| V2T2 | 1.66 | 1.00bc | 1.39 | 1.50bc |
| V2T3 | 1.66 | 1.00bc | 2.15 | 1.47bc |
| V2T4 | 1.66 | 1.00bc | 2.00 | 1.48bc |
| V2T5 | 0.66 | 0.66c | 0.92 | 1.09c |
| V2T6 | 1.33 | 1.00bc | 1.30 | 1.54bc |
| V2T7 | 1.33 | 1.00bc | 1.63 | 1.46bc |
| LSD (0.05) | 1.03 | 1.35 | 1.01 | 2.04 |
| Level of significance | NS | \* | NS | \* |
| CV (%) | 14.03 | 27.73 |  | 23.15 |

*In a column, figures with the same letter do not differ significantly as per DMRT. \* =Significant at 5% level of probability, NS = Not significant, V1 =Binadhan-13, V2 = BRRI dhan34, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.2 *Marsilea quadrifolia* L. (Shusni Shak)**

**3.2.2.1 Effect of variety**

Weed population and dry weight of Shusni shakgrass were significantly affected by variety at 25 DAT and nonsignificant at 50 DAT. The highest weed population was found in (3.80) Binadhan-13 at 25 DAT and the lowest weed population was found in (1.80) BRRI dhan34 at 50 DAT (Table 7). The highest weed dry weight (0.65 g) was found in Binadhan-13 at 25 DAT and the lowest weed dry weight (0.30 g) was in BRRI dhan34 at 50 DAT.

**Table 7. Effect of variety on weed population and dry weight of Shusni Shak (*Marsilea quadrifolia* L.)**

|  |  |
| --- | --- |
| **Variety** | ***Marsilea quadrifolia* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1 | 3.80a | 2.23 | 0.65a | 0.41 |
| V2 | 2.90b | 1.80 | 0.54b | 0.30 |
| LSD (0.05) | 0.43 | 0.71 | 0.08 | 0.14 |
| Level of significance | \*\* | NS | \*\* | NS |
| CV (%) | 10.20 | 25.10 | 11.95 | 21.33 |

*In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. \*\* = Significant at 1% level of probability, NS = Not significant, V1 =Binadhan-13, V2 = BRRI dhan34, 1 quadrate = 0.25 m × 0.25 m.*

**3.2.2.2 Effect of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

Weed population and dry weight of shusni shakwere significantly affected by combination of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea*. The highest weed population (6.50) was found in T1 at 25 DAT(control) and the lowest (1.33) was found in T4, T5 and T6 treatment at 50 DAT (Table 8). The highest weed dry weight (1.25 g) was found in T1 at 25 DAT(control) treatment and the lowest weed dry weight (0.24 g) was in T5 treatment at 50 DAT (Table 8).

**Table 8. Effect of combination of manures and fertilizers with the residues of *C****.* ***difformis* *and* *E. atropurpurea*** **on weed population and dry weight of Shusni Shak (*Marsilea quadrifolia* L.)**

|  |  |
| --- | --- |
| **Crop residues** | ***Marsilea quadrifolia* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| T1 | 6.50a | 4.66a | 1.25a | 0.80a |
| T2 | 3.66b | 2.00b | 0.61b | 0.35b |
| T3 | 3.00bc | 2.00b | 0.51bcd | 0.36b |
| T4 | 2.33cd | 1.33b | 0.36d | 0.20b |
| T5 | 3.33b | 1.33b | 0.54bc | 0.24b |
| T6 | 2.16d | 1.33b | 0.40cd | 0.26b |
| T7 | 2.50cd | 1.50b | 0.49bcd | 0.28b |
| LSD (0.05) | 0.80 | 1.32 | 0.15 | 0.26 |
| Level of significance | \*\* | \*\* | \*\* | \*\* |
| CV (%) | 10.20 | 25.10 | 11.95 | 21.33 |

*In a column, figures with the same letter do not differ significantly as per DMRT. \*\* = Significant at 1% level of probability,T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.2.3 Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

The interaction between variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea* was found to be significant on weed population and dry weight of shusni shak. The highest shusni shak(6.66) was found in V1T1 (Binadhan-13 × control) at 25 DAT and the lowest was found in V2T4 (BRRI dhan34 × residues 3 t ha-1+vermicompost 5 t ha-1) treatment at 50 DAT (Table 9). The highest weed dry weight (1.27g) was found in V1T1 (Binadhan-13 × control) at 25 DAT and the lowest weed dry weight (0.14) was in V2T4 (BRRI dhan34 × residues 3 t ha-1 +vermicompost 5 t ha-1) at 50 DAT.

**Table 9. Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea*** **on weed population and dry weight of Susni Shak (*Marsilea quadrifolia* L.).**

|  |  |
| --- | --- |
| **Interaction** | ***Marsilea quadrifolia* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1T1 | 6.66a | 4.66a | 1.27a | 0.82a |
| V1T2 | 4.66b | 2.66b | 0.80b | 0.48abc |
| V1T3 | 3.33c | 2.33b | 0.51c | 0.42bc |
| V1T4 | 3.33c | 1.66b | 0.47cd | 0.26c |
| V1T5 | 3.33c | 1.33b | 0.48cd | 0.26c |
| V1T6 | 3.00c | 1.33b | 0.54c | 0.28c |
| V1T7 | 2.33cd | 1.66b | 0.46cde | 0.36c |
| V2T1 | 6.33a | 4.66a | 1.22a | 0.78ab |
| V2T2 | 2.66c | 1.33b | 0.42cde | 0.23c |
| V2T3 | 2.66c | 1.66b | 0.50c | 0.31c |
| V2T4 | 1.33d | 1.00b | 0.24e | 0.14c |
| V2T5 | 3.33c | 1.33b | 0.60bc | 0.23c |
| V2T6 | 1.33d | 1.33b | 0.26de | 0.25c |
| V2T7 | 2.66c | 1.33b | 0.53c | 0.19c |
| LSD (0.05) | 1.13 | 1.87 | 0.22 | 0.37 |
| Level of significance | \*\* | \* | \*\* | \* |
| CV (%) | 10.20 | 25.10 | 11.95 | 21.33 |

*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, V1 =**Binadhan-13, V2 = BRRI dhan34, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.3 *Monochoria vaginalis* (Panikachu)**

**3.2.3.1 Effect of variety**

Weed population and dry weight of panikachu were significantly affected by variety at 25 DAT and non-significant at 50 DAT. The highest weed population (3.19) was found in BRRI dhan34 at 25 DAT and the lowest weed population was (1.66) found in Binadhan-13 at 50 DAT (Table 10). The highest weed dry weight (1.60 g) was found in BRRI dhan34 at 25 DAT and the lowest weed dry weight (0.52 g) was in Binadhan-13 at 50 DAT (Table 10).

**Table 10.** **Effect of variety on weed population and dry weight of Panikachu (*Monochoria vaginalis*)**

|  |  |
| --- | --- |
| **Variety** | ***Monochoria vaginalis*** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1 | 2.33b | 1.66 | 1.12b | 0.54 |
| V2 | 3.19a | 1.76 | 1.60a | 0.62 |
| LSD (0.05) | 0.45 | 0.55 | 0.21 | 0.15 |
| Level of significance | \*\* | NS | \*\* | NS |
| CV (%) | 15.70 | 21.34 | 14.43 | 20.92 |

*In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. \*\* = Significant at 1% level of probability, NS = Not significant, V1 =Binadhan-13, V2 = BRRI dhan34, 1 quadrate = 0.25 m × 0.25 m.*

**3.2.3.2 Effect of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

Weed population and dry weight of panikachu were significantly affected by combination of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea*. The highest weed population (5.00) was found in T1 (control) at 25 DAT and the lowest (1.16) was found in T4 (residues 3 t ha-1+vermicompost 5 t ha-1) andT5 (residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers (N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1)) treatment at 50 DAT. The highest weed dry weight (3.51 g) was found in T1 at 25 DAT and the lowest weed dry weigh (0.62) was in T6 treatment at 25 DAT.

**Table 11. Effect of combination of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea* on weed population and dry weight of Panikachu (*Monochoria vaginalis*)**

|  |  |
| --- | --- |
| **Crop residues** | ***Marsilea quadrifolia* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| T1 | 5.00a | 3.66a | 3.51a | 2.72a |
| T2 | 2.83b | 1.66b | 1.02bcd | 1.00b |
| T3 | 2.33b | 1.33b | 1.24b | 0.82b |
| T4 | 2.00b | 1.16b | 0.81cd | 0.65b |
| T5 | 2.33b | 1.16b | 1.07bc | 0.64b |
| T6 | 2.50b | 1.50b | 0.62d | 0.81b |
| T7 | 2.33b | 1.50b | 1.22b | 1.02b |
| LSD (0.05) | 0.84 | 1.04 | 0.39 | 0.70 |
| Level of significance | \*\* | \*\* | \*\* | \*\* |
| CV (%) | 15.70 | 21.34 | 14.43 | 23.92 |

*In a column, figures with the same letter do not differ significantly as per DMRT. \*\* = Significant at 1% level of probability, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.3.3 Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

The interaction between variety and manures and fertilizers with residues of *Cyperus difformis* (L.) *and* *Eleocharis atropurpurea*was found to be significant on weed population and dry weight of panikachu. The highest panikachu weed population (7.67) was found in V1T1 at 25 DAT, and the lowest (1.00) was found in V2T4 and V2T5 (BRRI dhan34 × residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers (N=55 kg ha-1, P=30 kg ha-1, K=25 kg ha-1, S=15 kg ha-1) at 50 DAT (Table 10). The highest weed dry weight (3.60 g) was found in V1T1 at 25 DAT (Binadhan-13× control), and the lowest weed dry weight (0.52 g) was in V2T4 (BRRI dhan34 × residues 3 t ha-1 +vermicompost 5 t ha-1).

**Table 12. Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea* on weed population and dry weight of panikachu (*Monochoria vaginalis*)**

|  |  |
| --- | --- |
| **Interaction** | ***Marsilea quadrifolia* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1T1 | 4.66ab | 3.33ab | 3.60a | 2.15b |
| V1T2 | 2.00efg | 1.33c | 0.93de | 0.77c |
| V1T3 | 1.33g | 1.00c | 0.69de | 0.66c |
| V1T4 | 1.66fg | 1.33c | 0.95de | 0.79c |
| V1T5 | 1.66fg | 1.33c | 0.54e | 0.64c |
| V1T6 | 2.66cdef | 1.66c | 0.60de | 0.77c |
| V1T7 | 2.33defg | 1.66c | 0.52e | 1.34bc |
| V2T1 | 5.33a | 4.00a | 3.43a | 3.28a |
| V2T2 | 3.66bc | 2.00bc | 1.11cd | 1.23bc |
| V2T3 | 3.33cd | 1.66c | 1.79b | 0.98c |
| V2T4 | 2.33defg | 1.00c | 0.66de | 0.52c |
| V2T5 | 3.00cde | 1.00c | 1.60bc | 0.64c |
| V2T6 | 2.33defg | 1.33c | 0.65de | 0.86c |
| V2T7 | 2.33defg | 1.33c | 1.93b | 0.70c |
| LSD (0.05) | 1.19 | 1.48 | 0.56 | 0.99 |
| Level of significance | \*\* | \* | \*\* | \* |
| CV (%) | 15.70 | 21.34 | 14.43 | 23.92 |

*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, V1 =**Binadhan-13, V2 = BRRI dhan34, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.4 *Cyperus difformis* L. (****Sabuj nakful)**

**3.2.4.1 Effect of variety**

Weed population and dry weight of Sabuj nakful were not significantly affected by variety. The highest weed population in (2.19) was found in Binadhan-13 at 25 DAT and the lowest weed population (0.90) was obtained in Binadhan-13 at 50 DAT. The highest weed dry weight (0.62 g) was BRRI dhan34 at 25 DAT and the lowest weed dry weight (0.21 g) was in Binadhan-13 at 50 DAT.

**Table 13. Effect of variety on weed population and dry weight of Sabuj nakful (*Cyperus difformis* L.)**

|  |  |
| --- | --- |
| **Variety** | ***Cyperus difformis* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1 | 2.19 | 0.90 | 0.54 | 0.21 |
| V2 | 2.38 | 1.28 | 0.62 | 0.29 |
| LSD (0.05) | 0.57 | 0.54 | 0.15 | 0.13 |
| Level of significance | NS | NS | NS | NS |
| CV (%) | 19.32 | 28.25 | 20.92 | 30.72 |

*In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. NS = Not significant, V1 =Binadhan-13, V2 = BRRI dhan34, 1 quadrate = 0.25 m × 0.25 m.*

**3.2.4.2 Effect of** **manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

Weed population and dry weight of Sabuj nakful were significantly affected by combination of manures and fertilizers with residues of *Cyperus difformis* (L.) *and* *Eleocharis atropurpurea* at 25 DAT. The highest weed population (4.16) was found in T1 (Control) treatment at 25 DAT and the lowest was found in T7 (residues 3 t ha-1+trichocompost 5 t ha-1+ fertilizers (N=55 kg ha-1, P=30 kg ha-1, K=25 kg ha-1, S=15 kg ha-1)) treatment (0.66) at 50 DAT. The highest weed dry weight (1.07 g) was found in T1 treatment at 25 DAT, and the lowest weed dry weight (0.15 g) was in T7 treatment at 25 DAT.

**Table 14. Effect of combination of manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea* on weed population and dry weight of** **Sabuj nakful (*Cyperus difformis* L.)**

|  |  |
| --- | --- |
| **Crop residues** | ***Cyperus difformis* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| T1 | 4.16a | 2.00 | 1.07a | 0.47 |
| T2 | 1.66b | 0.83 | 0.44b | 0.21 |
| T3 | 1.83b | 1.00 | 0.53b | 0.19 |
| T4 | 2.33b | 1.33 | 0.63b | 0.30 |
| T5 | 1.66b | 0.83 | 0.46b | 0.16 |
| T6 | 2.33b | 1.00 | 0.52b | 0.24 |
| T7 | 2.00b | 0.66 | 0.40b | 0.15 |
| LSD (0.05) | 1.06 | 1.02 | 0.28 | 0.24 |
| Level of significance | \*\* | NS | \*\* | NS |
| CV (%) | 19.32 | 28.25 | 20.92 | 30.72 |

*In a column, figures with the same letter do not differ significantly as per DMRT. \*\* = Significant at 1% level of probability, \* =Significant at 5% level of probability, NS = Not significant, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**3.2.4.3 Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea***

The interaction between variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea*was found to be nonsignificant on weed population and dry weight of Sabuj Nakful but dry weight at 25 DAT. The highest sabuj nakful weed population was (4.00) found in V1T1 (Binadhan-13 x Control)at 25 DAT and the lowest (0.66) was found in V1T2 (Binadhan-13 x residues 3 t ha-1+cowdung 5 t ha-1), V1T3 (Binadhan-13 x residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1)), V1T5 (Binadhan-13 x residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1) )and V1T7 (Binadhan-13 x residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1)treatment (Table 15) at 50 DAT. The highest weed dry weight (1.06 g) was found in V1T1 at 25 DAT and the lowest weed dry weight (0.12 g) was in V1T3 at 50 DAT.

**Table 15. Combined effect of interaction of variety and manures and fertilizers with residues of *C. difformis* *and* *E. atropurpurea* on weed population and dry weight of Sabuj nakful (*Cyperus difformis* L.)**

|  |  |
| --- | --- |
| **Interaction** | ***Cyperus difformis* L.** |
| **Weed population****(no./quadrate)** | **Dry weight****(g/quadrate)** |
| **25 days** | **50 days** | **25 days** | **50 days** |
| V1T1 | 4.00 | 1.66 | 1.06ab | 0.38 |
| V1T2 | 1.66 | 0.66 | 0.47cd | 0.19 |
| V1T3 | 1.33 | 0.66 | 0.37d | 0.12 |
| V1T4 | 1.66 | 1.00 | 0.41d | 0.21 |
| V1T5 | 1.66 | 0.66 | 0.47cd | 0.13 |
| V1T6 | 2.33 | 1.00 | 0.54cd | 0.24 |
| V1T7 | 2.66 | 0.66 | 0.44d | 0.15 |
| V2T1 | 4.33 | 2.33 | 1.09a | 0.56 |
| V2T2 | 1.66 | 1.00 | 0.41d | 0.23 |
| V2T3 | 2.33 | 1.33 | 0.69bcd | 0.26 |
| V2T4 | 3.00 | 1.66 | 0.85abc | 0.39 |
| V2T5 | 1.66 | 1.00 | 0.45d | 0.20 |
| V2T6 | 2.33 | 1.00 | 0.50cd | 0.24 |
| V2T7 | 1.33 | 0.66 | 0.37d | 0.14 |
| LSD (0.05) | 1.51 | 1.44 | 0.40 | 0.34 |
| Level of significance | NS | NS | \* | NS |
| CV (%) | 19.32 | 28.25 | 20.92 | 30.72 |

*In a column, figures with the same letter do not differ significantly as per DMRT. \* =Significant at 5% level of probability, NS = Not significant, V1 =**Binadhan-13, V2 = BRRI dhan34, T1=control, T2=residues 3 t ha-1+cowdung 5 t ha-1, T3=residues 3 t ha-1+cowdung 2.5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T4=residues 3 t ha-1+vermicompost 5 t ha-1, T5= residues 3 t ha-1+vermicompost 2.5 t ha-1+ fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1), T6=residues 3 t ha-1+trichocompost 10 t ha-1, T7= residues 3 t ha-1+trichocompost 5 t ha-1+fertilizers(N=55 kg ha-1 ,P=30 kg ha-1,K=25 kg ha-1,S=15 kg ha-1).*

**4. Conclusion**

The study found that weed population and weed dry weight were significantly influenced by the crop variety, the residues of *Cyperus difformis* and *Eleocharis atropurpurea*, the use of manures and fertilizers, as well as their interactions. Among the treatments, the highest weed population and dry weight for all weed species were recorded in the control treatment (T1), where no residues or nutrient inputs were applied. The findings suggest that the combined use of *Cyperus difformis* and *Eleocharis atropurpurea* residues exhibited herbicidal properties, effectively suppressing weed growth. Additionally, the integration of manures and fertilizers contributed to improved crop yield and associated yield parameters. Thus, incorporating these weed residues along with organic and inorganic fertilizers presents a promising, eco-friendly strategy for effective weed control and enhanced productivity in sustainable crop production systems.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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